

**MOTOROLA SOLUTIONS**

TESTING CERT # 2518.01

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

**Motorola Solutions, Inc**  
**EME Test Laboratory**  
 8000 West Sunrise Blvd  
 Fort Lauderdale, FL. 33322

**Date of Report:** 12/11/2014  
**Report Revision:** A

**Responsible Engineer:** Deanna Zakharia (Plantation Lab Director EME Test Lab)  
**Report Author:** Tan Kai Yan (EME Engineer)  
**Date/s Tested:** 10/01/14 – 10/15/14  
**Manufacturer/Location:** Motorola Solutions, Inc, Penang  
**Sector/Group/Div.:** EMS  
**Date submitted for test:** 09/12/14  
**DUT Description:** RDU4100+ UHF BRUS 10CH Non-Display, Removable Antenna, 4.0 Watts, Black, Li-Ion; &  
 RDU4160+ UHF BRUS 16CH Display, Removable Antenna 4.0 Watts, Black, Li-Ion  
**Test TX mode(s):** TDMA (PTT)  
**Max. Power output:** 4.2 W  
**Nominal Power:** 4.0 W  
**Tx Frequency Bands:** 438-470 MHz  
**Signaling type:** FM  
**Model(s) Tested:** PMUE4599A & PMUE4618A  
**Model(s) Certified:** PMUE4599A & PMUE4618A  
**Serial Number(s):** 11 & 6  
**Classification:** Occupational/Controlled  
**FCC ID:** AZ489FT4923; (438-470 MHz)  
**IC :** 109U-89FT4923 ; (450-470 MHz)

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 47 CFR 2.1093(d). 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.

**Deanna Zakharia**  
**EME Lab Senior Resource Manager,**  
**Laboratory Director**  
**Approval Date:** 12/12/2014

**Deanna**  
**Zakharia**

Digitally signed by Deanna Zakharia  
 DN: cn=Deanna Zakharia, o=Motorola  
 Solutions, ou=Regulatory Compliance  
 Lab, email=ed015@motorolasolutions.com,  
 c=US  
 Date: 2014.12.12 07:47:37 -0500

**Certification Date:** 10/23/2014

**Certification No.** L1141010P &  
 L1141011P

**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 .....                 | 4  |
| 5.0    | SAR Limits .....                                          | 6  |
| 6.0    | Description of Device Under Test (DUT) .....              | 6  |
| 7.0    | Optional Accessories and Test Criteria.....               | 7  |
| 7.1    | Antenna.....                                              | 7  |
| 7.2    | Battery.....                                              | 7  |
| 7.3    | Body worn Accessory .....                                 | 7  |
| 7.4    | Audio Cable 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 .....                      | 11 |
| 11.0   | Environmental Test Conditions .....                       | 12 |
| 12.0   | DUT Test Setup and Methodology.....                       | 12 |
| 12.1   | Measurements .....                                        | 12 |
| 12.2   | DUT Configuration(s).....                                 | 13 |
| 12.3   | DUT Positioning Procedures .....                          | 13 |
| 12.3.1 | Body.....                                                 | 13 |
| 12.3.2 | Head .....                                                | 13 |
| 12.3.3 | Face.....                                                 | 13 |
| 12.4   | DUT Test Channels .....                                   | 13 |
| 12.5   | SAR Result Scaling Methodology.....                       | 14 |
| 12.6   | DUT Test Plan .....                                       | 14 |
| 13.0   | DUT Test Data.....                                        | 15 |
| 13.1   | Assessments at the Body.....                              | 15 |
| 13.2   | Assessments at the Face.....                              | 16 |
| 13.3   | Assessments for Industry Canada .....                     | 16 |
| 13.4   | Shortened Scan Assessment.....                            | 16 |
| 14.0   | Simultaneous Transmission Exclusion .....                 | 17 |
| 15.0   | Results Summary .....                                     | 17 |
| 16.0   | Variability Assessment .....                              | 17 |
| 17.0   | System Uncertainty .....                                  | 17 |

**APPENDICES**

|   |                                       |    |
|---|---------------------------------------|----|
| A | Measurement Uncertainty Budget .....  | 18 |
| B | Probe Calibration Certificates .....  | 20 |
| C | Dipole Calibration Certificates ..... | 35 |

**Part 2 of 2****APPENDICES**

|   |                                                   |    |
|---|---------------------------------------------------|----|
| D | System Verification Check Scans .....             | 2  |
| E | DUT Scans .....                                   | 6  |
| F | Shortened Scan of Highest SAR Configuration ..... | 10 |
| G | DUT Power Slump .....                             | 12 |
| H | DUT Test Position Photos .....                    | 13 |
| I | DUT, Body worn and audio accessories Photos ..... | 14 |

**Report Revision History**

| Date       | Revision | Comments                 |
|------------|----------|--------------------------|
| 10/23/2014 | O        | Initial release          |
| 12/11/2014 | A        | References updated Pg. 5 |

## 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 model number PMUE4599A and PMUE4618A. These devices are classified as Occupational/Controlled.

## 2.0 FCC SAR Summary

**TABLE 1**

| Equipment Class       | Frequency band (MHz) | Max Calc at Body (W/Kg) |         | Max Calc at Face (W/Kg) |         | Max Calc at Head (W/Kg) |         |
|-----------------------|----------------------|-------------------------|---------|-------------------------|---------|-------------------------|---------|
|                       |                      | 1g-SAR                  | 10g-SAR | 1g-SAR                  | 10g-SAR | 1g-SAR                  | 10g-SAR |
| TNF                   | 438-470              | 2.18                    | 1.59    | 2.34                    | 1.75    | NA                      | NA      |
| *Simultaneous Results |                      | NA                      | NA      | NA                      | NA      | NA                      | NA      |

## 3.0 Abbreviations / Definitions

CNR: Calibration Not Required  
 EME: Electromagnetic Energy  
 DUT: Device Under Test  
 NA: Not Applicable  
 PTT: Push to Talk  
 SAR: Specific Absorption Rate  
 RSM: Remote Speaker Microphone  
 FM: Frequency Modulation  
 IF: Intermediate Frequency  
 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

These products are designed to comply with the following applicable national and international standards and guidelines.

- IEC62209-1\*(2005) Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)

- Federal Communications Commission, “Evaluating Compliance with FCC Guidelines for Human Exposure to Radio frequency Electromagnetic Fields”, OET Bulletin 65, FCC, Washington, D.C.:1997.
- IEEE 1528\*(2003), Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques
- American National Standards Institute (ANSI) / Institute of Electrical and Electronics Engineers (IEEE) C95. 1-1992
- Institute of Electrical and Electronics Engineers (IEEE) C95.1-2005
- International Commission on Non-Ionizing Radiation Protection (ICNIRP) 1998
- Ministry of Health (Canada) Safety Code 6 (2009), Limits of Human Exposure to Radio frequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz
- Australian Communications Authority Radio communications (Electromagnetic Radiation - Human Exposure) Standard (2003)
- ANATEL, Brazil Regulatory Authority, Resolution No. 303 of July 2, 2002 "Regulation of the limitation of exposure to electrical, magnetic, and electromagnetic fields in the radio frequency range between 9 kHz and 300 GHz." and “Attachment to resolution # 303 from July 2, 2002”
- IEC62209-2 Edition 1.0 2010-03, Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures – Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz).

(\* )The IEC62209-1 and IEEE 1528 are applicable for hand-held devices used in close proximity to the ear only.

- FCC KDB – 648474 D04 SAR Evaluation Considerations for Wireless Handsets v01r02 (12/04/2013)
- FCC KDB – 643646 D01 SAR Test for PTT Radios v01r01 (04/04/2011)
- FCC KDB – 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r03 (02/07/2014)  
D02 RF Exposure Reporting v01r01 (05/28/2013)
- FCC KDB – 447498 D01 General RF Exposure Guidance v05r02 (02/07/2014)

## 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)

These portable devices operate using Zero Intermediate Frequency (IF) with analog Frequency Modulation (FM) signaling incorporating traditional simplex two-way radio transmission protocol. These models intended use are to be 5-5-90 (5% TX, 5% RX and 90% standby), with a maximum duty cycle of 50%.

The models represented under this filing utilize removable antennas capable of transmitting in the 438-470 MHz band respectively. The nominal output powers are 4.0 W with maximum output powers of 4.2 W as defined by upper limit of the production line final test station. 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.

Models PMUE4599A and PMUE4618A are being offered with the accessories listed in section 7.0.

## 7.0 Optional Accessories and Test Criteria

These devices is offered with optional accessories. All accessories were individually evaluated during the test plan creation to determine if testing was required per the guidelines outlined in section 4.0 to assess compliance of these devices. The following sections identify the test criteria and details for each accessory category.

### 7.1 Antenna

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

**TABLE 3**

| Antenna Models | Description                                     | Selected for test | Tested |
|----------------|-------------------------------------------------|-------------------|--------|
| 8575099C01     | Helical antenna, 403-470MHz, ¼ wave, 3 dBi gain | Yes               | Yes    |

### 7.2 Battery

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

**TABLE 4**

| Battery Models | Description                   | Selected for test | Tested | Comments |
|----------------|-------------------------------|-------------------|--------|----------|
| 60012000001    | Ultra high cap Li-Ion 2400mAh | Yes               | Yes    |          |

### 7.3 Body worn Accessory

There is one body worn accessory offered for this product. The table below lists the body worn accessory, and body worn accessory description.

**TABLE 5**

| Body worn Models | Description             | Selected for test | Tested | Comments |
|------------------|-------------------------|-------------------|--------|----------|
| 4280383X62       | Spring Action Belt Clip | Yes               | Yes    |          |

### 7.4 Audio Cable Accessories

All offered audio cable accessories were considered. The table below lists the audio cable accessories and their descriptions. Exhibit 7B illustrates photos of the tested audio accessories.

**TABLE 6**

| Audio Acc. Models | Description                             | Selected for test | Tested | Comments                                                 |
|-------------------|-----------------------------------------|-------------------|--------|----------------------------------------------------------|
| HKLN4604A         | Swivel Earpiece W/PTT (RLN6423F)        | Yes               | Yes    |                                                          |
| HKLN4606A         | Remote Speaker Mic (53862F)             | Yes               | No     | Intended for test. Per KDB provisions test not required. |
| HKLN4601A         | Dual Pin Surveillance W/PTT (HKLN4477F) | Yes               | No     | Intended for test. Per KDB provisions test not required. |
| HKLN4605A         | EarBud W clip PTT Mic (53866F)          | Yes               | No     | Intended for test. Per KDB provisions test not required. |
| HKLN4599A         | Earpiece with in-line PTT Mic (56517F)  | No                | No     | By similarity to HKLN4604A                               |

## 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>(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 EME 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 ID (s)       | Material Parameters                                   | Phantom Dimensions LxWxD (mm) | Material Thickness (mm) | Support Structure Material | Loss Tangent (Wood) |
|--------------|----------------------|-------------------------------------------------------|-------------------------------|-------------------------|----------------------------|---------------------|
| Dual Flat    | NA                   | 300MHz -6GHz;<br>Er = 4+/- 1,<br>Loss Tangent = ≤0.05 | 600x400x190                   | 2mm<br>+/- 0.2mm        | Wood                       | < 0.05              |
| SAM          | NA                   |                                                       |                               |                         |                            |                     |
| Elliptical   | OVAL1019<br>OVAL1020 |                                                       |                               |                         |                            |                     |

## 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 (by mass)

**TABLE 9**

| Ingredients       | 450 MHz |       |
|-------------------|---------|-------|
|                   | Head    | Body  |
| Sugar             | 56.0    | 46.5  |
| Diacetin          | 0       | 0     |
| De ionized –Water | 39.1    | 50.53 |
| Salt              | 3.8     | 1.87  |
| HEC               | 1.0     | 1.0   |
| Bacteria          | 0.1     | 0.1   |

## 9.0 Additional Test Equipment

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

**TABLE 10**

| <b>Equipment Type</b>                          | <b>Model Number</b> | <b>Serial Number</b> | <b>Calibration Date</b> | <b>Calibration Due Date</b> |
|------------------------------------------------|---------------------|----------------------|-------------------------|-----------------------------|
| Power Meter (Agilent)                          | E4419B              | MY45103725           | 3/3/2014                | 3/3/2015                    |
| E-Series Avg. Power Sensor (Agilent)           | E9301B              | MY41495730           | 4/10/2014               | 4/10/2015                   |
| E-Series Avg. Power Sensor                     | E9301B              | MY41495733           | 4/10/2014               | 4/10/2015                   |
| Power Meter (HP)                               | E4418B              | US39251267           | 1/27/2014               | 1/27/2015                   |
| Power Sensor (HP)                              | 8481B               | 3318A10982           | 4/9/2014                | 4/9/2015                    |
| Signal Generator (Agilent)                     | E4428C              | MY47381119           | 6/7/2013                | 6/7/2015                    |
| Bi-Dir. Coupler (NARDA)                        | 40296               | 40296                | 1/31/2014               | 1/31/2016                   |
| AMP (Amplifier Research)                       | 1W1000              | 16625                | CNR                     | CNR                         |
| AMP (Amplifier Research)                       | 10W1000             | 5924                 | CNR                     | CNR                         |
| Dickson Temperature Recorder                   | TM320               | 7081356              | 9/16/2014               | 9/16/2015                   |
| Dickson Temperature Recorder                   | TM325               | 12121144             | 5/16/2014               | 5/16/2015                   |
| Omega Digital Thermometer with J Type TC Probe | HH200A              | 20857                | 10/23/2013              | 10/23/2014                  |
| Omega Digital Thermometer with J Type TC Probe | HH200A              | 48870                | 6/9/2014                | 6/9/2015                    |
| Omega Digital Thermometer with J Type TC Probe | HH202A              | 18800                | 3/3/2014                | 3/3/2015                    |
| Omega Digital Thermometer with J Type TC Probe | HH202A              | 18801                | 6/9/2014                | 6/9/2015                    |
| Agilent PNA-L Network Analyzer                 | N5230C              | MY49002155           | 8/4/2014                | 8/4/2015                    |
| Dielectric Probe Kit (DAK)                     | DAK-3.5             | 1059                 | 5/15/2014               | 5/15/2015                   |
| Dielectric Probe Kit (DAK)                     | DAK-12              | 1013                 | 5/15/2014               | 5/15/2015                   |
| Speag Dipole                                   | D450V3              | 1077                 | 11/18/2013              | 11/18/2015                  |
| Speag Probe                                    | ES3DV3              | 3163                 | 5/15/2014               | 5/15/2015                   |
| Speag DAE                                      | DAE4                | 1231                 | 2/12/2014               | 2/12/2015                   |

## 10.0 SAR Measurement System Validation and Verification

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

### 10.1 System Validation

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

**TABLE 11**

| Dates      | Probe Calibration Point |     | Probe SN | Measured Tissue Parameters |              | Validation for CW |           |          |
|------------|-------------------------|-----|----------|----------------------------|--------------|-------------------|-----------|----------|
|            |                         |     |          | $\sigma$                   | $\epsilon_r$ | Sensitivity       | Linearity | Isotropy |
| 06/12/2014 | Body                    | 450 | 3163     | 0.97                       | 57.2         | Pass              | Pass      | Pass     |
| 06/11/2014 | Head                    | 450 | 3163     | 0.86                       | 42.6         | Pass              | Pass      | Pass     |

### 10.2 System Verification

System performance 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 |
|----------------|---------------|-----------------------|---------------------|--------------------------------------|--------------------------------------------------------|-------------|
| 3163           | FCC Body      | SPEAG D450V3/ 1077    | *4.50 +/- 10%       | 1.10                                 | 4.40                                                   | 10/15/14    |
|                | IEEE/IEC Head | SPEAG D450V3/ 1077    | *4.64 +/- 10%       | 1.20                                 | 4.80                                                   | 10/01/14    |
|                |               |                       |                     | 1.20                                 | 4.80                                                   | 10/15/14    |

\*Dipole manufacture's reference target

### 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 |
|-----------------|-------------------|---------------------------|----------------------------|--------------------------|---------------------------|-------------|
| 450             | FCC Body          | 0.94<br>(0.89 – 0.99)     | 56.7<br>(53.9 – 59.5)      | 0.98                     | 55.3                      | 10/15/2014  |
|                 | IEEE/<br>IEC Head | 0.87<br>(0.83 – 0.91)     | 43.5<br>(41.3 – 45.7)      | 0.90                     | 45.6                      | 10/01/2014  |
|                 |                   |                           |                            | 0.88                     | 43.5                      | 10/15/2014  |
| 458             | FCC Body          | 0.94<br>(0.89 – 0.99)     | 56.7<br>(53.8 – 59.5)      | 0.98                     | 55.2                      | 10/15/2014  |
|                 | IEEE/<br>IEC Head | 0.87<br>(0.83 – 0.91)     | 43.5<br>(41.3 – 45.6)      | 0.91                     | 45.4                      | 10/01/2014  |
|                 |                   |                           |                            | 0.88                     | 43.3                      | 10/15/2014  |

## 11.0 Environmental Test Conditions

The EME Laboratory's ambient environment is well controlled resulting in very stable simulated tissue temperature and therefore stable dielectric properties. Simulated tissue temperature is measured prior to each scan to insure it is within  $\pm 2^{\circ}\text{C}$  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: 21.1-23.1 °C<br>Avg. 22.3 °C |
| Relative Humidity   | 30 – 70 %  | Range: 56.0-63.0 %<br>Avg. 58.8 %   |
| Tissue Temperature  | NA         | Range: 21.7-22.8 °C<br>Avg. 22.1 °C |

Relative humidity target range is a recommended target

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

## 12.0 DUT Test Setup and Methodology

### 12.1 Measurements

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

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

**TABLE 15**

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

## 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 H.

### 12.3.1 Body

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

### 12.3.2 Head

Not applicable.

### 12.3.3 Face

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

## 12.4 DUT Test Channels

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

KDB 447498 number of test channels formula.

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

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 power slump. A table and graph of output power versus time is provided in APPENDIX F. For these devices 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 from section 4.0 were used to assess compliance of these devices. All modes of operation identified in section 6.0 were considered during the development of the test plan. All tests were performed in TDMA mode and then 50% duty cycle was applied respectively to the final results.

### 13.0 DUT Test Data

#### 13.1 Assessments at the Body

The battery 60012000001 was used for assessments at the Body because it is the only offered battery (refer to Exhibit 7B for the illustration of the battery). The conducted power measurement for all test channels within Part 90 frequency range (438-470 MHz) which is listed in Table 16. SAR plots of the highest result per Table (bolded) is presented in Appendix E.

**TABLE 16**

| Test Freq (MHz) | Power (W) |
|-----------------|-----------|
| 438             | 3.94      |
| 451.1875        | 4.12      |
| 457.8625        | 4.20      |
| 470             | 4.10      |

#### Assessments at the Body with Body-worn 4280383X62

Assessment of the offered antennas with the default battery and body worn per KDB 643646. Testing of additional channels was not required per KDB 447498. All results are below 4.0 W/kg. SAR plots of the highest results per Table (bolded) is 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#             |
|------------|-------------|-----------------|-----------------|-----------------|--------------|----------------|---------------------|----------------------|-------------------------|--------------------------|------------------|
| 8575099C01 | 60012000001 | 4280383X62      | HKLN4604A       | 438.0000        |              |                |                     |                      |                         |                          |                  |
|            |             |                 |                 | 451.1875        |              |                |                     |                      |                         |                          |                  |
|            |             |                 |                 | 457.8625        | 4.2          | -0.56          | 3.83                | 2.80                 | <b>2.18</b>             | <b>1.59</b>              | AvG-Ab-141015-03 |
|            |             |                 |                 | 470.000         |              |                |                     |                      |                         |                          |                  |

#### Assessment at the Body with other audio accessories

Assessment per “KDB 643646 D01 Body SAR Test Consideration for Audio Accessories without Built-in Antenna; Sec 1, A. when overall < 4.0 W/kg, SAR testing for that audio accessory is not necessary.” This was applicable to all remaining accessories.

### 13.2 Assessments at the Face

The battery 60012000001 was used for assessments at the Face because it is only offered battery (refer to Exhibit 7B for the illustration of the battery). The conducted power measurement for all test channels within Part 90 frequency range (438-470 MHz) which is listed in Table 18. SAR plot of the highest result per Table (bolded) is presented in Appendix E.

**TABLE 18**

| Test Freq (MHz) | Power (W) |
|-----------------|-----------|
| 438             | 3.88      |
| 451.1875        | 4.10      |
| 457.8625        | 4.20      |
| 470             | 4.05      |

Assessment of the offered antennas with the default battery with front of DUT positioned 2.5cm facing phantom. SAR plot of the highest result per Table (bolded) is presented in Appendix E.

**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#               |
|------------|-------------|-----------------|-----------------|-----------------|--------------|----------------|---------------------|----------------------|-------------------------|--------------------------|--------------------|
| 8575099C01 | 60012000001 | NONE            | NONE            | 438.0000        |              |                |                     |                      |                         |                          |                    |
|            |             |                 |                 | 451.1875        |              |                |                     |                      |                         |                          |                    |
|            |             |                 |                 | 457.8625        | 4.20         | -0.61          | 4.07                | 3.04                 | <b>2.34</b>             | <b>1.75</b>              | ErC-Face-141001-06 |
|            |             |                 |                 | 470.000         |              |                |                     |                      |                         |                          |                    |

### 13.3 Assessments for Industry Canada

Based on the assessment results for body and face per KDB643646 D01, additional tests were not required for the Industry Canada frequency range (450-470 MHz) as the testing performed is in compliance with Industry Canada frequency range.

### 13.4 Shortened Scan Assessment

A “shortened” scan using the highest SAR configuration overall from the Part 90 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 E demonstrate that the scaling methodology used to determine the calculated SAR results presented herein are valid. The SAR results from the table below is provided in APPENDIX E.

**TABLE 20**

| Antenna             | Battery     | Carry Accessory | Cable Accessory | Test Freq (MHz) | Init Pwr (W) | SAR Drift (dB) | Meas. 1g-SAR (mW/g) | Meas. 10g-SAR (mW/g) | Max Calc. 1g-SAR (mW/g) | Max Calc. 10g-SAR (mW/g) | Run#               |
|---------------------|-------------|-----------------|-----------------|-----------------|--------------|----------------|---------------------|----------------------|-------------------------|--------------------------|--------------------|
| <b>Shorten scan</b> |             |                 |                 |                 |              |                |                     |                      |                         |                          |                    |
| 8575099C01          | 60012000001 | NONE            | NONE            | 457.8625        | 4.20         | -0.69          | 3.80                | 2.83                 | 2.23                    | 1.66                     | AvG-Face-141015-06 |

**14.0 Simultaneous Transmission Exclusion**

Not applicable.

**15.0 Results Summary**

Based on the test guidelines from KDB 643646 and satisfying frequencies with Part 15 FCC band to be in compliance with Industry Canada Frequency range, the highest Operational Maximum Calculated 1-gram and 10-gram average SAR values found for this filing:

**TABLE 21**

| Designator      | Frequency band (MHz) | Max Calc at Body (W/kg) |         | Max Calc at Face (W/kg) |         |
|-----------------|----------------------|-------------------------|---------|-------------------------|---------|
|                 |                      | 1g-SAR                  | 10g-SAR | 1g-SAR                  | 10g-SAR |
| Overall         | 438-470              | 2.18                    | 1.59    | 2.34                    | 1.75    |
| FCC             | 438-470              | 2.18                    | 1.59    | 2.34                    | 1.75    |
| Industry Canada | 450-470              | 2.18                    | 1.59    | 2.34                    | 1.75    |

All results are scaled to the maximum output power

The test results clearly demonstrate compliance with FCC Occupational/Controlled RF Exposure limits of 8 W/kg averaged over 1 gram per the requirements of 47 CFR 2.1093(d). The 10 grams result is not applicable to FCC filing.

**16.0 Variability Assessment**

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

**17.0 System Uncertainty**

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

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

## **Appendix A**

### **Measurement Uncertainty Budget**

## Uncertainty Budget for Device Under Test, for 300 MHz to 550 MHz

| <i>a</i>                                              | <i>b</i>                | <i>c</i>      | <i>d</i>     | <i>e = f(d,k)</i> | <i>f</i>                      | <i>g</i>                       | <i>h =<br/>c x f / e</i>            | <i>i =<br/>c x g / 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              | 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          |                   |                               |                                | 12                                  | 11                                   | 482                  |
| <b>Expanded Uncertainty</b><br>(95% CONFIDENCE LEVEL) |                         |               | <i>k</i> =2  |                   |                               |                                | 23                                  | 23                                   |                      |

### FCD-0558 Uncertainty Budget Rev.8.1

Notes for uncertainty budget Table:

- Column headings *a-k* are given for reference.
- Tol. - tolerance in influence quantity.
- Prob. Dist. – Probability distribution
- N, R - normal, rectangular probability distributions
- Div. - divisor used to translate tolerance into normally distributed standard uncertainty
- c<sub>i</sub>* - sensitivity coefficient that should be applied to convert the variability of the uncertainty component into a variability of SAR.
- u<sub>i</sub>* – SAR uncertainty
- v<sub>i</sub>* - 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  
**S** Swiss Calibration Service

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

Accreditation No.: **SCS 108**

Client **Motorola EME**

Certificate No: **ES3-3163\_May14**

## CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3163**

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 15, 2014**

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

All calibrations have been conducted in the closed laboratory facility: environment temperature  $(22 \pm 3)^{\circ}\text{C}$  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: S6054 (3c)  | 03-Apr-14 (No. 217-01915)         | Apr-15                 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 03-Apr-14 (No. 217-01919)         | Apr-15                 |
| Reference 30 dB Attenuator | SN: S5129 (30b) | 03-Apr-14 (No. 217-01920)         | Apr-15                 |
| Reference Probe ES3DV2     | SN: 3013        | 30-Dec-13 (No. ES3-3013_Dec13)    | Dec-14                 |
| DAE4                       | SN: 680         | 13-Dec-13 (No. DAE4-680_Dec13)    | Dec-14                 |
|                            |                 |                                   |                        |
| Secondary Standards        | ID              | Check Date (in house)             | Scheduled Check        |
| RF generator HP 8648C      | US3642U01700    | 4-Aug-99 (in house check Apr-13)  | In house check: Apr-16 |
| Network Analyzer HP 8753E  | US37390585      | 18-Oct-01 (in house check Oct-13) | In house check: Oct-14 |

|                                                                                                                 |                                |                                          |                      |
|-----------------------------------------------------------------------------------------------------------------|--------------------------------|------------------------------------------|----------------------|
| Calibrated by:                                                                                                  | Name<br><b>Claudio Leubler</b> | Function<br><b>Laboratory Technician</b> |                      |
| Approved by:                                                                                                    | Name<br><b>Katja Pokovic</b>   | Function<br><b>Technical Manager</b>     |                      |
|                                                                                                                 |                                |                                          | Issued: May 17, 2014 |
| This calibration certificate shall not be reproduced except in full without written approval of the laboratory. |                                |                                          |                      |

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



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

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

Accreditation No.: **SCS 108**

### Glossary:

|                          |                                                                                                                                                         |
|--------------------------|---------------------------------------------------------------------------------------------------------------------------------------------------------|
| TSL                      | tissue simulating liquid                                                                                                                                |
| NORM <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:3163

May 15, 2014

# Probe ES3DV3

## SN:3163

Manufactured: October 8, 2007  
Calibrated: May 15, 2014

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

ES3DV3- SN:3163

May 15, 2014

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3163

### Basic Calibration Parameters

|                                     | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|-------------------------------------|----------|----------|----------|-----------|
| Norm $(\mu V/(V/m))^2$ <sup>A</sup> | 1.31     | 1.12     | 1.04     | ± 10.1 %  |
| DCP (mV) <sup>B</sup>               | 104.3    | 102.9    | 104.6    |           |

### 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    | 216.3    | ±3.5 %                    |
|           |                                                | Y | 0.0     | 0.0        | 1.0  |         | 203.1    |                           |
|           |                                                | Z | 0.0     | 0.0        | 1.0  |         | 190.3    |                           |
| 10012-CAA | IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)       | X | 3.01    | 69.5       | 19.3 | 1.87    | 128.2    | ±0.5 %                    |
|           |                                                | Y | 3.15    | 69.9       | 19.2 |         | 138.1    |                           |
|           |                                                | Z | 2.99    | 69.2       | 18.8 |         | 130.7    |                           |
| 10013-CAA | IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps)  | X | 11.13   | 70.8       | 23.5 | 9.46    | 123.4    | ±3.0 %                    |
|           |                                                | Y | 10.99   | 70.3       | 22.9 |         | 135.5    |                           |
|           |                                                | Z | 10.75   | 70.0       | 22.9 |         | 124.0    |                           |
| 10059-CAA | IEEE 802.11b WiFi 2.4 GHz (DSSS, 2 Mbps)       | X | 3.57    | 72.0       | 20.4 | 2.12    | 127.7    | ±0.5 %                    |
|           |                                                | Y | 3.62    | 71.7       | 19.9 |         | 138.6    |                           |
|           |                                                | Z | 3.29    | 70.3       | 19.3 |         | 130.8    |                           |
| 10060-CAA | IEEE 802.11b WiFi 2.4 GHz (DSSS, 5.5 Mbps)     | X | 14.52   | 99.5       | 30.0 | 2.83    | 137.9    | ±0.7 %                    |
|           |                                                | Y | 9.55    | 90.9       | 26.8 |         | 148.9    |                           |
|           |                                                | Z | 11.15   | 94.5       | 28.1 |         | 138.7    |                           |
| 10061-CAA | IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps)      | X | 12.48   | 92.4       | 28.1 | 3.60    | 140.5    | ±0.9 %                    |
|           |                                                | Y | 8.08    | 84.0       | 24.8 |         | 127.8    |                           |
|           |                                                | Z | 9.07    | 87.0       | 26.1 |         | 142.2    |                           |
| 10071-CAA | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 9 Mbps)  | X | 11.42   | 71.4       | 24.2 | 9.83    | 121.7    | ±3.0 %                    |
|           |                                                | Y | 11.12   | 70.5       | 23.3 |         | 131.7    |                           |
|           |                                                | Z | 10.98   | 70.5       | 23.5 |         | 122.8    |                           |
| 10072-CAA | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 12 Mbps) | X | 11.79   | 73.3       | 25.2 | 9.62    | 147.0    | ±3.3 %                    |
|           |                                                | Y | 10.74   | 70.4       | 23.2 |         | 129.7    |                           |
|           |                                                | Z | 11.22   | 72.1       | 24.4 |         | 147.1    |                           |
| 10073-CAA | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 18 Mbps) | X | 11.95   | 73.8       | 25.7 | 9.94    | 143.0    | ±3.8 %                    |
|           |                                                | Y | 10.82   | 70.7       | 23.6 |         | 126.7    |                           |
|           |                                                | Z | 11.27   | 72.4       | 24.8 |         | 141.9    |                           |
| 10074-CAA | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 24 Mbps) | X | 12.20   | 74.4       | 26.4 | 10.30   | 140.5    | ±3.0 %                    |
|           |                                                | Y | 10.89   | 70.7       | 23.8 |         | 125.5    |                           |
|           |                                                | Z | 11.43   | 72.8       | 25.3 |         | 138.7    |                           |
| 10075-CAA | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 36 Mbps) | X | 12.44   | 75.1       | 27.1 | 10.77   | 136.0    | ±3.0 %                    |
|           |                                                | Y | 11.06   | 71.1       | 24.4 |         | 122.5    |                           |
|           |                                                | Z | 11.63   | 73.3       | 26.0 |         | 136.0    |                           |

ES3DV3--SN:3163

May 15, 2014

|           |                                                |   |       |      |      |       |       |        |
|-----------|------------------------------------------------|---|-------|------|------|-------|-------|--------|
| 10076-CAA | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 48 Mbps) | X | 12.59 | 75.5 | 27.5 | 10.94 | 135.6 | ±3.3 % |
|           |                                                | Y | 11.11 | 71.2 | 24.6 |       | 121.3 |        |
|           |                                                | Z | 11.73 | 73.7 | 26.4 |       | 134.6 |        |
| 10077-CAA | IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 54 Mbps) | X | 12.60 | 75.6 | 27.6 | 11.00 | 134.5 | ±3.3 % |
|           |                                                | Y | 11.12 | 71.3 | 24.7 |       | 120.5 |        |
|           |                                                | Z | 11.69 | 73.7 | 26.4 |       | 133.1 |        |
| 10111-CAB | LTE-FDD (SC-FDMA, 100% RB, 5 MHz, 16-QAM)      | X | 7.09  | 67.8 | 20.4 | 6.44  | 144.0 | ±1.7 % |
|           |                                                | Y | 6.91  | 66.9 | 19.7 |       | 133.8 |        |
|           |                                                | Z | 7.02  | 67.8 | 20.3 |       | 147.3 |        |
| 10112-CAB | LTE-FDD (SC-FDMA, 100% RB, 10 MHz, 64-QAM)     | X | 7.30  | 67.3 | 20.1 | 6.59  | 125.3 | ±1.9 % |
|           |                                                | Y | 7.38  | 67.3 | 19.9 |       | 139.7 |        |
|           |                                                | Z | 7.22  | 67.1 | 19.8 |       | 127.8 |        |
| 10113-CAB | LTE-FDD (SC-FDMA, 100% RB, 5 MHz, 64-QAM)      | X | 7.35  | 68.1 | 20.7 | 6.62  | 145.8 | ±1.7 % |
|           |                                                | Y | 7.12  | 67.0 | 19.8 |       | 134.5 |        |
|           |                                                | Z | 7.27  | 68.0 | 20.5 |       | 148.4 |        |
| 10114-CAA | IEEE 802.11n (HT Greenfield, 13.5 Mbps, BPSK)  | X | 10.29 | 69.3 | 21.7 | 8.10  | 129.5 | ±2.5 % |
|           |                                                | Y | 10.19 | 68.9 | 21.2 |       | 144.0 |        |
|           |                                                | Z | 10.14 | 69.0 | 21.3 |       | 131.5 |        |
| 10115-CAA | IEEE 802.11n (HT Greenfield, 81 Mbps, 16-QAM)  | X | 10.84 | 69.9 | 22.2 | 8.46  | 133.8 | ±2.7 % |
|           |                                                | Y | 10.75 | 69.5 | 21.7 |       | 148.7 |        |
|           |                                                | Z | 10.70 | 69.6 | 21.9 |       | 135.5 |        |
| 10116-CAA | IEEE 802.11n (HT Greenfield, 135 Mbps, 64-QAM) | X | 10.33 | 69.4 | 21.7 | 8.15  | 131.0 | ±2.5 % |
|           |                                                | Y | 10.23 | 69.0 | 21.3 |       | 144.3 |        |
|           |                                                | Z | 10.21 | 69.2 | 21.5 |       | 132.1 |        |
| 10142-CAB | LTE-FDD (SC-FDMA, 100% RB, 3 MHz, QPSK)        | X | 5.92  | 67.1 | 19.9 | 5.73  | 135.8 | ±1.4 % |
|           |                                                | Y | 5.91  | 66.7 | 19.4 |       | 146.3 |        |
|           |                                                | Z | 5.79  | 66.7 | 19.5 |       | 136.2 |        |
| 10143-CAB | LTE-FDD (SC-FDMA, 100% RB, 3 MHz, 16-QAM)      | X | 6.91  | 68.0 | 20.5 | 6.35  | 142.5 | ±1.4 % |
|           |                                                | Y | 6.64  | 66.8 | 19.6 |       | 128.9 |        |
|           |                                                | Z | 6.73  | 67.6 | 20.1 |       | 142.1 |        |
| 10145-CAB | LTE-FDD (SC-FDMA, 100% RB, 1.4 MHz, QPSK)      | X | 5.66  | 66.8 | 19.8 | 5.76  | 131.2 | ±1.4 % |
|           |                                                | Y | 5.64  | 66.4 | 19.3 |       | 140.0 |        |
|           |                                                | Z | 5.49  | 66.4 | 19.3 |       | 131.2 |        |
| 10146-CAB | LTE-FDD (SC-FDMA, 100% RB, 1.4 MHz, 16-QAM)    | X | 6.59  | 67.8 | 20.5 | 6.41  | 135.3 | ±1.7 % |
|           |                                                | Y | 6.60  | 67.7 | 20.1 |       | 144.9 |        |
|           |                                                | Z | 6.38  | 67.5 | 20.0 |       | 134.6 |        |
| 10154-CAB | LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK)        | X | 6.02  | 67.0 | 19.8 | 5.75  | 136.2 | ±1.4 % |
|           |                                                | Y | 6.09  | 67.0 | 19.5 |       | 146.1 |        |
|           |                                                | Z | 5.95  | 66.8 | 19.5 |       | 137.9 |        |
| 10155-CAB | LTE-FDD (SC-FDMA, 50% RB, 10 MHz, 16-QAM)      | X | 7.09  | 67.8 | 20.5 | 6.43  | 143.8 | ±1.7 % |
|           |                                                | Y | 6.88  | 66.9 | 19.7 |       | 130.7 |        |
|           |                                                | Z | 6.99  | 67.7 | 20.2 |       | 145.9 |        |

ES3DV3- SN:3163

May 15, 2014

|           |                                            |   |      |      |      |      |       |        |
|-----------|--------------------------------------------|---|------|------|------|------|-------|--------|
| 10156-CAB | LTE-FDD (SC-FDMA, 50% RB, 5 MHz, QPSK)     | X | 5.83 | 66.8 | 19.8 | 5.79 | 132.8 | ±1.4 % |
|           |                                            | Y | 5.86 | 66.6 | 19.4 |      | 142.3 |        |
|           |                                            | Z | 5.73 | 66.6 | 19.4 |      | 134.5 |        |
| 10157-CAB | LTE-FDD (SC-FDMA, 50% RB, 5 MHz, 16-QAM)   | X | 6.85 | 67.8 | 20.5 | 6.49 | 138.3 | ±1.9 % |
|           |                                            | Y | 6.88 | 67.7 | 20.2 |      | 149.6 |        |
|           |                                            | Z | 6.73 | 67.6 | 20.2 |      | 140.6 |        |
| 10158-CAB | LTE-FDD (SC-FDMA, 50% RB, 10 MHz, 64-QAM)  | X | 7.35 | 68.1 | 20.7 | 6.62 | 145.2 | ±1.7 % |
|           |                                            | Y | 7.10 | 67.0 | 19.8 |      | 132.0 |        |
|           |                                            | Z | 7.23 | 67.8 | 20.3 |      | 147.6 |        |
| 10159-CAB | LTE-FDD (SC-FDMA, 50% RB, 5 MHz, 64-QAM)   | X | 6.98 | 67.9 | 20.6 | 6.56 | 139.4 | ±1.4 % |
|           |                                            | Y | 6.73 | 66.8 | 19.7 |      | 127.1 |        |
|           |                                            | Z | 6.83 | 67.7 | 20.3 |      | 140.9 |        |
| 10166-CAB | LTE-FDD (SC-FDMA, 50% RB, 1.4 MHz, QPSK)   | X | 5.23 | 67.2 | 20.0 | 5.46 | 146.3 | ±1.2 % |
|           |                                            | Y | 5.05 | 66.1 | 19.1 |      | 133.7 |        |
|           |                                            | Z | 5.12 | 67.1 | 19.7 |      | 148.6 |        |
| 10167-CAB | LTE-FDD (SC-FDMA, 50% RB, 1.4 MHz, 16-QAM) | X | 5.99 | 67.5 | 20.3 | 6.21 | 126.9 | ±1.4 % |
|           |                                            | Y | 5.98 | 67.4 | 19.9 |      | 137.9 |        |
|           |                                            | Z | 6.05 | 68.3 | 20.5 |      | 149.6 |        |
| 10175-CAB | LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK)      | X | 5.05 | 67.3 | 20.2 | 5.72 | 139.4 | ±1.2 % |
|           |                                            | Y | 4.84 | 66.1 | 19.3 |      | 128.3 |        |
|           |                                            | Z | 4.94 | 67.1 | 19.9 |      | 140.9 |        |
| 10176-CAB | LTE-FDD (SC-FDMA, 1 RB, 10 MHz, 16-QAM)    | X | 5.88 | 68.5 | 21.2 | 6.52 | 139.1 | ±1.7 % |
|           |                                            | Y | 5.57 | 67.1 | 20.1 |      | 127.6 |        |
|           |                                            | Z | 5.66 | 68.1 | 20.8 |      | 138.6 |        |
| 10177-CAC | LTE-FDD (SC-FDMA, 1 RB, 5 MHz, QPSK)       | X | 5.07 | 67.4 | 20.3 | 5.73 | 139.4 | ±1.2 % |
|           |                                            | Y | 4.87 | 66.3 | 19.4 |      | 127.2 |        |
|           |                                            | Z | 4.96 | 67.3 | 20.0 |      | 139.7 |        |
| 10178-CAB | LTE-FDD (SC-FDMA, 1 RB, 5 MHz, 16-QAM)     | X | 5.92 | 68.7 | 21.3 | 6.52 | 140.7 | ±1.7 % |
|           |                                            | Y | 5.58 | 67.2 | 20.1 |      | 127.3 |        |
|           |                                            | Z | 5.63 | 68.0 | 20.7 |      | 138.4 |        |
| 10179-CAB | LTE-FDD (SC-FDMA, 1 RB, 10 MHz, 64-QAM)    | X | 5.88 | 68.6 | 21.2 | 6.50 | 140.3 | ±1.7 % |
|           |                                            | Y | 5.59 | 67.3 | 20.2 |      | 127.6 |        |
|           |                                            | Z | 5.63 | 68.1 | 20.7 |      | 137.3 |        |
| 10180-CAB | LTE-FDD (SC-FDMA, 1 RB, 5 MHz, 64-QAM)     | X | 5.91 | 68.7 | 21.3 | 6.50 | 141.3 | ±1.7 % |
|           |                                            | Y | 5.80 | 68.2 | 20.7 |      | 145.8 |        |
|           |                                            | Z | 5.62 | 68.0 | 20.7 |      | 136.9 |        |
| 10184-CAB | LTE-FDD (SC-FDMA, 1 RB, 3 MHz, QPSK)       | X | 5.09 | 67.4 | 20.3 | 5.73 | 140.2 | ±1.4 % |
|           |                                            | Y | 5.03 | 67.0 | 19.8 |      | 146.0 |        |
|           |                                            | Z | 4.92 | 67.0 | 19.9 |      | 139.3 |        |
| 10185-CAB | LTE-FDD (SC-FDMA, 1 RB, 3 MHz, 16-QAM)     | X | 5.92 | 68.7 | 21.3 | 6.51 | 141.5 | ±1.7 % |
|           |                                            | Y | 5.77 | 68.0 | 20.6 |      | 145.2 |        |
|           |                                            | Z | 5.63 | 68.0 | 20.7 |      | 138.1 |        |

ES3DV3-- SN:3163

May 15, 2014

|           |                                                               |   |       |      |      |      |       |        |
|-----------|---------------------------------------------------------------|---|-------|------|------|------|-------|--------|
| 10187-CAB | LTE-FDD (SC-FDMA, 1 RB, 1.4 MHz, QPSK)                        | X | 5.10  | 67.5 | 20.4 | 5.73 | 140.4 | ±1.4 % |
|           |                                                               | Y | 5.04  | 67.0 | 19.8 |      | 144.6 |        |
|           |                                                               | Z | 4.95  | 67.2 | 20.0 |      | 139.5 |        |
| 10188-CAB | LTE-FDD (SC-FDMA, 1 RB, 1.4 MHz, 16-QAM)                      | X | 5.93  | 68.7 | 21.2 | 6.52 | 143.8 | ±1.9 % |
|           |                                                               | Y | 5.79  | 68.1 | 20.6 |      | 145.0 |        |
|           |                                                               | Z | 5.67  | 68.2 | 20.8 |      | 139.6 |        |
| 10298-AAA | LTE-FDD (SC-FDMA, 50% RB, 3 MHz, QPSK)                        | X | 5.74  | 66.9 | 19.8 | 5.72 | 135.2 | ±1.4 % |
|           |                                                               | Y | 5.67  | 66.4 | 19.3 |      | 134.7 |        |
|           |                                                               | Z | 5.54  | 66.3 | 19.3 |      | 131.0 |        |
| 10299-AAA | LTE-FDD (SC-FDMA, 50% RB, 3 MHz, 16-QAM)                      | X | 6.73  | 67.9 | 20.5 | 6.39 | 141.9 | ±1.4 % |
|           |                                                               | Y | 6.65  | 67.4 | 20.0 |      | 141.4 |        |
|           |                                                               | Z | 6.56  | 67.7 | 20.2 |      | 136.9 |        |
| 10315-AAA | IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 96pc duty cycle)     | X | 3.01  | 70.5 | 20.1 | 1.71 | 131.6 | ±0.5 % |
|           |                                                               | Y | 3.00  | 69.6 | 19.1 |      | 133.8 |        |
|           |                                                               | Z | 2.89  | 69.2 | 18.9 |      | 131.3 |        |
| 10316-AAA | IEEE 802.11g WiFi 2.4 GHz (ERP-OFDM, 6 Mbps, 96pc duty cycle) | X | 10.21 | 69.5 | 22.1 | 8.36 | 127.7 | ±2.5 % |
|           |                                                               | Y | 9.98  | 68.6 | 21.3 |      | 129.8 |        |
|           |                                                               | Z | 9.93  | 68.9 | 21.6 |      | 124.4 |        |

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.

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3163

### 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) | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|------------|-------------|
| 150                  | 52.3                               | 0.76                            | 7.15    | 7.15    | 7.15    | 0.05               | 1.20       | ± 13.3 %    |
| 220                  | 49.0                               | 0.81                            | 7.09    | 7.09    | 7.09    | 0.05               | 1.20       | ± 13.3 %    |
| 300                  | 45.3                               | 0.87                            | 7.34    | 7.34    | 7.34    | 0.25               | 1.25       | ± 13.3 %    |
| 450                  | 43.5                               | 0.87                            | 6.51    | 6.51    | 6.51    | 0.22               | 1.80       | ± 13.3 %    |
| 750                  | 41.9                               | 0.89                            | 6.41    | 6.41    | 6.41    | 0.44               | 1.50       | ± 12.0 %    |
| 900                  | 41.5                               | 0.97                            | 6.06    | 6.06    | 6.06    | 0.35               | 1.72       | ± 12.0 %    |
| 1810                 | 40.0                               | 1.40                            | 5.18    | 5.18    | 5.18    | 0.77               | 1.27       | ± 12.0 %    |
| 1950                 | 40.0                               | 1.40                            | 4.87    | 4.87    | 4.87    | 0.66               | 1.29       | ± 12.0 %    |
| 2300                 | 39.5                               | 1.67                            | 4.67    | 4.67    | 4.67    | 0.80               | 1.23       | ± 12.0 %    |
| 2450                 | 39.2                               | 1.80                            | 4.35    | 4.35    | 4.35    | 0.53               | 1.64       | ± 12.0 %    |
| 2600                 | 39.0                               | 1.96                            | 4.26    | 4.26    | 4.26    | 0.71               | 1.42       | ± 12.0 %    |
| 3500                 | 37.9                               | 2.91                            | 4.27    | 4.27    | 4.27    | 0.80               | 1.20       | ± 13.1 %    |
| 3700                 | 37.7                               | 3.12                            | 4.15    | 4.15    | 4.15    | 0.90               | 1.20       | ± 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.

<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.

## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3163

### 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 (mm) <sup>g</sup> | Unct. (k=2) |
|----------------------|------------------------------------|---------------------------------|---------|---------|---------|--------------------|-------------------------|-------------|
| 150                  | 61.9                               | 0.80                            | 6.87    | 6.87    | 6.87    | 0.08               | 1.35                    | ± 13.3 %    |
| 220                  | 60.2                               | 0.86                            | 6.65    | 6.65    | 6.65    | 0.05               | 1.35                    | ± 13.3 %    |
| 300                  | 58.2                               | 0.92                            | 6.94    | 6.94    | 6.94    | 0.13               | 1.80                    | ± 13.3 %    |
| 450                  | 56.7                               | 0.94                            | 7.19    | 7.19    | 7.19    | 0.15               | 1.82                    | ± 13.3 %    |
| 750                  | 55.5                               | 0.96                            | 6.14    | 6.14    | 6.14    | 0.65               | 1.28                    | ± 12.0 %    |
| 900                  | 55.0                               | 1.05                            | 5.94    | 5.94    | 5.94    | 0.50               | 1.43                    | ± 12.0 %    |
| 1810                 | 53.3                               | 1.52                            | 4.82    | 4.82    | 4.82    | 0.62               | 1.45                    | ± 12.0 %    |
| 1950                 | 53.3                               | 1.52                            | 4.82    | 4.82    | 4.82    | 0.53               | 1.55                    | ± 12.0 %    |
| 2300                 | 52.9                               | 1.81                            | 4.43    | 4.43    | 4.43    | 0.76               | 1.28                    | ± 12.0 %    |
| 2450                 | 52.7                               | 1.95                            | 4.22    | 4.22    | 4.22    | 0.70               | 1.18                    | ± 12.0 %    |
| 2600                 | 52.5                               | 2.16                            | 4.07    | 4.07    | 4.07    | 0.80               | 1.03                    | ± 12.0 %    |
| 3500                 | 51.3                               | 3.31                            | 3.72    | 3.72    | 3.72    | 0.85               | 1.30                    | ± 13.1 %    |
| 3700                 | 51.0                               | 3.55                            | 3.53    | 3.53    | 3.53    | 0.80               | 1.50                    | ± 13.1 %    |

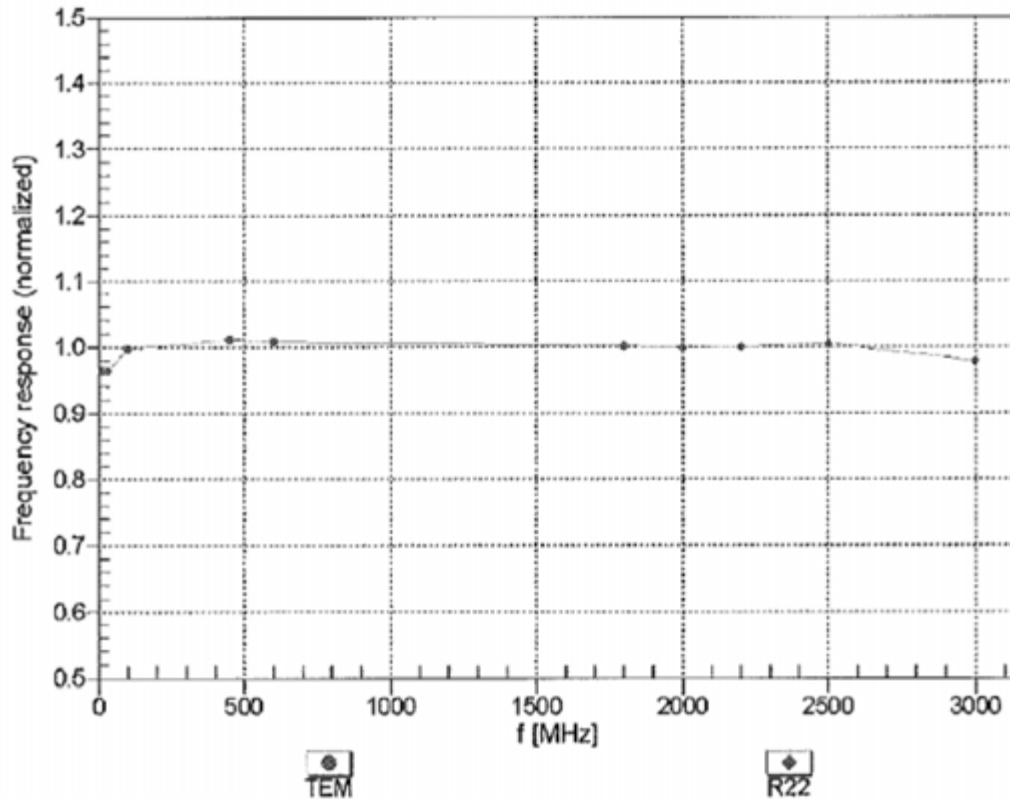
<sup>c</sup> Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively.

<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.

## Frequency Response of E-Field

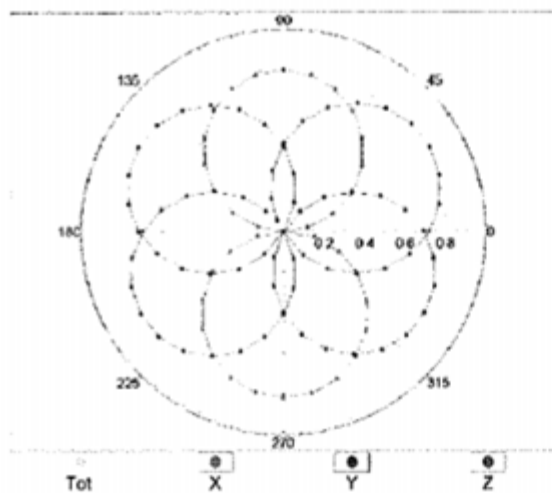
(TEM-Cell:ifi110 EXX, Waveguide: R22)



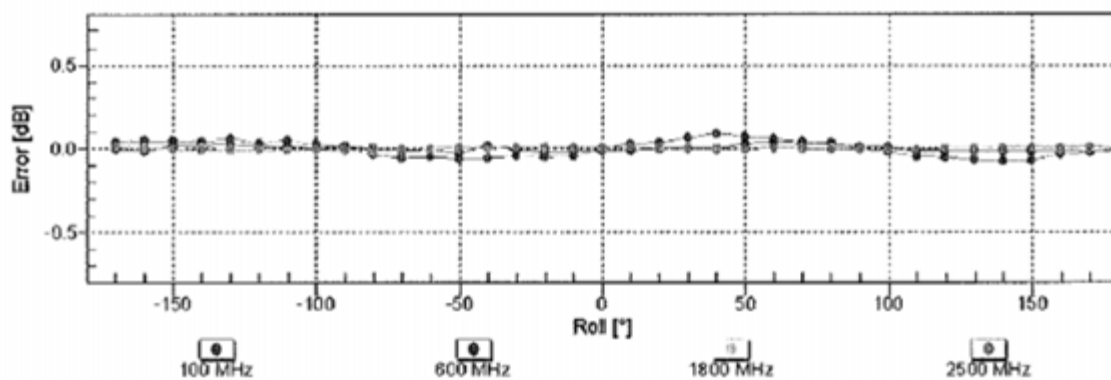
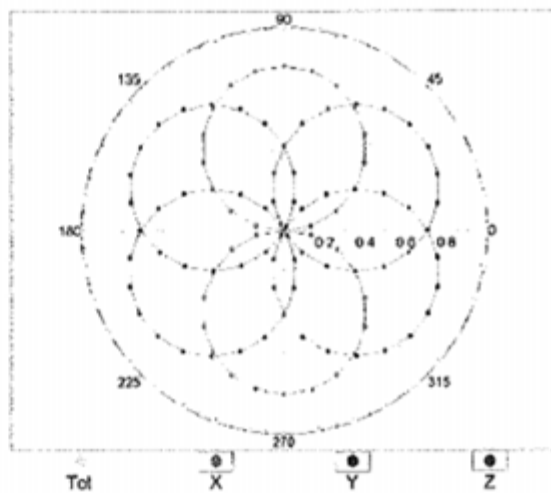
Uncertainty of Frequency Response of E-field:  $\pm 6.3\%$  (k=2)

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

f=600 MHz,TEM

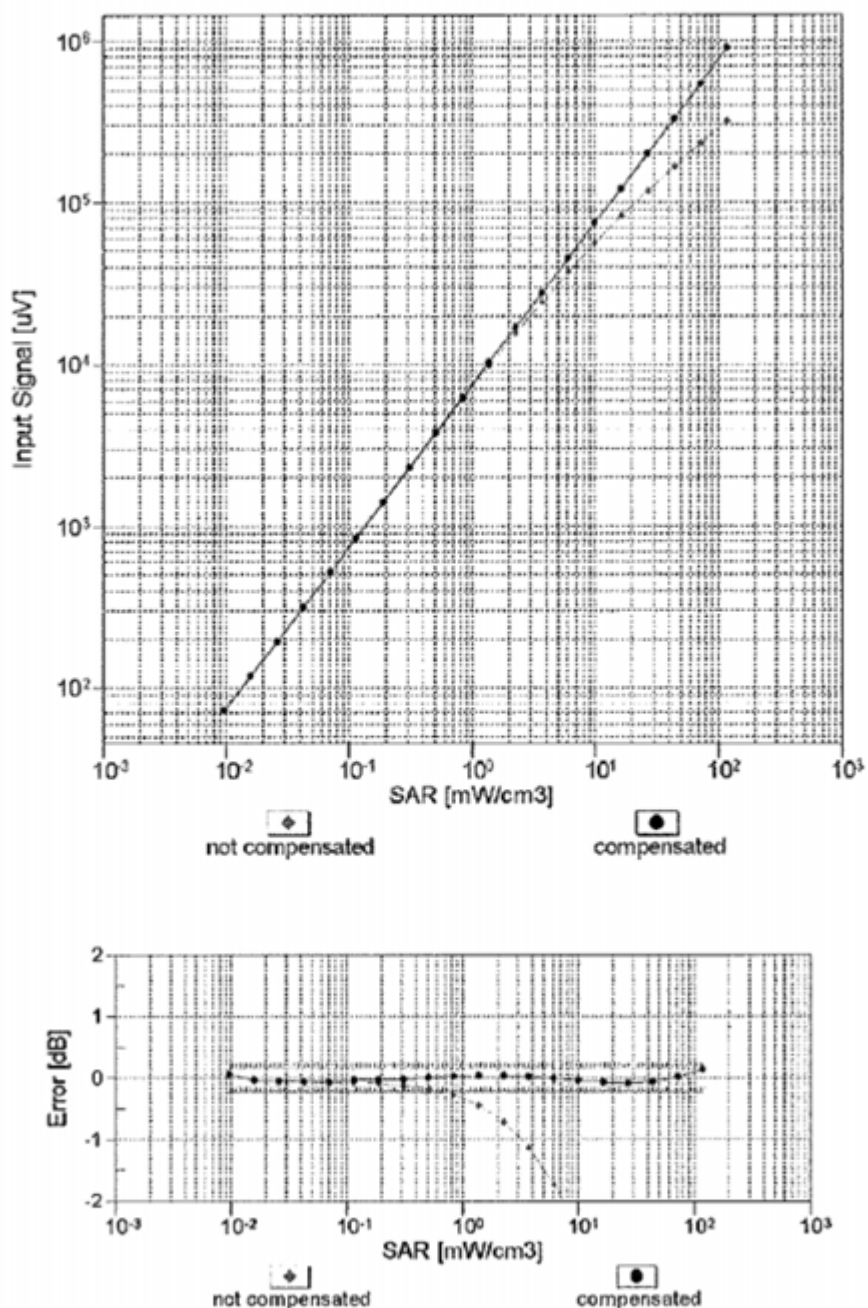


f=1800 MHz,R22



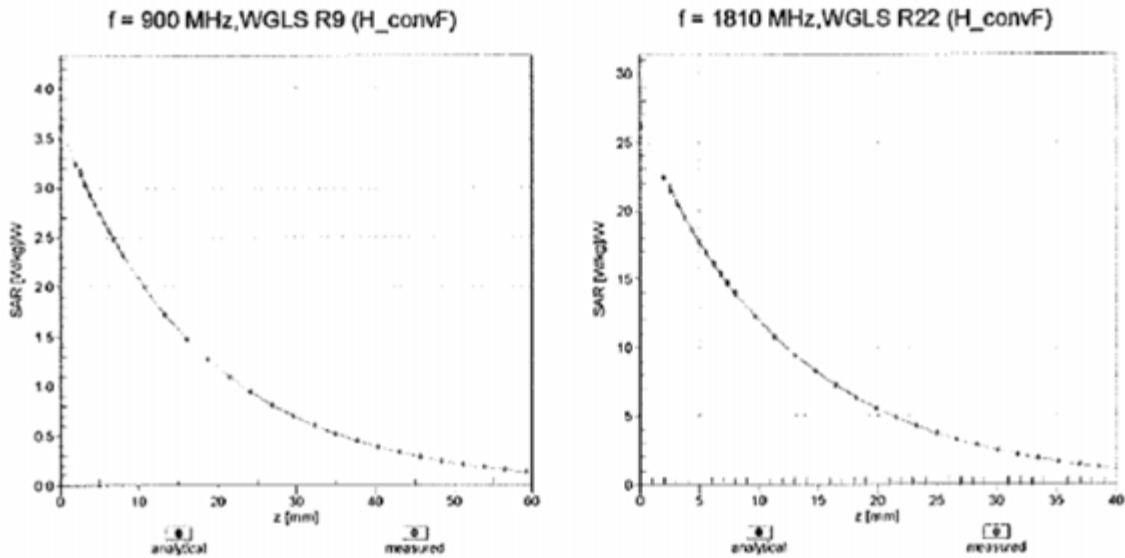
Uncertainty of Axial Isotropy Assessment:  $\pm 0.5\%$  (k=2)

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

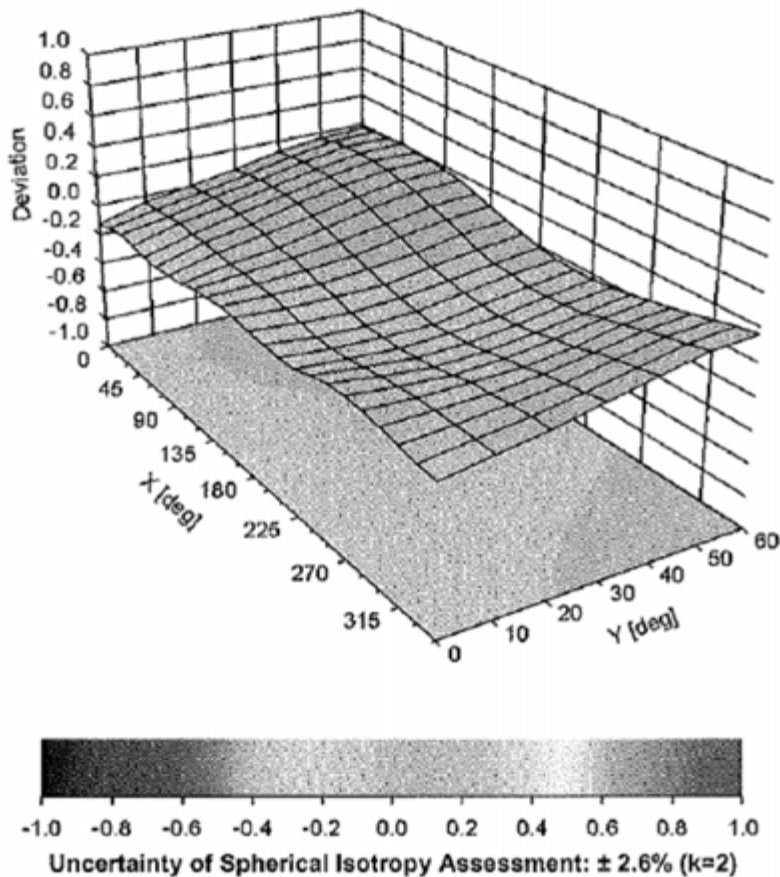


Uncertainty of Linearity Assessment:  $\pm 0.6\%$  ( $k=2$ )

Conversion Factor Assessment



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



## DASY/EASY - Parameters of Probe: ES3DV3 - SN:3163

### Other Probe Parameters

|                                               |            |
|-----------------------------------------------|------------|
| Sensor Arrangement                            | Triangular |
| Connector Angle (°)                           | 9.7        |
| 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       |

## **Appendix C**

### **Dipole Calibration Certificates**

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



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

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

Accreditation No.: **SCS 108**

Client **Motorola EME**

Certificate No: **D450V3-1077\_Nov13**

## CALIBRATION CERTIFICATE

Object **D450V3 - SN: 1077**

Calibration procedure(s) **QA CAL-15.v7**  
Calibration procedure for dipole validation kits below 700 MHz

Calibration date: **November 18, 2013**

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards           | ID #               | Cal Date (Certificate No.)     | Scheduled Calibration |
|-----------------------------|--------------------|--------------------------------|-----------------------|
| Power meter E4419B          | GB41293874         | 04-Apr-13 (No. 217-01733)      | Apr-14                |
| Power sensor E4412A         | MY41498087         | 04-Apr-13 (No. 217-01733)      | Apr-14                |
| Reference 3 dB Attenuator   | SN: S5054 (3c)     | 04-Apr-13 (No. 217-01737)      | Apr-14                |
| Reference 20 dB Attenuator  | SN: S5058 (20k)    | 04-Apr-13 (No. 217-01736)      | Apr-14                |
| Type-N mismatch combination | SN: 5047.3 / 06327 | 04-Apr-13 (No. 217-01739)      | Apr-14                |
| Reference Probe ET3DV6      | SN: 1507           | 28-Dec-12 (No. ET3-1507_Dec12) | Dec-13                |
| DAE4                        | SN: 654            | 18-Jul-13 (No. DAE4-654_Jul13) | Jul-14                |

| 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-15 |
| Network Analyzer HP 8753E | US37390585 S4206 | 18-Oct-01 (in house check Oct-13) | In house check: Oct-14 |

|                |                               |                                   |               |
|----------------|-------------------------------|-----------------------------------|---------------|
| Calibrated by: | Name<br><b>Jeton Kastrati</b> | Function<br>Laboratory Technician | Signature<br> |
| Approved by:   | Name<br><b>Katja Pokovic</b>  | Technical Manager                 |               |

Issued: November 18, 2013

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

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



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

Accredited by the Swiss Accreditation Service (SAS)

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

Accreditation No.: **SCS 108**

#### Glossary:

|       |                                 |
|-------|---------------------------------|
| TSL   | tissue simulating liquid        |
| 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
- 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.

|                              |                        |                                 |
|------------------------------|------------------------|---------------------------------|
| DASY Version                 | DASY5                  | V52.8.7                         |
| Extrapolation                | Advanced Extrapolation |                                 |
| Phantom                      | ELI4 Flat Phantom      | Shell thickness: $2 \pm 0.2$ mm |
| Distance Dipole Center - TSL | 15 mm                  | with Spacer                     |
| Zoom Scan Resolution         | dx, dy, dz = 5 mm      |                                 |
| Frequency                    | 450 MHz $\pm$ 1 MHz    |                                 |

**Head TSL parameters**

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Head TSL parameters             | 22.0 °C             | 43.5           | 0.87 mho/m           |
| Measured Head TSL parameters            | (22.0 $\pm$ 0.2) °C | 43.3 $\pm$ 6 % | 0.87 mho/m $\pm$ 6 % |
| Head TSL temperature change during test | < 0.5 °C            | ----           | ----                 |

**SAR result with Head TSL**

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Head TSL | Condition          |                              |
|-------------------------------------------------------|--------------------|------------------------------|
| SAR measured                                          | 250 mW input power | 1.16 W/kg                    |
| SAR for nominal Head TSL parameters                   | normalized to 1W   | 4.64 W/kg $\pm$ 18.1 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Head TSL | condition          |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR measured                                            | 250 mW input power | 0.764 W/kg                   |
| SAR for nominal Head TSL parameters                     | normalized to 1W   | 3.05 W/kg $\pm$ 17.6 % (k=2) |

**Body TSL parameters**

The following parameters and calculations were applied.

|                                         | Temperature         | Permittivity   | Conductivity         |
|-----------------------------------------|---------------------|----------------|----------------------|
| Nominal Body TSL parameters             | 22.0 °C             | 56.7           | 0.94 mho/m           |
| Measured Body TSL parameters            | (22.0 $\pm$ 0.2) °C | 55.8 $\pm$ 6 % | 0.93 mho/m $\pm$ 6 % |
| Body TSL temperature change during test | < 0.5 °C            | ----           | ----                 |

**SAR result with Body TSL**

| SAR averaged over 1 cm <sup>3</sup> (1 g) of Body TSL | Condition          |                              |
|-------------------------------------------------------|--------------------|------------------------------|
| SAR measured                                          | 250 mW input power | 1.12 W/kg                    |
| SAR for nominal Body TSL parameters                   | normalized to 1W   | 4.50 W/kg $\pm$ 18.1 % (k=2) |

| SAR averaged over 10 cm <sup>3</sup> (10 g) of Body TSL | condition          |                              |
|---------------------------------------------------------|--------------------|------------------------------|
| SAR measured                                            | 250 mW input power | 0.742 W/kg                   |
| SAR for nominal Body TSL parameters                     | normalized to 1W   | 2.98 W/kg $\pm$ 17.6 % (k=2) |

**Appendix****Antenna Parameters with Head TSL**

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 58.1 $\Omega$ - 3.2 j $\Omega$ |
| Return Loss                          | - 21.8 dB                      |

**Antenna Parameters with Body TSL**

|                                      |                                |
|--------------------------------------|--------------------------------|
| Impedance, transformed to feed point | 54.9 $\Omega$ - 6.1 j $\Omega$ |
| Return Loss                          | - 22.6 dB                      |

**General Antenna Parameters and Design**

|                                  |          |
|----------------------------------|----------|
| Electrical Delay (one direction) | 1.350 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: 18.11.2013

Test Laboratory: The name of your organization

**DUT: Dipole 450 MHz; Type: D450V3; Serial: D450V3 - SN: 1077**

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

Medium parameters used:  $f = 450$  MHz;  $\sigma = 0.87$  S/m;  $\epsilon_r = 43.3$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

**DASY52 Configuration:**

- Probe: ET3DV6 - SN1507; ConvF(6.59, 6.59, 6.59); Calibrated: 28.12.2012;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 18.07.2013
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

**Dipole Calibration for Head Tissue/d=15mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:**

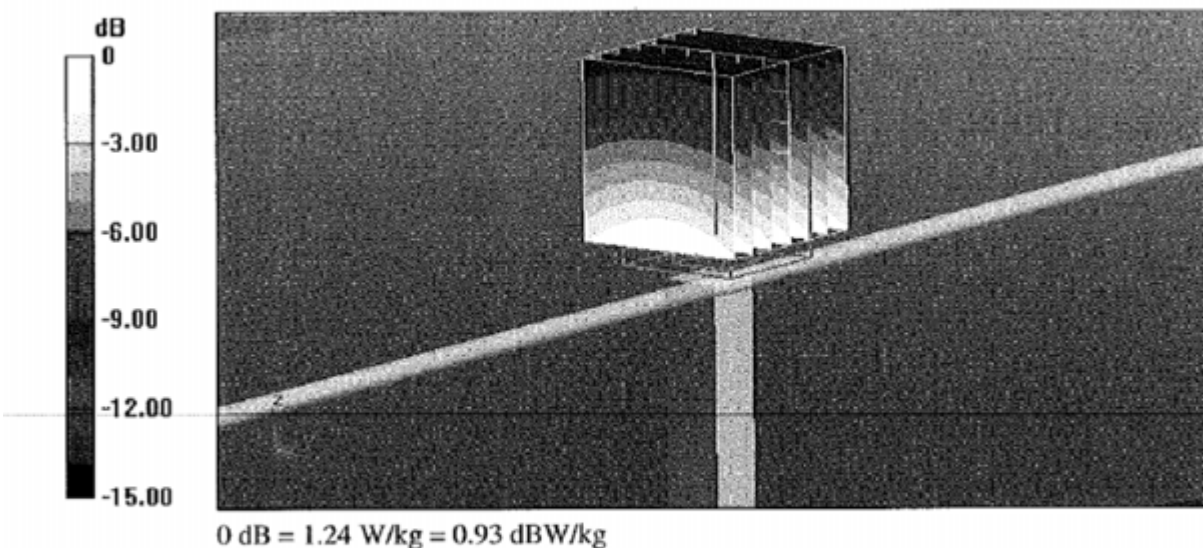
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 39.227 V/m; Power Drift = -0.03 dB

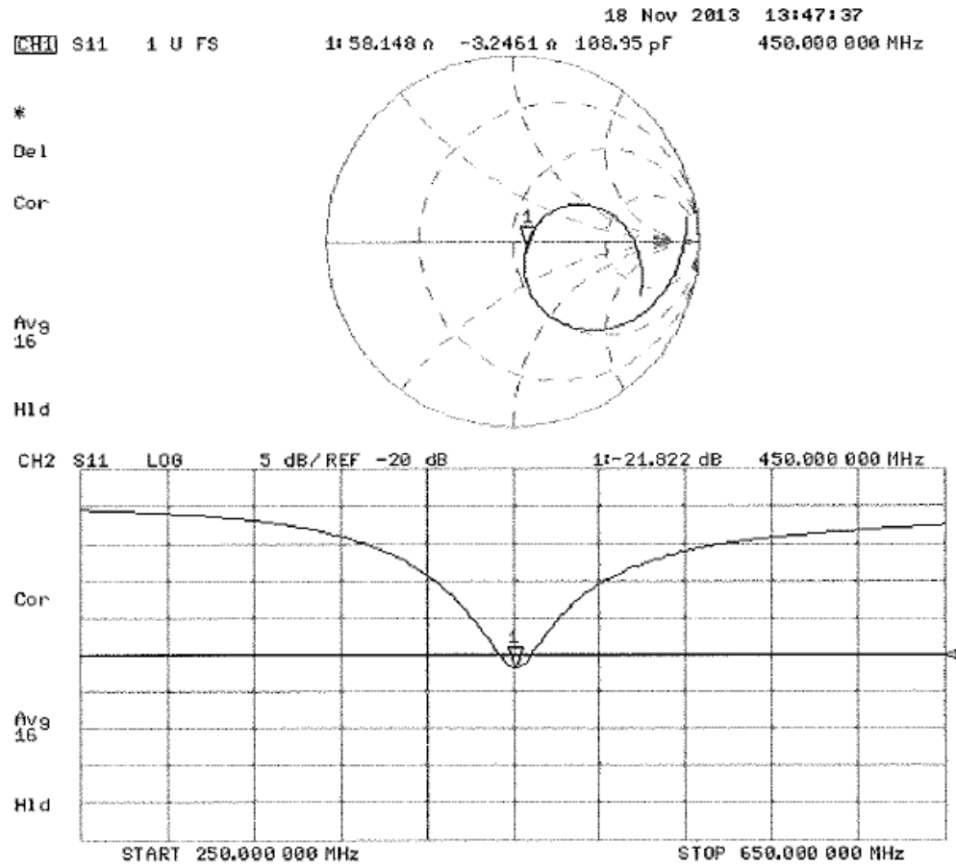
Peak SAR (extrapolated) = 1.79 W/kg

**SAR(1 g) = 1.16 W/kg; SAR(10 g) = 0.764 W/kg**

Maximum value of SAR (measured) = 1.24 W/kg



## Impedance Measurement Plot for Head TSL



**DASY5 Validation Report for Body TSL**

Date: 18.11.2013

Test Laboratory: The name of your organization

**DUT: Dipole 450 MHz D450V3; Type: D450V3; Serial: D450V3 - SN:1077**

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

Medium parameters used:  $f = 450$  MHz;  $\sigma = 0.93$  S/m;  $\epsilon_r = 55.8$ ;  $\rho = 1000$  kg/m<sup>3</sup>

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

**DASY52 Configuration:**

- Probe: ET3DV6 - SN1507; ConvF(7.03, 7.03, 7.03); Calibrated: 28.12.2012;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 18.07.2013
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

**Dipole Calibration for Body Tissue/d=15mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:**

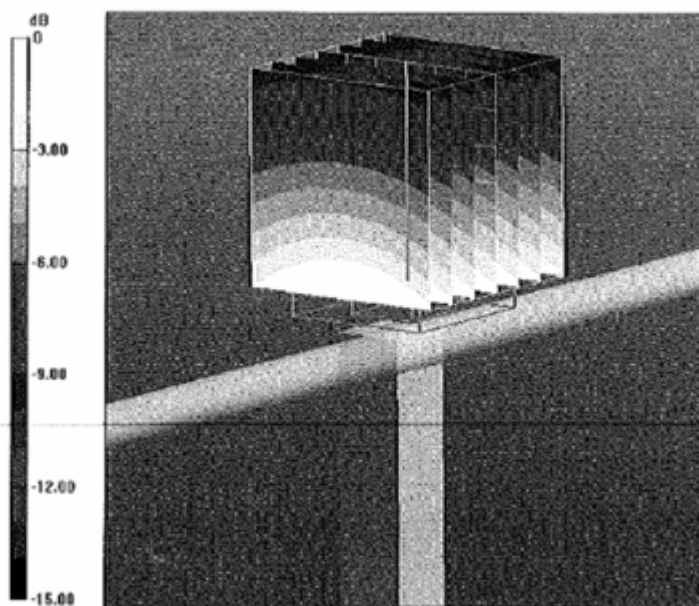
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 36.878 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 1.75 W/kg

**SAR(1 g) = 1.12 W/kg; SAR(10 g) = 0.742 W/kg**

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



0 dB = 1.20 W/kg = 0.79 dBW/kg

## Impedance Measurement Plot for Body TSL

