MOTOROLA SOLUTIONS

MS ISO/IEC 17025 TESTING SAMM No. 0826

ACCREDITED CERTIFICATE 2518.05

# DECLARATION OF COMPLIANCE SAR ASSESSMENT PCII Report Part 1 of 2

**Motorola Solutions Inc.**
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**Date of Report:** 4/20/2020
**Report Revision:** B

| | |
|---|---|
| **Responsible Engineer:** | Lee Kin Kting |
| **Report Author:** | Lee Kin Kting |
| **Date/s Tested:** | 1/12/2020, 3/31/2020 |
| **Manufacturer:** | Motorola Solutions Inc. |
| **DUT Description:** | Handheld Portable – 450 – 520 MHz, 5W rated power, 6.25K/12.5K/25K |
| **Test TX mode(s):** | CW (PTT); Bluetooth |
| **Max. Power output:** | 5.6W (LMR) ;10.0 mW (Bluetooth) |
| **Nominal Power:** | 5.0W (LMR) ;10.0 mW (Bluetooth) |
| **Tx Frequency Bands:** | 450-520 MHz; 2402-2480 MHz |
| **Signaling type:** | FM, TDMA; FHSS (BT) |
| **Model(s) Tested:** | H51SDH9PW7AN (MUE4080), H51SDF9PW6AN (MUE4414) |
| **Model(s) Certified:** | H51SDH9PW7AN (MUE4080), H51SDF9PW6AN (MUE4414) |
| **Serial Number(s):** | 426CQV0734, 426TNF1483 |
| **Classification:** | Occupational/Controlled |
| **Applicant Name:** | Motorola Solutions Inc. |
| **Applicant Address:** | 8000 West Sunrise Boulevard, Fort Lauderdale, Florida 33322 |
| **FCC ID:** | AZ489FT4910; LMR 450-512 MHz |
| **FCC Test Firm Registration Number:** | 823256 |

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 FCC 47 CFR § 2.1093.

**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 (no deviation from standard methods). This report shall not be reproduced without written approval from an officially designated representative of the Motorola Solutions Inc EME Laboratory.**
**I attest to the accuracy of the data and assume full responsibility for the completeness of these measurements. This reporting format is consistent with the suggested guidelines of the TIA TSB-150 December 2004. The results and statements contained in this report pertain only to the device(s) evaluated.**

Tiong Nguk Ing
Digitally signed by Tiong Nguk Ing
Date: 2020.04.27 23:56:40 +08'00'

**Tiong Nguk Ing**
**Deputy Technical Manager (Approved Signatory)**
**Approval Date: 4/27/2020**

**Part 1 of 2**

## APPENDICES



**Part 2 of 2**

## APPENDICES



### Report Revision History

| Date | Revision | Comments |
|---|---|---|
| 4/7/2020 | A | Release of PCII results |
| 4/20/2020 | B | Include Applicant name and address and include SAR plot for initial filing. |

## 1.0 Introduction

This report details the utilization, test setup, test equipment, and test results of the Specific Absorption Rate (SAR) measurements performed at the Motorola Solutions Inc. EME Test Laboratory for handheld portable model number H51SDH9PW7AN (MUE4080) and H51SDF9PW6AN (MUE4414). These devices are classified as Occupational/Controlled. The information herein is to show evidence of Class II Permissive Change compliance based on the SAR evaluation of new battery NNTN8128C.

## 2.0 FCC SAR Summary

**Table 1**

| Equipment Class | Frequency band (MHz) | Max Calc at Body (W/kg) | Max Calc at Face (W/kg) |
|---|---|---|---|
| | | 1g-SAR | 1g-SAR |
| TNF | 450-512 | 7.60* | 4.85* |

**Note:**
* indicates the new reported SAR value at the body and face is 7.60 W/kg and 4.85 W/kg. (Previous filed reported SAR value for body and face is 6.88 W/kg and 4.07 W/kg).

## 3.0 Abbreviations / Definitions

CNR: Calibration Not Required
CW: Continuous Wave
DUT: Device Under Test
DSP: Digital Signal Processing
EME: Electromagnetic Energy
FM: Frequency Modulation
NA: Not Applicable
PTT: Push to Talk
SAR: Specific Absorption Rate
TDMA: Time Division Multiple Access
BT: Bluetooth

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

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

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

## 4.0 Referenced Standards and Guidelines

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

- IEC62209-1 (2016) Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)
- Federal Communications Commission, “Evaluating Compliance with FCC Guidelines for Human Exposure to Radio frequency Electromagnetic Fields”, OET Bulletin 65, FCC, Washington, D.C.: 1997.
- IEEE 1528 (2013), Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques
- American National Standards Institute (ANSI) / Institute of Electrical and Electronics Engineers (IEEE) C95. 1-1992
- Institute of Electrical and Electronics Engineers (IEEE) C95.1-2005
- International Commission on Non-Ionizing Radiation Protection (ICNIRP) 1998
- Ministry of Health (Canada) Safety Code 6 (2015), Limits of Human Exposure to Radio frequency Electromagnetic Fields in the Frequency Range from 3 kHz to 300 GHz
- RSS-102 (Issue 5) – Radio Frequency (RF) Exposure Compliance of Radio communication Apparatus (All Frequency Bands)
- Australian Communications Authority Radio communications (Electromagnetic Radiation - Human Exposure) Standard (2014)
- ANATEL, Brazil Regulatory Authority, Resolution No. 303 of July 2, 2002 "Regulation of the limitation of exposure to electrical, magnetic, and electromagnetic fields in the radio frequency range between 9 kHz and 300 GHz." and “Attachment to resolution # 303 from July 2, 2002”
- IEC62209-2 Edition 1.0 2010-03, Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Human models, instrumentation, and procedures – Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz).
- FCC KDB – 643646 D01 SAR Test for PTT Radios v01r03
- FCC KDB – 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04
- FCC KDB – 865664 D02 RF Exposure Reporting v01r02
- FCC KDB – 447498 D01 General RF Exposure Guidance v06
- FCC KDB – 178919 D01 Permissive Change Policy v06

## 5.0 SAR Limits

**Table 2**

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

## 6.0 Description of Device Under Test (DUT)

These portable devices operate in the LMR band using either frequency modulation (FM) with 100% transmit duty cycle or TDMA signal with 50% transmit duty cycle. For conservative assessment, FM signal with higher average power was tested.

These devices operate in a half duplex system. A half duplex system only allows the user to transmit or receive. These devices cannot transmit and receive simultaneously. The user must stop transmitting in order to receive a signal or listen for a response, regardless of PTT button or use of voice activated audio accessories. This type of operation, along with the RF safety booklet, which instructs the user to transmit no more than 50% of the time, justifies the use of 50% duty factor for this device. This device also incorporates a Class 1 Bluetooth device which is Frequency Hooping Spread Spectrum (FHSS) technology. This Bluetooth radio modem is used to wireless link audio accessories. The maximum actual transmission duty cycle is imposed by the Bluetooth standard. The maximum duty cycle for BT is 76.1%.

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

## 7.0 Optional Accessories and Test Criteria

These devices are 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 applicable for this PCII filing only. Detailed listings of all the approved offered accessories are available in the original filing report.

### 7.1 Antenna

There is only one antenna applicable for this PCII filing. The Table below lists its descriptions.

**Table 3**

| Antenna No. | Antenna Models | Description | Selected for test | Tested |
|---|---|---|---|---|
| 1 | FAF5260A | Stubby Antenna w/ GPS, 450-520 MHz & 1575MHz, 1/4 wave, -2dBd | Yes | Yes |

### 7.2 Battery

There is only one battery applicable for this PCII filing. The Table below lists its description.

**Table 4**

| Battery No. | Battery Models | Description | Selected for test | Tested | Comments |
|---|---|---|---|---|---|
| 1 | NNTN8128C | Battery IMPRES Li-ION 2000mAh Typical | Yes | Yes | |

### 7.3 Body worn Accessories

There is only one body worn applicable for this PCII filing. The Table below lists its descriptions.

**Table 5**

| Body worn No. | Body worn Models | Description | Selected for test | Tested | Comments |
|---|---|---|---|---|---|
| 1 | PMLN4651A | Belt Clip 2.0 inch | Yes | Yes | |

### 7.4 Audio Accessory

There is no audio accessory is applicable for this PCII filing.

## 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 Engineering AG SPEAG DASY 5 | 52.10.2.1495 | DAE4 | EX3DV4 (E-Field) |

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

## 8.2 Description of Phantom(s)

**Table 8**

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

## 8.3 Description of Simulated Tissue

The sugar based simulate tissue is produced by placing the correct measured amount of De-ionized water into a large container. Each of the dried ingredients are weighed and added to the water carefully to avoid clumping. If the solution has a high sugar concentration the water is pre-heated to aid in dissolving the ingredients.

The simulated tissue mixture was mixed based on the Simulated Tissue Composition indicated in Table 9. During the daily testing of this product, the applicable mixture was used to measure the Di-electric parameters at each of the tested frequencies to verify that the Di-electric parameters were within the tolerance of the tissue specifications.

**Simulated Tissue Composition (percent by mass)**

**Table 9**

| Ingredients | 450MHz | |
|---|---|---|
| | Head | Body |
| Sugar | 56.0 | 46.5 |
| De ionized Water | 39.1 | 50.53 |
| Salt | 3.8 | 1.87 |
| HEC | 1.0 | 1.0 |
| Bact. | 0.1 | 0.1 |

## 9.0 Additional Test Equipment

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

**Table 10**

| Equipment Type | Model Number | Serial Number | Calibration Date | Calibration Due Date |
|---|---|---|---|---|
| SPEAG PROBE | EX3DV4 | 7486 | 10/24/2019 | 10/24/2020 |
| SPEAG PROBE | EX3DV4 | 7511 | 10/24/2019 | 10/24/2020 |
| SPEAG DAE | DAE4 | 850 | 10/16/2019 | 10/16/2020 |
| SPEAG DAE | DAE4 | 729 | 10/16/2019 | 10/16/2020 |
| AMPLIFIER | 10W1000C | 312859 | CNR | CNR |
| AMPLIFIER | 50W 1000A | 14715 | CNR | CNR |
| POWER METER | E4418B | MY45100911 | 08/30/2019 | 08/30/2021 |
| POWER METER | E4419B | MY45103725 | 06/10/2019 | 06/10/2021 |
| POWER METER | E4418B | MY45100739 | 12/09/2018 | 12/09/2020 |
| POWER SENSOR | 8481B | 3318A10982 | 2/5/2020 | 2/5/2021 |
| POWER SENSOR | E9301B | MY55210003 | 04/26/2019 | 04/26/2020 |
| POWER SENSOR* | E4412A | US38488023 | 03/24/2019 | 03/24/2020 |
| POWER SENSOR | 8481B | MY41091243 | 12/17/2019 | 12/17/2020 |
| BI-DIRECTIONAL COUPLER | 3020A | 40295 | 09/12/2019 | 09/12/2020 |
| VECTOR SIGNAL GENERATOR | E4438C | MY42081753 | 09/05/2019 | 09/05/2021 |
| DATA LOGGER | DSB | 16326831 | 11/25/2019 | 11/25/2020 |
| DATA LOGGER | DSB | 16326820 | 11/25/2019 | 11/25/2020 |
| DIGITAL THERMOMETER | 1523 | 3492108 | 05/03/2019 | 05/03/2020 |
| TEMPERATURE PROBE | 80PK-22 | 05032017 | 12/24/2019 | 12/24/2020 |
| TEMPERATURE PROBE | PR-10-3-100-1/4-6-E | WNWR020579 | 07/06/2019 | 07/06/2020 |
| DIELECTRIC ASSESSMENT KIT | DAK-3.5 | 1120 | 07/11/2019 | 07/11/2020 |
| NETWORK ANALYZER | E5071B | MY42403147 | 12/27/2019 | 12/27/2020 |
| SPEAG DIPOLE | D450V3 | 1053 | 10/19/2018 | 10/19/2020 |

Note: * indicates equipment used for SAR assessment before calibration due date

## 10.0 SAR Measurement System Validation and Verification

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

### 10.1 System Validation

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

**Table 11**

| Dates | Probe Calibration Point | | Probe SN | Measured Tissue Parameters | | Validation | | |
|---|---|---|---|---|---|---|---|---|
| | | | | σ | $\epsilon_r$ | Sensitivity | Linearity | Isotropy |
| CW | | | | | | | | |
| 11/07/2019 | Body | 450 | 7486 | 0.96 | 53.9 | Pass | Pass | Pass |
| 11/07/2019 | Head | | | 0.85 | 43.4 | Pass | Pass | Pass |
| 11/27/2019 | Body | | 7511 | 0.93 | 54.8 | Pass | Pass | Pass |
| 11/26/2019 | Head | | | 0.89 | 42.3 | Pass | Pass | Pass |

### 10.2 System Verification

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

**Table 12**

| Probe Serial # | Tissue Type | Dipole Kit / Serial # | Ref SAR @ 1W (W/kg) | System Check Results Measured (W/kg) | System Check Test Results when normalized to 1W (W/kg) | Tested Date |
|---|---|---|---|---|---|---|
| 7486 | IEEE/IEC Head | SPEAG D450V3 / 1053 | 4.57 +/- 10% | 1.22 | 4.88 | 01/12/2020 |
| | FCC Body | | 4.53 +/- 10% | 1.20 | 4.80 | 01/12/2020 |
| 7511 | FCC Body | SPEAG D450V3 / 1053 | 4.53 +/- 10% | 1.19 | 4.76 | 03/31/2020 |

## 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 (0.89-0.99) | 56.7 (53.9-59.5) | 0.95 | 55.4 | 01/12/2020 |
| | | | | 0.97 | 54.3 | 03/31/2020 |
| | IEEE/ IEC Head | 0.87 (0.83-0.91) | 43.5 (41.3-45.7) | 0.91 | 41.6 | 01/12/2020 |
| 466 | FCC Body | 0.94 (0.89-0.99) | 56.6 (53.8-59.5) | 0.96 | 55.2 | 01/12/2020 |
| | | | | 0.99 | 54.0 | 03/31/2020 |

## 11.0 Environmental Test Conditions

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

**Table 14**

| | Target | Measured |
|---|---|---|
| **Ambient Temperature** | 18 – 25 ˚C | Range: 22.1 – 24.7˚C<br>Avg. 23.4 ˚C |
| **Tissue Temperature** | 18 – 25 ˚C | Range: 21.5 – 23.4˚C<br>Avg. 22.5˚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 disturbances that could possibly affect the test results. If such unwanted signals are discovered the SAR scans are repeated.

## 12.0 DUT Test Setup and Methodology

### 12.1 Measurements

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

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

**Table 15**

| Description | | ≤ 3 GHz | > 3 GHz |
|---|---|---|---|
| Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface | | 5 ± 1 mm | ½·δ·ln(2) ± 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.

## 12.3 DUT Positioning Procedures

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

### 12.3.1 Body

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

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

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

## 12.5 SAR Result Scaling Methodology

The calculated 1-gram and 10-gram averaged SAR results indicated as "Max Calc. 1g-SAR" in the data Tables is determined by scaling the measured SAR to account for power leveling variations and drift. Appendix F includes a shortened scan to justify SAR scaling for drift. For this device the "Max Calc. 1g-SAR" are scaled using the following formula:

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

P_max = Maximum Power (W)
P_int = Initial Power (W)
Drift = DASY drift results (dB)
SAR_meas = Measured 1-g or 10-g Avg. SAR (W/kg)
DC = Transmission mode duty cycle in % where applicable
50% duty cycle is applied for PTT operation

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

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

## 12.6 DUT Test Plan

The DUT was assessed at the body and face using the highest applicable configuration found during initial compliance assessment on filed with the FCC. All modes of operation identified in section 6.0 were considered during the development of the test plan. All tests were performed in CW 50% duty cycle was applied to PTT configurations in the final results.

# 13.0 DUT Test Data

## 13.1 Assessment for FCC (450-512 MHz)

This new battery NNTN8128C were assessed using the accessories indicated in section 7.0 which represent the highest applicable configurations at the body and face found during the initial compliance assessment on file with the FCC. The initial and new battery SAR distributions are comparable, as shown in the SAR plots presented in Appendix E.

**Table 16**

| Antenna | Battery | Carry Accessory | Cable Accessory | Test Freq (MHz) | Init Pwr (W) | SAR Drift (dB) | Meas. 1g-SAR (W/kg) | Max Calc. 1g-SAR (W/kg) | Run# |
|---|---|---|---|---|---|---|---|---|---|
| Body | | | | | | | | | |
| FAF5260A | NNTN8128C | PMLN4651A | None | 465.5000 | 5.24 | -0.47 | 11.90 | **7.09** | IZ(NZ)-AB-200112-04 |
| Face | | | | | | | | | |
| FAF5260A | NNTN8128C | Front @ 2.5cm | None | 450.000 | 5.36 | -0.28 | 8.71 | **4.85** | ZZ-FACE-200112-12 |

## 13.2 Shortened Scan Assessment

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

**Table 17**

| Antenna | Battery | Carry Accessory | Cable Accessory | Test Freq (MHz) | Init Pwr (W) | SAR Drift (dB) | Meas. 1g-SAR (W/kg) | Max Calc. 1g-SAR (W/kg) | Run# |
|---|---|---|---|---|---|---|---|---|---|
| FAF5260A | NNTN8128C | PMLN4651A | None | 465.5000 | 5.32 | -0.26 | 13.60 | **7.60** | BL-AB-200331-04 |

## 14.0 Results Summary

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

**Table 18**

| Designator | Frequency band (MHz) | Max Calc at Body (W/kg) | Max Calc at Face (W/kg) |
|---|---|---|---|
| | | 1g-SAR | 1g-SAR |
| **FCC US** | | | |
| LMR | 450-512 | 7.60* | 4.85* |
| **Overall** | | | |
| LMR | 450-520 | 7.60* | 4.85* |

All results are scaled to the maximum output power.

**Note:**
* indicates the new reported SAR value at the body and face is 7.60 W/kg and 4.85 W/kg. (Previous filed reported SAR value for body and face is 6.88 W/kg and 4.07 W/kg).

The test results clearly demonstrate compliance with FCC Occupational/Controlled RF Exposure limits of 8 W/kg averaged over 1 gram per the requirements of FCC 47 CFR § 2.1093.

## 15.0 Variability Assessment

Per the guidelines in KDB 865664 SAR variability assessment is required because SAR results are above 4.0W/kg (Occupational).

**Table 19**

| Run# | Antenna | Battery | Carry Accessory | Cable Accessory | Test Freq. (MHz) | Adj Calc. 1g-SAR (W/kg) | Ratio | Comments |
|---|---|---|---|---|---|---|---|---|
| IZ(NZ)-AB-200112-04 | FAF5260A | NNTN8128C | PMLN4651A | None | 465.5000 | 6.63 | 1.09 | No additional repeated scans is required due to the Ratio ($SAR_{high}/SAR_{low}$) < 1.20 |
| BL-AB-200331-04 | | | | | | 7.22 | | |

## 16.0 System Uncertainty

A system uncertainty analysis is not required for this report per KDB 865664 because the highest report SAR value 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 450 MHz

| *a* | *b* | *c* | *d* | *e = f(d,k)* | *f* | *g* | *h = c x f / e* | *i = c x g / e* | *k* |
|---|---|---|---|---|---|---|---|---|---|
| **Uncertainty Component** | **IEEE 1528 section** | **Tol. (± %)** | **Prob Dist** | **Div.** | **$c_i$ (1 g)** | **$c_i$ (10 g)** | **1 g $u_i$ (±%)** | **10 g $u_i$ (±%)** | **$v_i$** |
| **Measurement System** | | | | | | | | | |
| Probe Calibration | E.2.1 | 6.7 | 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 | ∞ |
| **Test sample Related** | | | | | | | | | |
| Test Sample Positioning | E.4.2 | 3.2 | N | 1.00 | 1 | 1 | 3.2 | 3.2 | 29 |
| Device Holder Uncertainty | E.4.1 | 4.0 | N | 1.00 | 1 | 1 | 4.0 | 4.0 | 8 |
| SAR drift | 6.6.2 | 5.0 | R | 1.73 | 1 | 1 | 2.9 | 2.9 | ∞ |
| **Phantom and Tissue Parameters** | | | | | | | | | |
| Phantom Uncertainty | E.3.1 | 4.0 | R | 1.73 | 1 | 1 | 2.3 | 2.3 | ∞ |
| Liquid Conductivity (target) | E.3.2 | 5.0 | R | 1.73 | 0.64 | 0.43 | 1.8 | 1.2 | ∞ |
| Liquid Conductivity (measurement) | E.3.3 | 3.3 | N | 1.00 | 0.64 | 0.43 | 2.1 | 1.4 | ∞ |
| Liquid Permittivity (target) | E.3.2 | 5.0 | R | 1.73 | 0.6 | 0.49 | 1.7 | 1.4 | ∞ |
| Liquid Permittivity (measurement) | E.3.3 | 1.9 | N | 1.00 | 0.6 | 0.49 | 1.1 | 0.9 | ∞ |
| **Combined Standard Uncertainty** | | | RSS | | | | 12 | 11 | 482 |
| **Expanded Uncertainty** (95% CONFIDENCE LEVEL) | | | *k*=2 | | | | 23 | 23 | |

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

## Uncertainty Budget for System Validation(Dipole & flat phantom) for 450 MHz

| *a* | *b* | *c* | *d* | *e = f(d,k)* | *f* | *g* | *h = c x f / e* | *i = c x g / e* | *k* |
|---|---|---|---|---|---|---|---|---|---|
| **Uncertainty Component** | **IEEE 1528 section** | **Tol. (± %)** | **Prob. Dist.** | **Div.** | **$c_i$ (1 g)** | **$c_i$ (10 g)** | **1 g $u_i$ (±%)** | **10 g $u_i$ (±%)** | **$v_i$** |
| **Measurement System** | | | | | | | | | |
| Probe Calibration | E.2.1 | 6.7 | N | 1.00 | 1 | 1 | 6.7 | 6.7 | ∞ |
| Axial Isotropy | E.2.2 | 4.7 | R | 1.73 | 1 | 1 | 2.7 | 2.7 | ∞ |
| Spherical Isotropy | E.2.2 | 9.6 | R | 1.73 | 0 | 0 | 0.0 | 0.0 | ∞ |
| Boundary Effect | E.2.3 | 1.0 | R | 1.73 | 1 | 1 | 0.6 | 0.6 | ∞ |
| Linearity | E.2.4 | 4.7 | R | 1.73 | 1 | 1 | 2.7 | 2.7 | ∞ |
| System Detection Limits | E.2.5 | 1.0 | R | 1.73 | 1 | 1 | 0.6 | 0.6 | ∞ |
| Readout Electronics | E.2.6 | 0.3 | N | 1.00 | 1 | 1 | 0.3 | 0.3 | ∞ |
| Response Time | E.2.7 | 1.1 | R | 1.73 | 1 | 1 | 0.6 | 0.6 | ∞ |
| Integration Time | E.2.8 | 0.0 | R | 1.73 | 1 | 1 | 0.0 | 0.0 | ∞ |
| RF Ambient Conditions - Noise | E.6.1 | 3.0 | R | 1.73 | 1 | 1 | 1.7 | 1.7 | ∞ |
| RF Ambient Conditions - Reflections | E.6.1 | 0.0 | R | 1.73 | 1 | 1 | 0.0 | 0.0 | ∞ |
| Probe Positioner Mechanical Tolerance | E.6.2 | 0.4 | R | 1.73 | 1 | 1 | 0.2 | 0.2 | ∞ |
| Probe Positioning w.r.t. Phantom | E.6.3 | 1.4 | R | 1.73 | 1 | 1 | 0.8 | 0.8 | ∞ |
| Max. SAR Evaluation (ext., int., avg.) | E.5 | 3.4 | R | 1.73 | 1 | 1 | 2.0 | 2.0 | ∞ |
| **Dipole** | | | | | | | | | |
| Dipole Axis to Liquid Distance | 8, E.4.2 | 2.0 | R | 1.73 | 1 | 1 | 1.2 | 1.2 | ∞ |
| Input Power and SAR Drift Measurement | 8, 6.6.2 | 5.0 | R | 1.73 | 1 | 1 | 2.9 | 2.9 | ∞ |
| **Phantom and Tissue Parameters** | | | | | | | | | |
| Phantom Uncertainty | E.3.1 | 4.0 | R | 1.73 | 1 | 1 | 2.3 | 2.3 | ∞ |
| Liquid Conductivity (target) | E.3.2 | 5.0 | R | 1.73 | 0.64 | 0.43 | 1.8 | 1.2 | ∞ |
| Liquid Conductivity (measurement) | E.3.3 | 3.3 | R | 1.73 | 0.64 | 0.43 | 1.2 | 0.8 | ∞ |
| Liquid Permittivity (target) | E.3.2 | 5.0 | R | 1.73 | 0.6 | 0.49 | 1.7 | 1.4 | ∞ |
| Liquid Permittivity (measurement) | E.3.3 | 1.9 | R | 1.73 | 0.6 | 0.49 | 0.6 | 0.5 | ∞ |
| **Combined Standard Uncertainty** | | | RSS | | | | 10 | 9 | 99999 |
| **Expanded Uncertainty** (95% CONFIDENCE LEVEL) | | | *k*=2 | | | | 19 | 18 | |

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

# Appendix B
# Probe Calibration Certificates

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

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

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

Accreditation No.: **SCS 0108**

Client **Motorola Solutions MY**

Certificate No: **EX3-7511_Oct19**

# CALIBRATION CERTIFICATE

Object EX3DV4 - SN:7511

Calibration procedure(s) QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v5, QA CAL-23.v5, QA CAL-25.v7
Calibration procedure for dosimetric E-field probes

Calibration date: October 24, 2019

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter NRP | SN: 104778 | 03-Apr-19 (No. 217-02892/02893) | Apr-20 |
| Power sensor NRP-Z91 | SN: 103244 | 03-Apr-19 (No. 217-02892) | Apr-20 |
| Power sensor NRP-Z91 | SN: 103245 | 03-Apr-19 (No. 217-02893) | Apr-20 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 04-Apr-19 (No. 217-02894) | Apr-20 |
| DAE4 | SN: 660 | 07-Oct-19 (No. DAE4-660_Oct19) | Oct-20 |
| Reference Probe ES3DV2 | SN: 3013 | 31-Dec-18 (No. ES3-3013_Dec18) | Dec-19 |
| | | | |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| Power meter E4419B | SN: GB41293874 | 06-Apr-16 (in house check Jun-18) | In house check: Jun-20 |
| Power sensor E4412A | SN: MY41498087 | 06-Apr-16 (in house check Jun-18) | In house check: Jun-20 |
| Power sensor E4412A | SN: 000110210 | 06-Apr-16 (in house check Jun-18) | In house check: Jun-20 |
| RF generator HP 8648C | SN: US3642U01700 | 04-Aug-99 (in house check Jun-18) | In house check: Jun-20 |
| Network Analyzer E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-18) | In house check: Oct-19 |

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

Issued: October 24, 2019

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

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

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

Accreditation No.: **SCS 0108**

## Glossary:

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

## Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, ", "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

## Methods Applied and Interpretation of Parameters:

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

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:7511

## Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|---|---|---|---|
| Norm ($\mu V/(V/m)^2$)[A] | 0.46 | 0.37 | 0.44 | ± 10.1 % |
| DCP (mV)[B] | 99.0 | 96.6 | 99.9 | |

## Calibration Results for Modulation Response

| UID | Communication System Name | | A dB | B dB$\sqrt{\mu V}$ | C | D dB | VR mV | Max dev. | Unc[E] (k=2) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 118.4 | ±3.8 % | ± 4.7 % |
| | | Y | 0.0 | 0.0 | 1.0 | | 133.1 | | |
| | | Z | 0.0 | 0.0 | 1.0 | | 117.4 | | |

Note: For details on UID parameters see Appendix

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

[A] The uncertainties of Norm X,Y,Z do not affect the $E^2$-field uncertainty inside TSL (see Pages 5 and 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:7511

## Other Probe Parameters

| | |
|---|---|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 0.8 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 9 mm |
| Tip Diameter | 2.5 mm |
| Probe Tip to Sensor X Calibration Point | 1 mm |
| Probe Tip to Sensor Y Calibration Point | 1 mm |
| Probe Tip to Sensor Z Calibration Point | 1 mm |
| Recommended Measurement Distance from Surface | 1.4 mm |

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:7511

## Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha [G] | Depth [G] (mm) | Unc (k=2) |
|---|---|---|---|---|---|---|---|---|
| 150 | 52.3 | 0.76 | 12.15 | 12.15 | 12.15 | 0.00 | 1.00 | ± 13.3 % |
| 300 | 45.3 | 0.87 | 10.87 | 10.87 | 10.87 | 0.08 | 1.20 | ± 13.3 % |
| 450 | 43.5 | 0.87 | 10.30 | 10.30 | 10.30 | 0.10 | 1.30 | ± 13.3 % |
| 750 | 41.9 | 0.89 | 9.57 | 9.57 | 9.57 | 0.46 | 0.80 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 9.28 | 9.28 | 9.28 | 0.33 | 1.01 | ± 12.0 % |
| 900 | 41.5 | 0.97 | 9.06 | 9.06 | 9.06 | 0.49 | 0.81 | ± 12.0 % |
| 1450 | 40.5 | 1.20 | 8.17 | 8.17 | 8.17 | 0.10 | 0.80 | ± 12.0 % |
| 1810 | 40.0 | 1.40 | 7.94 | 7.94 | 7.94 | 0.28 | 0.80 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 7.69 | 7.69 | 7.69 | 0.34 | 0.80 | ± 12.0 % |
| 2100 | 39.8 | 1.49 | 7.73 | 7.73 | 7.73 | 0.33 | 0.80 | ± 12.0 % |
| 2300 | 39.5 | 1.67 | 7.35 | 7.35 | 7.35 | 0.36 | 0.90 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 7.06 | 7.06 | 7.06 | 0.33 | 0.90 | ± 12.0 % |
| 2600 | 39.0 | 1.96 | 6.81 | 6.81 | 6.81 | 0.39 | 0.90 | ± 12.0 % |
| 3500 | 37.9 | 2.91 | 6.66 | 6.66 | 6.66 | 0.35 | 1.30 | ± 13.1 % |
| 3700 | 37.7 | 3.12 | 6.56 | 6.56 | 6.56 | 0.35 | 1.30 | ± 13.1 % |

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.

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

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

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:7511

## Calibration Parameter Determined in Body Tissue Simulating Media

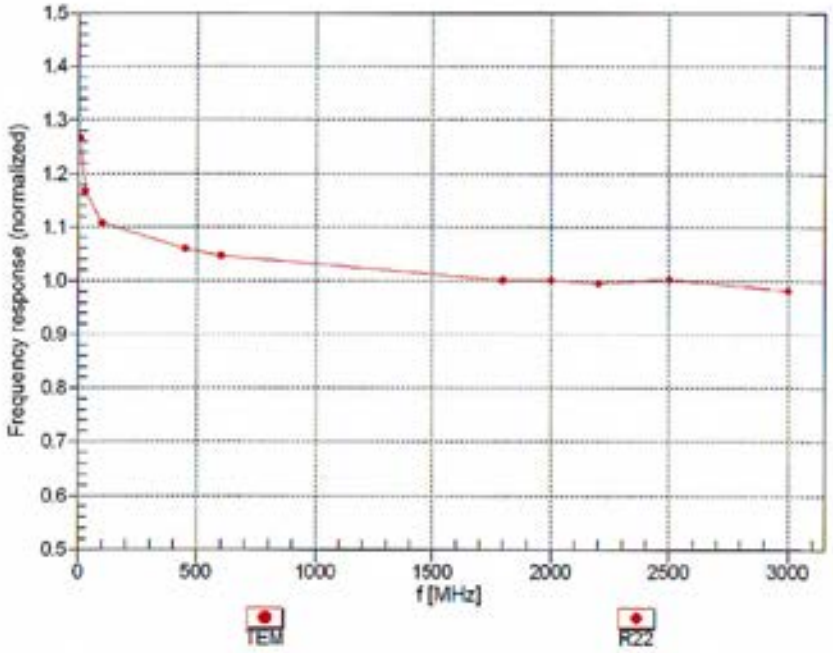
| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha [G] | Depth [G] (mm) | Unc (k=2) |
|---|---|---|---|---|---|---|---|---|
| 150 | 61.9 | 0.80 | 11.72 | 11.72 | 11.72 | 0.00 | 1.00 | ± 13.3 % |
| 300 | 58.2 | 0.92 | 11.12 | 11.12 | 11.12 | 0.04 | 1.20 | ± 13.3 % |
| 450 | 56.7 | 0.94 | 10.59 | 10.59 | 10.59 | 0.08 | 1.30 | ± 13.3 % |
| 750 | 55.5 | 0.96 | 9.52 | 9.52 | 9.52 | 0.49 | 0.80 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 9.26 | 9.26 | 9.26 | 0.40 | 0.80 | ± 12.0 % |
| 900 | 55.0 | 1.05 | 9.14 | 9.14 | 9.14 | 0.42 | 0.84 | ± 12.0 % |
| 1450 | 54.0 | 1.30 | 7.97 | 7.97 | 7.97 | 0.30 | 0.80 | ± 12.0 % |
| 1810 | 53.3 | 1.52 | 7.64 | 7.64 | 7.64 | 0.34 | 0.80 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 7.37 | 7.37 | 7.37 | 0.44 | 0.80 | ± 12.0 % |
| 2100 | 53.2 | 1.62 | 7.46 | 7.46 | 7.46 | 0.31 | 0.86 | ± 12.0 % |
| 2300 | 52.9 | 1.81 | 7.21 | 7.21 | 7.21 | 0.35 | 0.90 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 6.97 | 6.97 | 6.97 | 0.36 | 0.90 | ± 12.0 % |
| 2600 | 52.5 | 2.16 | 6.88 | 6.88 | 6.88 | 0.32 | 0.90 | ± 12.0 % |
| 3500 | 51.3 | 3.31 | 6.11 | 6.11 | 6.11 | 0.40 | 1.35 | ± 13.1 % |
| 3700 | 51.0 | 3.55 | 6.02 | 6.02 | 6.02 | 0.40 | 1.35 | ± 13.1 % |

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.

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

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

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




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

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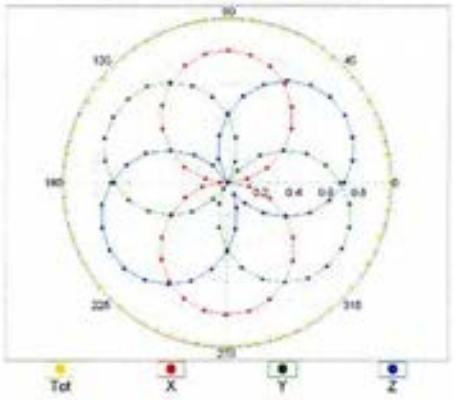
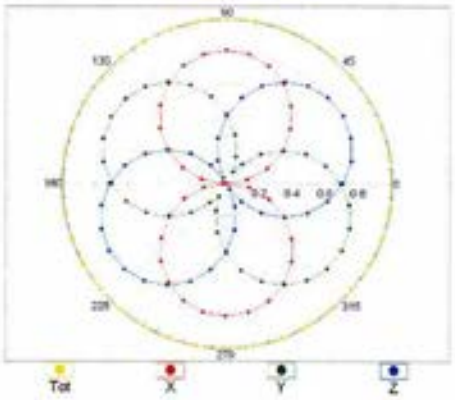
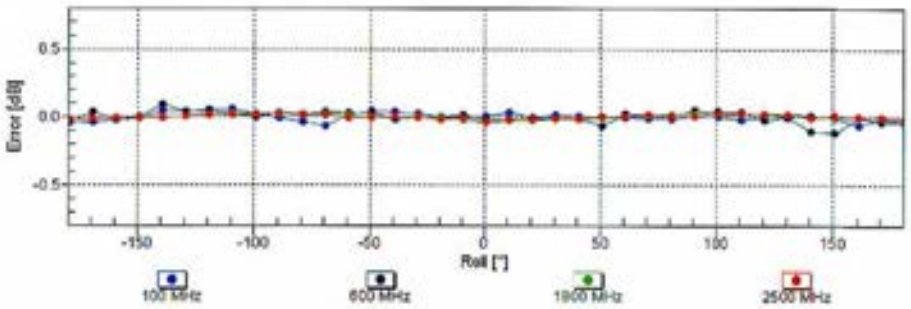
## Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



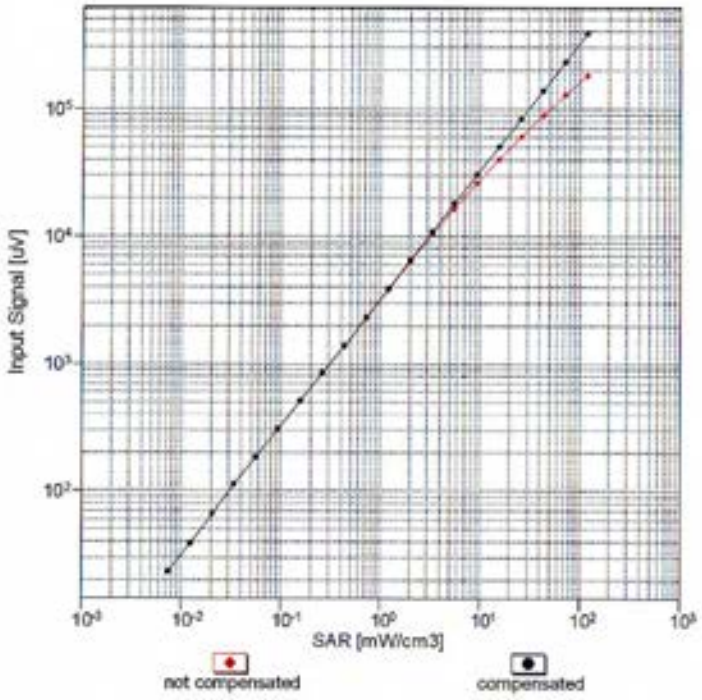

f=1800 MHz,R22

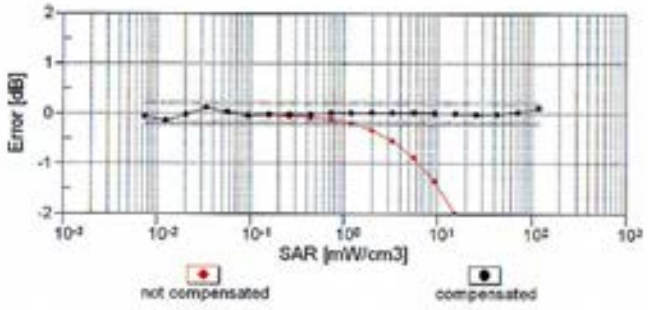



**Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)**

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




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

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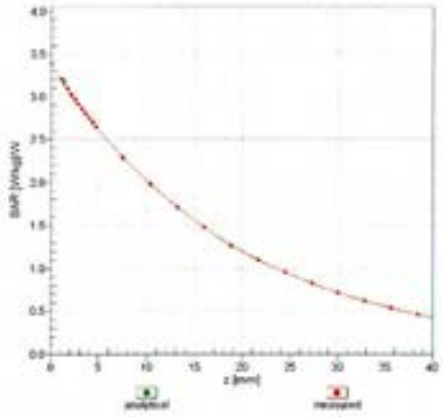
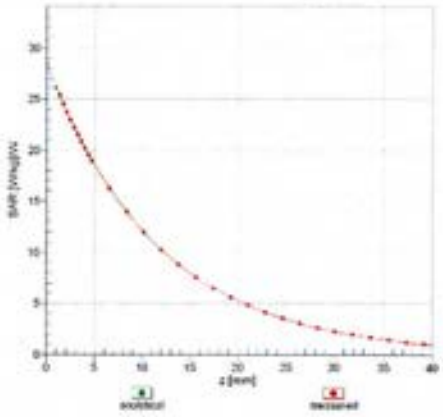
## Conversion Factor Assessment

f = 835 MHz,WGLS R9 (H_convF)

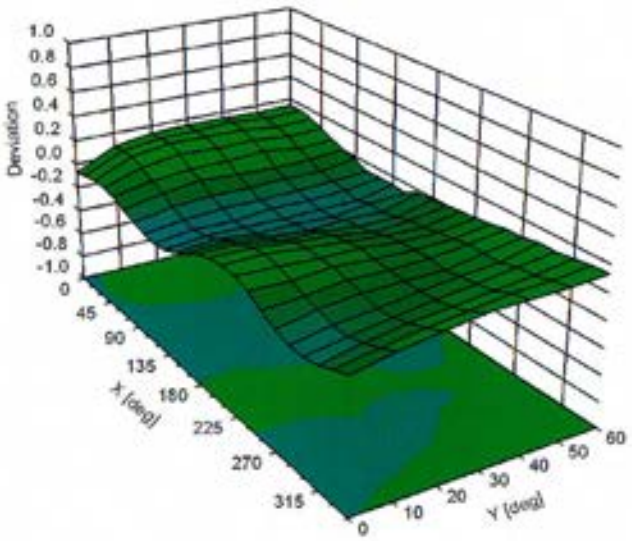


f = 1900 MHz,WGLS R22 (H_convF)



## Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz





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

## Appendix: Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB√μV | C | D dB | VR mV | Max dev. | Unc[E] (k=2) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 118.4 | ±3.8 % | ± 4.7 % |
| | | Y | 0.0 | 0.0 | 1.0 | | 133.1 | | |
| | | Z | 0.0 | 0.0 | 1.0 | | 117.4 | | |
| 10100-CAE | LTE-FDD (SC-FDMA, 100% RB, 20 MHz, QPSK) | X | 6.43 | 67.6 | 19.8 | 5.67 | 141.8 | ±1.4 % | ± 4.7 % |
| | | Y | 6.81 | 70.2 | 22.1 | | 112.8 | | |
| | | Z | 6.36 | 67.4 | 19.7 | | 140.0 | | |
| 10108-CAG | LTE-FDD (SC-FDMA, 100% RB, 10 MHz, QPSK) | X | 6.29 | 67.3 | 19.8 | 5.80 | 138.5 | ±2.2 % | ± 4.7 % |
| | | Y | 7.56 | 73.7 | 24.5 | | 110.1 | | |
| | | Z | 6.26 | 67.3 | 19.8 | | 136.5 | | |
| 10110-CAG | LTE-FDD (SC-FDMA, 100% RB, 5 MHz, QPSK) | X | 5.97 | 67.0 | 19.8 | 5.75 | 134.4 | ±2.5 % | ± 4.7 % |
| | | Y | 6.87 | 72.6 | 24.2 | | 149.0 | | |
| | | Z | 5.93 | 66.8 | 19.6 | | 132.2 | | |
| 10154-CAG | LTE-FDD (SC-FDMA, 50% RB, 10 MHz, QPSK) | X | 5.97 | 67.0 | 19.8 | 5.75 | 134.3 | ±2.5 % | ± 4.7 % |
| | | Y | 6.95 | 73.0 | 24.5 | | 149.0 | | |
| | | Z | 5.95 | 66.9 | 19.6 | | 132.6 | | |
| 10156-CAG | LTE-FDD (SC-FDMA, 50% RB, 5 MHz, QPSK) | X | 5.77 | 67.1 | 19.8 | 5.79 | 129.9 | ±2.5 % | ± 4.7 % |
| | | Y | 6.92 | 74.0 | 25.2 | | 144.8 | | |
| | | Z | 5.72 | 66.8 | 19.7 | | 128.0 | | |
| 10160-CAE | LTE-FDD (SC-FDMA, 50% RB, 15 MHz, QPSK) | X | 6.41 | 67.5 | 20.0 | 5.82 | 140.2 | ±2.5 % | ± 4.7 % |
| | | Y | 8.27 | 76.0 | 25.8 | | 111.2 | | |
| | | Z | 6.37 | 67.4 | 19.9 | | 137.5 | | |
| 10169-CAE | LTE-FDD (SC-FDMA, 1 RB, 20 MHz, QPSK) | X | 4.81 | 67.0 | 20.0 | 5.73 | 116.5 | ±2.7 % | ± 4.7 % |
| | | Y | 7.29 | 81.0 | 29.2 | | 129.3 | | |
| | | Z | 4.77 | 66.7 | 19.8 | | 114.7 | | |
| 10175-CAG | LTE-FDD (SC-FDMA, 1 RB, 10 MHz, QPSK) | X | 4.80 | 66.9 | 20.0 | 5.72 | 116.1 | ±2.5 % | ± 4.7 % |
| | | Y | 6.87 | 79.0 | 28.1 | | 129.3 | | |
| | | Z | 4.80 | 66.9 | 19.9 | | 114.1 | | |
| 10177-CAI | LTE-FDD (SC-FDMA, 1 RB, 5 MHz, QPSK) | X | 4.82 | 67.1 | 20.1 | 5.73 | 115.5 | ±2.5 % | ± 4.7 % |
| | | Y | 6.68 | 78.1 | 27.6 | | 129.4 | | |
| | | Z | 4.78 | 66.8 | 19.9 | | 113.9 | | |
| 10181-CAE | LTE-FDD (SC-FDMA, 1 RB, 15 MHz, QPSK) | X | 4.88 | 67.4 | 20.3 | 5.72 | 116.3 | ±2.5 % | ± 4.7 % |
| | | Y | 6.81 | 78.7 | 27.9 | | 129.1 | | |
| | | Z | 4.80 | 66.8 | 19.9 | | 114.1 | | |
| 10297-AAD | LTE-FDD (SC-FDMA, 50% RB, 20 MHz, QPSK) | X | 6.37 | 67.7 | 20.2 | 5.81 | 138.2 | ±2.5 % | ± 4.7 % |
| | | Y | 7.95 | 75.1 | 25.4 | | 110.4 | | |
| | | Z | 6.32 | 67.5 | 20.0 | | 136.2 | | |
| 10311-AAD | LTE-FDD (SC-FDMA, 100% RB, 15 MHz, QPSK) | X | 6.90 | 68.1 | 20.4 | 6.06 | 144.1 | ±2.5 % | ± 4.7 % |
| | | Y | 8.57 | 75.6 | 25.7 | | 113.8 | | |
| | | Z | 6.90 | 68.0 | 20.4 | | 140.7 | | |

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 10415-AAA | IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle) | X | 3.27 | 71.5 | 20.0 | 1.54 | 130.5 | ±3.0 % | ± 4.7 % |
| | | Y | 7.44 | 100.0 | 36.1 | | 146.5 | | |
| | | Z | 3.30 | 71.7 | 20.1 | | 128.2 | | |
| 10435-AAF | LTE-TDD (SC-FDMA, 1 RB, 20 MHz, QPSK, UL Subframe=2,3,4,7,8,9) | X | 5.67 | 70.0 | 23.2 | 7.82 | 134.0 | ±2.2 % | ± 4.7 % |
| | | Y | 6.40 | 76.6 | 28.9 | | 142.3 | | |
| | | Z | 5.66 | 69.8 | 23.0 | | 132.2 | | |
| 10467-AAF | LTE-TDD (SC-FDMA, 1 RB, 5 MHz, QPSK, UL Subframe=2,3,4,7,8,9) | X | 5.67 | 70.0 | 23.2 | 7.82 | 133.7 | ±1.4 % | ± 4.7 % |
| | | Y | 5.81 | 72.6 | 26.0 | | 142.6 | | |
| | | Z | 5.65 | 69.7 | 22.9 | | 131.7 | | |
| 10470-AAF | LTE-TDD (SC-FDMA, 1 RB, 10 MHz, QPSK, UL Subframe=2,3,4,7,8,9) | X | 5.64 | 69.8 | 23.0 | 7.82 | 133.5 | ±1.4 % | ± 4.7 % |
| | | Y | 5.73 | 71.9 | 25.4 | | 142.7 | | |
| | | Z | 5.69 | 69.9 | 23.0 | | 131.9 | | |
| 10473-AAE | LTE-TDD (SC-FDMA, 1 RB, 15 MHz, QPSK, UL Subframe=2,3,4,7,8,9) | X | 5.67 | 70.1 | 23.2 | 7.82 | 133.5 | ±1.2 % | ± 4.7 % |
| | | Y | 5.65 | 71.4 | 25.1 | | 142.7 | | |
| | | Z | 5.67 | 69.8 | 23.0 | | 131.5 | | |
| 10485-AAF | LTE-TDD (SC-FDMA, 50% RB, 5 MHz, QPSK, UL Subframe=2,3,4,7,8,9) | X | 6.02 | 67.8 | 21.6 | 7.59 | 110.4 | ±1.2 % | ± 4.7 % |
| | | Y | 6.00 | 69.0 | 23.2 | | 121.1 | | |
| | | Z | 6.30 | 68.9 | 22.1 | | 149.7 | | |
| 10488-AAF | LTE-TDD (SC-FDMA, 50% RB, 10 MHz, QPSK, UL Subframe=2,3,4,7,8,9) | X | 6.35 | 67.6 | 21.5 | 7.70 | 114.9 | ±1.2 % | ± 4.7 % |
| | | Y | 6.26 | 68.5 | 22.9 | | 124.7 | | |
| | | Z | 6.37 | 67.6 | 21.4 | | 113.3 | | |
| 10491-AAE | LTE-TDD (SC-FDMA, 50% RB, 15 MHz, QPSK, UL Subframe=2,3,4,7,8,9) | X | 6.74 | 68.0 | 21.6 | 7.74 | 119.3 | ±1.2 % | ± 4.7 % |
| | | Y | 6.58 | 68.6 | 22.9 | | 129.0 | | |
| | | Z | 6.73 | 67.8 | 21.5 | | 117.8 | | |
| 10494-AAF | LTE-TDD (SC-FDMA, 50% RB, 20 MHz, QPSK, UL Subframe=2,3,4,7,8,9) | X | 6.75 | 68.1 | 21.7 | 7.74 | 119.1 | ±1.2 % | ± 4.7 % |
| | | Y | 6.56 | 68.6 | 23.0 | | 128.9 | | |
| | | Z | 6.74 | 67.9 | 21.6 | | 117.6 | | |
| 10503-AAF | LTE-TDD (SC-FDMA, 100% RB, 5 MHz, QPSK, UL Subframe=2,3,4,7,8,9) | X | 6.37 | 67.7 | 21.5 | 7.72 | 114.8 | ±1.4 % | ± 4.7 % |
| | | Y | 6.34 | 68.9 | 23.2 | | 124.8 | | |
| | | Z | 6.36 | 67.4 | 21.3 | | 113.4 | | |
| 10506-AAF | LTE-TDD (SC-FDMA, 100% RB, 10 MHz, QPSK, UL Subframe=2,3,4,7,8,9) | X | 6.72 | 68.0 | 21.7 | 7.74 | 118.9 | ±1.4 % | ± 4.7 % |
| | | Y | 6.56 | 68.6 | 23.0 | | 128.6 | | |
| | | Z | 6.73 | 67.9 | 21.6 | | 117.8 | | |
| 10509-AAE | LTE-TDD (SC-FDMA, 100% RB, 15 MHz, QPSK, UL Subframe=2,3,4,7,8,9) | X | 7.35 | 68.6 | 22.0 | 7.99 | 124.0 | ±1.4 % | ± 4.7 % |
| | | Y | 7.06 | 68.7 | 23.0 | | 133.6 | | |
| | | Z | 7.37 | 68.5 | 22.0 | | 122.9 | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 10512-AAF | LTE-TDD (SC-FDMA, 100% RB, 20 MHz, QPSK, UL Subframe=2,3,4,7,8,9) | X | 7.09 | 68.6 | 21.9 | 7.74 | 122.9 | ±1.4 % | ± 4.7 % |
| | | Y | 6.83 | 69.0 | 23.0 | | 131.8 | | |
| | | Z | 7.10 | 68.5 | 21.8 | | 121.3 | | |
| 10571-AAA | IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 90pc duty cycle) | X | 3.42 | 71.9 | 20.4 | 1.99 | 127.1 | ±1.9 % | ± 4.7 % |
| | | Y | 9.13 | 99.3 | 33.8 | | 140.7 | | |
| | | Z | 3.61 | 72.9 | 21.0 | | 124.4 | | |

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

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Accreditation No.: SCS 0108

Client **Motorola Solutions MY**

Certificate No: **EX3-7486_Oct19**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | EX3DV4 - SN:7486 |
| Calibration procedure(s) | QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v5, QA CAL-23.v5, QA CAL-25.v7<br>Calibration procedure for dosimetric E-field probes |
| Calibration date: | October 24, 2019 |

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter NRP | SN: 104778 | 03-Apr-19 (No. 217-02892/02893) | Apr-20 |
| Power sensor NRP-Z91 | SN: 103244 | 03-Apr-19 (No. 217-02892) | Apr-20 |
| Power sensor NRP-Z91 | SN: 103245 | 03-Apr-19 (No. 217-02893) | Apr-20 |
| Reference 20 dB Attenuator | SN: S5277 (20x) | 04-Apr-19 (No. 217-02894) | Apr-20 |
| DAE4 | SN: 660 | 07-Oct-19 (No. DAE4-660_Oct19) | Oct-20 |
| Reference Probe ES3DV2 | SN: 3013 | 31-Dec-18 (No. ES3-3013_Dec18) | Dec-19 |
| | | | |
| Secondary Standards | ID | Check Date (in house) | Scheduled Check |
| Power meter E4419B | SN: GB41293874 | 06-Apr-16 (in house check Jun-18) | In house check: Jun-20 |
| Power sensor E4412A | SN: MY41498087 | 06-Apr-16 (in house check Jun-18) | In house check: Jun-20 |
| Power sensor E4412A | SN: 000110210 | 06-Apr-16 (in house check Jun-18) | In house check: Jun-20 |
| RF generator HP 8648C | SN: US3642U01700 | 04-Aug-99 (in house check Jun-18) | In house check: Jun-20 |
| Network Analyzer E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-18) | In house check: Oct-19 |

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

Issued: October 24, 2019

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

## Glossary:

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

## Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, ", "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

## Methods Applied and Interpretation of Parameters:

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

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:7486

## Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|---|---|---|---|
| Norm ($\mu V/(V/m)^2$)[A] | 0.37 | 0.47 | 0.48 | ± 10.1 % |
| DCP (mV)[B] | 105.6 | 93.2 | 97.9 | |

## Calibration Results for Modulation Response

| UID | Communication System Name | | A dB | B dB√μV | C | D dB | VR mV | Max dev. | Unc[E] (k=2) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 137.7 | ±3.8 % | ± 4.7 % |
| | | Y | 0.0 | 0.0 | 1.0 | | 152.0 | | |
| | | Z | 0.0 | 0.0 | 1.0 | | 161.5 | | |

Note: For details on UID parameters see Appendix

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

[A] The uncertainties of Norm X,Y,Z do not affect the $E^2$-field uncertainty inside TSL (see Pages 5 and 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:7486

## Other Probe Parameters

| | |
|---|---|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 19.4 |
| Mechanical Surface Detection Mode | enabled |
| Optical Surface Detection Mode | disabled |
| Probe Overall Length | 337 mm |
| Probe Body Diameter | 10 mm |
| Tip Length | 9 mm |
| Tip Diameter | 2.5 mm |
| Probe Tip to Sensor X Calibration Point | 1 mm |
| Probe Tip to Sensor Y Calibration Point | 1 mm |
| Probe Tip to Sensor Z Calibration Point | 1 mm |
| Recommended Measurement Distance from Surface | 1.4 mm |

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:7486

## Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha [G] | Depth [G] (mm) | Unc (k=2) |
|---|---|---|---|---|---|---|---|---|
| 150 | 52.3 | 0.76 | 13.49 | 13.49 | 13.49 | 0.00 | 1.00 | ± 13.3 % |
| 300 | 45.3 | 0.87 | 12.20 | 12.20 | 12.20 | 0.07 | 1.20 | ± 13.3 % |
| 450 | 43.5 | 0.87 | 11.40 | 11.40 | 11.40 | 0.10 | 1.30 | ± 13.3 % |
| 750 | 41.9 | 0.89 | 10.68 | 10.68 | 10.68 | 0.34 | 1.06 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 10.46 | 10.46 | 10.46 | 0.45 | 0.85 | ± 12.0 % |
| 900 | 41.5 | 0.97 | 10.31 | 10.31 | 10.31 | 0.32 | 1.00 | ± 12.0 % |
| 1810 | 40.0 | 1.40 | 8.50 | 8.50 | 8.50 | 0.31 | 0.87 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 8.46 | 8.46 | 8.46 | 0.34 | 0.87 | ± 12.0 % |
| 2100 | 39.8 | 1.49 | 8.36 | 8.36 | 8.36 | 0.34 | 0.87 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 7.59 | 7.59 | 7.59 | 0.34 | 0.90 | ± 12.0 % |
| 5250 | 35.9 | 4.71 | 5.60 | 5.60 | 5.60 | 0.40 | 1.80 | ± 13.1 % |
| 5500 | 35.6 | 4.96 | 5.07 | 5.07 | 5.07 | 0.40 | 1.80 | ± 13.1 % |
| 5600 | 35.5 | 5.07 | 4.85 | 4.85 | 4.85 | 0.40 | 1.80 | ± 13.1 % |
| 5750 | 35.4 | 5.22 | 5.02 | 5.02 | 5.02 | 0.40 | 1.80 | ± 13.1 % |

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.

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

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

# DASY/EASY - Parameters of Probe: EX3DV4 - SN:7486

## Calibration Parameter Determined in Body Tissue Simulating Media

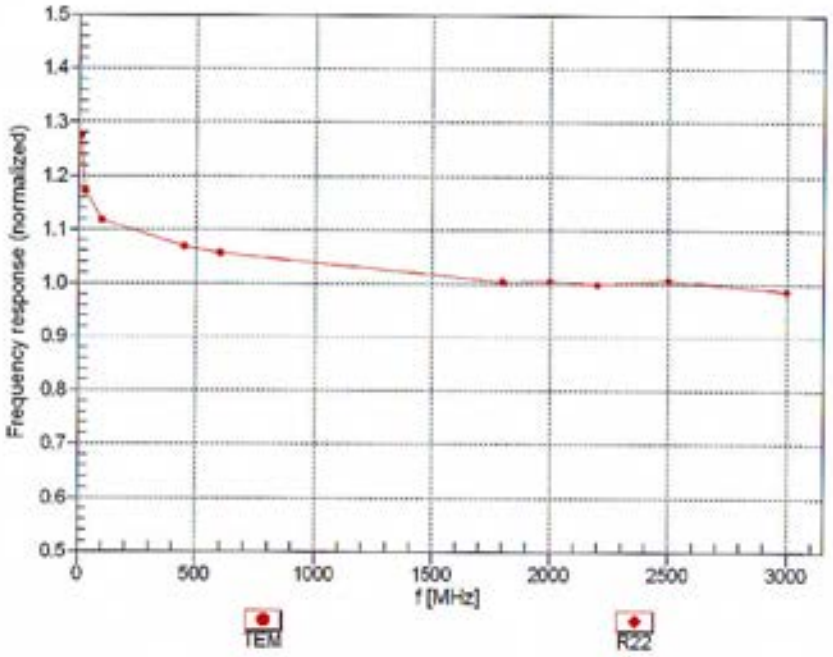
| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha [G] | Depth [G] (mm) | Unc (k=2) |
|---|---|---|---|---|---|---|---|---|
| 150 | 61.9 | 0.80 | 13.04 | 13.04 | 13.04 | 0.00 | 1.00 | ± 13.3 % |
| 300 | 58.2 | 0.92 | 11.99 | 11.99 | 11.99 | 0.04 | 1.20 | ± 13.3 % |
| 450 | 56.7 | 0.94 | 11.73 | 11.73 | 11.73 | 0.08 | 1.30 | ± 13.3 % |
| 750 | 55.5 | 0.96 | 10.49 | 10.49 | 10.49 | 0.25 | 1.08 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 10.28 | 10.28 | 10.28 | 0.32 | 0.94 | ± 12.0 % |
| 900 | 55.0 | 1.05 | 10.03 | 10.03 | 10.03 | 0.26 | 1.01 | ± 12.0 % |
| 1810 | 53.3 | 1.52 | 8.48 | 8.48 | 8.48 | 0.36 | 0.87 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 8.37 | 8.37 | 8.37 | 0.38 | 0.87 | ± 12.0 % |
| 2100 | 53.2 | 1.62 | 8.34 | 8.34 | 8.34 | 0.34 | 0.87 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 7.67 | 7.67 | 7.67 | 0.37 | 0.90 | ± 12.0 % |
| 5250 | 48.9 | 5.36 | 4.72 | 4.72 | 4.72 | 0.50 | 1.90 | ± 13.1 % |
| 5500 | 48.6 | 5.65 | 4.28 | 4.28 | 4.28 | 0.50 | 1.90 | ± 13.1 % |
| 5600 | 48.5 | 5.77 | 4.12 | 4.12 | 4.12 | 0.50 | 1.90 | ± 13.1 % |
| 5750 | 48.3 | 5.94 | 4.26 | 4.26 | 4.26 | 0.50 | 1.90 | ± 13.1 % |

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.

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

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

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

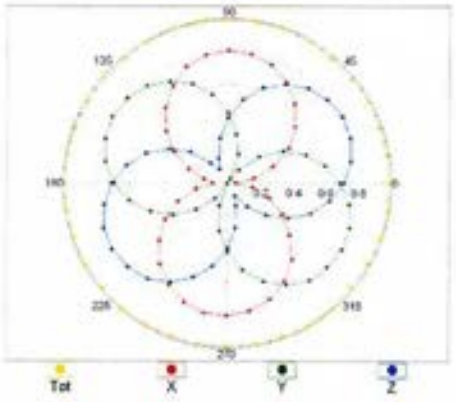



Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

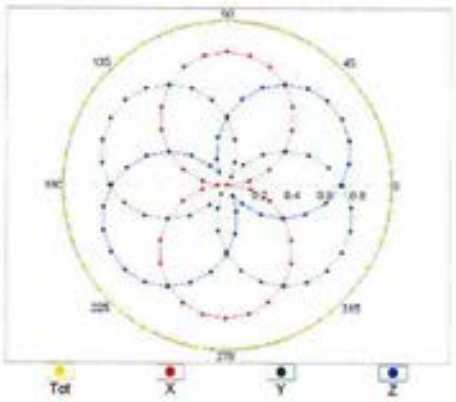
EX3DV4– SN:7486 October 24, 2019

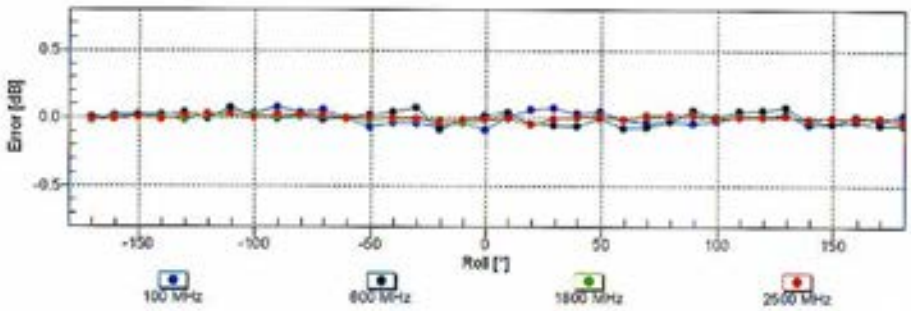
## Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM




f=1800 MHz,R22




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

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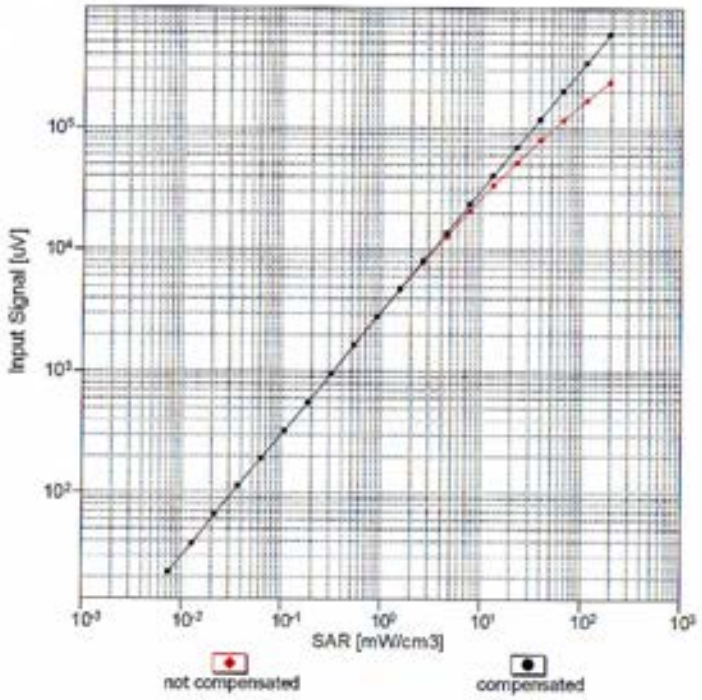
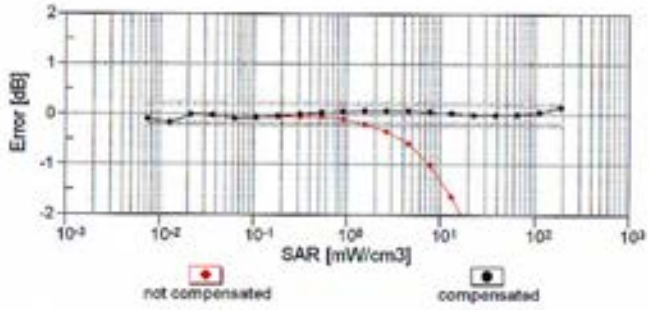
## Dynamic Range f(SAR$_{head}$)
(TEM cell , $f_{eval}$= 1900 MHz)




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

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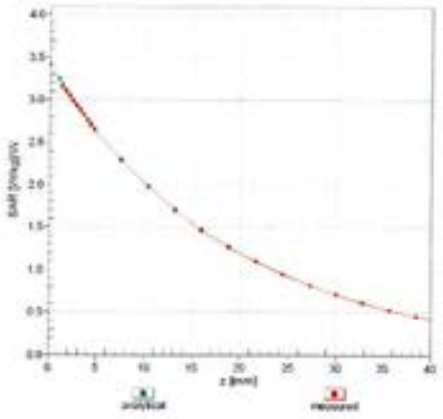
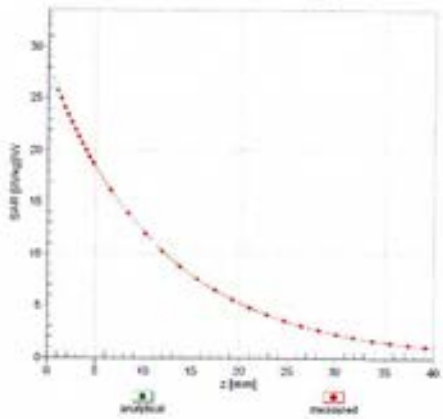
## Conversion Factor Assessment

f = 835 MHz,WGLS R9 (H_convF)

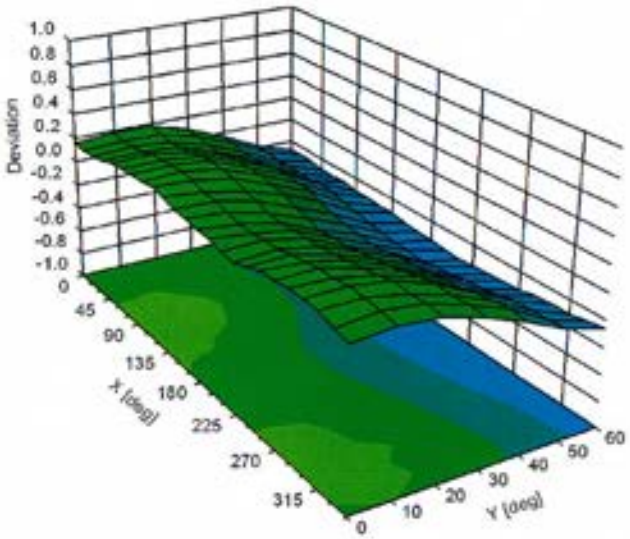


f = 1900 MHz,WGLS R22 (H_convF)



## Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz





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

## Appendix: Modulation Calibration Parameters

| UID | Communication System Name | | A dB | B dB√μV | C | D dB | VR mV | Max dev. | Unc[E] (k=2) |
|---|---|---|---|---|---|---|---|---|---|
| 0 | CW | X | 0.0 | 0.0 | 1.0 | 0.00 | 137.7 | ±3.8 % | ± 4.7 % |
| | | Y | 0.0 | 0.0 | 1.0 | | 152.0 | | |
| | | Z | 0.0 | 0.0 | 1.0 | | 161.5 | | |
| 10021-DAC | GSM-FDD (TDMA, GMSK) | X | 15.47 | 100.0 | 26.2 | 9.39 | 82.1 | ±3.5 % | ± 4.7 % |
| | | Y | 14.51 | 99.4 | 26.0 | | 66.7 | | |
| | | Z | 10.49 | 99.5 | 28.8 | | 96.2 | | |
| 10023-DAC | GPRS-FDD (TDMA, GMSK, TN 0) | X | 1.66 | 65.0 | 12.6 | 9.57 | 80.2 | ±2.7 % | ± 4.7 % |
| | | Y | 29.46 | 99.7 | 23.7 | | 64.9 | | |
| | | Z | 10.83 | 98.5 | 28.3 | | 93.5 | | |
| 10024-DAC | GPRS-FDD (TDMA, GMSK, TN 0-1) | X | 0.99 | 60.7 | 8.4 | 6.56 | 125.8 | ±3.0 % | ± 4.7 % |
| | | Y | 21.05 | 99.6 | 23.1 | | 122.6 | | |
| | | Z | 2.48 | 74.1 | 17.0 | | 147.2 | | |
| 10025-DAC | EDGE-FDD (TDMA, 8PSK, TN 0) | X | 8.37 | 89.3 | 34.3 | 12.62 | 52.9 | ±1.7 % | ± 4.7 % |
| | | Y | 5.46 | 77.1 | 29.2 | | 42.7 | | |
| | | Z | 8.46 | 91.9 | 37.4 | | 62.0 | | |
| 10026-DAC | EDGE-FDD (TDMA, 8PSK, TN 0-1) | X | 5.58 | 79.9 | 28.0 | 9.55 | 119.8 | ±1.9 % | ± 4.7 % |
| | | Y | 4.75 | 75.8 | 26.8 | | 96.9 | | |
| | | Z | 5.41 | 78.1 | 27.7 | | 141.1 | | |
| 10027-DAC | GPRS-FDD (TDMA, GMSK, TN 0-1-2) | X | 34.47 | 99.9 | 21.2 | 4.80 | 121.3 | ±3.0 % | ± 4.7 % |
| | | Y | 29.06 | 99.9 | 21.4 | | 126.1 | | |
| | | Z | 13.02 | 99.2 | 24.7 | | 142.4 | | |
| 10028-DAC | GPRS-FDD (TDMA, GMSK, TN 0-1-2-3) | X | 29.63 | 98.9 | 20.4 | 3.55 | 136.1 | ±2.7 % | ± 4.7 % |
| | | Y | 15.01 | 99.2 | 22.1 | | 144.3 | | |
| | | Z | 9.31 | 99.4 | 25.2 | | 120.3 | | |
| 10029-DAC | EDGE-FDD (TDMA, 8PSK, TN 0-1-2) | X | 9.47 | 98.7 | 36.4 | 7.78 | 117.6 | ±2.2 % | ± 4.7 % |
| | | Y | 5.43 | 82.2 | 29.6 | | 149.9 | | |
| | | Z | 10.13 | 99.2 | 36.7 | | 139.4 | | |
| 10039-CAB | CDMA2000 (1xRTT, RC1) | X | 6.17 | 76.0 | 24.7 | 4.57 | 146.7 | ±1.4 % | ± 4.7 % |
| | | Y | 4.90 | 69.1 | 21.1 | | 118.1 | | |
| | | Z | 5.96 | 74.2 | 23.7 | | 126.2 | | |
| 10056-CAA | UMTS-TDD (TD-SCDMA, 1.28 Mcps) | X | 4.87 | 78.5 | 30.0 | 11.01 | 77.6 | ±2.2 % | ± 4.7 % |
| | | Y | 3.98 | 73.0 | 28.0 | | 62.2 | | |
| | | Z | 4.65 | 75.3 | 28.7 | | 90.2 | | |
| 10058-DAC | EDGE-FDD (TDMA, 8PSK, TN 0-1-2-3) | X | 6.68 | 87.2 | 29.7 | 6.52 | 134.1 | ±1.7 % | ± 4.7 % |
| | | Y | 5.19 | 81.2 | 27.9 | | 142.8 | | |
| | | Z | 4.96 | 79.0 | 26.7 | | 118.1 | | |
| 10081-CAB | CDMA2000 (1xRTT, RC3) | X | 6.20 | 79.7 | 26.3 | 3.97 | 143.7 | ±1.4 % | ± 4.7 % |
| | | Y | 4.66 | 71.7 | 22.4 | | 115.6 | | |
| | | Z | 5.76 | 76.7 | 24.8 | | 123.9 | | |
| 10090-DAC | GPRS-FDD (TDMA, GMSK, TN 0-4) | X | 15.43 | 99.6 | 24.4 | 6.56 | 125.4 | ±3.5 % | ± 4.7 % |
| | | Y | 18.16 | 99.6 | 23.6 | | 121.1 | | |
| | | Z | 9.82 | 99.2 | 27.4 | | 147.6 | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 10099-DAC | EDGE-FDD (TDMA, 8PSK, TN 0-4) | X | 10.19 | 99.2 | 37.2 | 9.55 | 118.7 | ±2.7 % | ±4.7 % |
| | | Y | 5.22 | 79.1 | 28.7 | | 95.2 | | |
| | | Z | 8.20 | 92.9 | 35.7 | | 139.5 | | |
| 10117-CAC | IEEE 802.11n (HT Mixed, 13.5 Mbps, BPSK) | X | 9.78 | 68.8 | 21.6 | 8.07 | 103.7 | ±1.7 % | ±4.7 % |
| | | Y | 9.82 | 68.4 | 21.5 | | 117.8 | | |
| | | Z | 10.24 | 69.7 | 22.2 | | 128.2 | | |
| 10196-CAC | IEEE 802.11n (HT Mixed, 6.5 Mbps, BPSK) | X | 10.17 | 71.0 | 23.1 | 8.10 | 144.0 | ±1.4 % | ±4.7 % |
| | | Y | 9.71 | 69.1 | 22.2 | | 112.3 | | |
| | | Z | 10.03 | 70.3 | 22.8 | | 122.1 | | |
| 10290-AAB | CDMA2000, RC1, SO55, Full Rate | X | 11.62 | 94.6 | 32.3 | 3.91 | 146.3 | ±1.9 % | ±4.7 % |
| | | Y | 7.57 | 82.8 | 27.6 | | 117.6 | | |
| | | Z | 7.76 | 83.3 | 27.7 | | 126.1 | | |
| 10291-AAB | CDMA2000, RC3, SO55, Full Rate | X | 11.80 | 99.2 | 34.4 | 3.46 | 143.4 | ±1.9 % | ±4.7 % |
| | | Y | 12.94 | 99.3 | 34.1 | | 115.2 | | |
| | | Z | 12.06 | 97.1 | 33.1 | | 123.5 | | |
| 10292-AAB | CDMA2000, RC3, SO32, Full Rate | X | 11.92 | 99.8 | 34.6 | 3.39 | 143.5 | ±1.9 % | ±4.7 % |
| | | Y | 12.32 | 98.8 | 34.0 | | 114.9 | | |
| | | Z | 13.37 | 99.8 | 33.9 | | 123.6 | | |
| 10293-AAB | CDMA2000, RC3, SO3, Full Rate | X | 11.76 | 99.1 | 34.4 | 3.50 | 143.5 | ±2.2 % | ±4.7 % |
| | | Y | 12.62 | 99.4 | 34.5 | | 115.0 | | |
| | | Z | 10.86 | 94.7 | 32.3 | | 123.6 | | |
| 10295-AAB | CDMA2000, RC1, SO3, 1/8th Rate 25 fr. | X | 4.92 | 66.4 | 23.8 | 12.49 | 63.0 | ±0.9 % | ±4.7 % |
| | | Y | 4.52 | 63.4 | 22.8 | | 50.7 | | |
| | | Z | 5.29 | 67.5 | 24.8 | | 74.0 | | |
| 10403-AAB | CDMA2000 (1xEV-DO, Rev. 0) | X | 17.21 | 99.8 | 32.2 | 3.76 | 147.7 | ±1.4 % | ±4.7 % |
| | | Y | 8.19 | 81.9 | 25.6 | | 119.6 | | |
| | | Z | 13.55 | 93.3 | 30.0 | | 127.1 | | |
| 10404-AAB | CDMA2000 (1xEV-DO, Rev. A) | X | 15.68 | 99.4 | 32.6 | 3.77 | 146.5 | ±1.9 % | ±4.7 % |
| | | Y | 15.19 | 96.4 | 31.5 | | 118.1 | | |
| | | Z | 16.70 | 99.3 | 32.4 | | 126.4 | | |
| 10406-AAB | CDMA2000, RC3, SO32, SCH0, Full Rate | X | 17.03 | 97.6 | 33.1 | 5.22 | 148.4 | ±1.9 % | ±4.7 % |
| | | Y | 11.79 | 86.9 | 29.1 | | 120.1 | | |
| | | Z | 10.22 | 84.1 | 27.9 | | 129.0 | | |
| 10415-AAA | IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 99pc duty cycle) | X | 7.42 | 98.4 | 34.5 | 1.54 | 109.8 | ±2.5 % | ±4.7 % |
| | | Y | 9.91 | 100.0 | 33.3 | | 120.8 | | |
| | | Z | 9.73 | 98.5 | 32.6 | | 131.8 | | |
| 10417-AAB | IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps, 99pc duty cycle) | X | 10.51 | 72.0 | 23.9 | 8.23 | 143.9 | ±1.7 % | ±4.7 % |
| | | Y | 10.07 | 70.1 | 23.0 | | 111.5 | | |
| | | Z | 10.21 | 70.7 | 23.2 | | 122.5 | | |
| 10418-AAA | IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps, 99pc duty cycle, Long preambule) | X | 10.40 | 72.0 | 23.9 | 8.14 | 142.3 | ±1.7 % | ±4.7 % |
| | | Y | 9.82 | 69.6 | 22.6 | | 110.3 | | |
| | | Z | 10.06 | 70.6 | 23.2 | | 121.0 | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 10458-AAA | CDMA2000 (1xEV-DO, Rev. B, 2 carriers) | X | 10.47 | 77.6 | 25.7 | 6.55 | 124.7 | ±1.7 % | ±4.7 % |
| | | Y | 8.97 | 72.5 | 23.3 | | 142.6 | | |
| | | Z | 9.40 | 74.2 | 24.0 | | 107.3 | | |
| 10459-AAA | CDMA2000 (1xEV-DO, Rev. B, 3 carriers) | X | 11.67 | 74.4 | 24.9 | 8.25 | 148.1 | ±1.7 % | ±4.7 % |
| | | Y | 11.22 | 72.3 | 24.0 | | 117.0 | | |
| | | Z | 11.08 | 72.4 | 23.9 | | 127.1 | | |
| 10515-AAA | IEEE 802.11b WiFi 2.4 GHz (DSSS, 2 Mbps, 99pc duty cycle) | X | 7.34 | 98.4 | 34.5 | 1.58 | 109.7 | ±2.2 % | ±4.7 % |
| | | Y | 9.17 | 98.7 | 33.0 | | 121.1 | | |
| | | Z | 10.32 | 99.6 | 32.8 | | 131.4 | | |
| 10525-AAB | IEEE 802.11ac WiFi (20MHz, MCS0, 99pc duty cycle) | X | 10.70 | 72.1 | 24.0 | 8.36 | 145.4 | ±1.7 % | ±4.7 % |
| | | Y | 10.29 | 70.4 | 23.3 | | 113.0 | | |
| | | Z | 10.39 | 70.8 | 23.3 | | 123.1 | | |
| 10534-AAB | IEEE 802.11ac WiFi (40MHz, MCS0, 99pc duty cycle) | X | 10.76 | 71.1 | 23.4 | 8.45 | 103.9 | ±1.7 % | ±4.7 % |
| | | Y | 10.58 | 70.0 | 22.9 | | 118.6 | | |
| | | Z | 10.94 | 71.1 | 23.4 | | 130.0 | | |
| 10544-AAB | IEEE 802.11ac WiFi (80MHz, MCS0, 99pc duty cycle) | X | 10.82 | 70.4 | 22.8 | 8.47 | 108.4 | ±1.4 % | ±4.7 % |
| | | Y | 10.78 | 69.9 | 22.7 | | 122.2 | | |
| | | Z | 11.31 | 71.4 | 23.5 | | 135.6 | | |
| 10571-AAA | IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps, 90pc duty cycle) | X | 9.46 | 100.0 | 33.9 | 1.99 | 147.9 | ±1.9 % | ±4.7 % |
| | | Y | 10.20 | 99.9 | 33.2 | | 116.6 | | |
| | | Z | 9.81 | 98.7 | 33.1 | | 128.4 | | |
| 10572-AAA | IEEE 802.11b WiFi 2.4 GHz (DSSS, 2 Mbps, 90pc duty cycle) | X | 8.79 | 99.6 | 34.2 | 1.99 | 147.3 | ±1.9 % | ±4.7 % |
| | | Y | 9.98 | 99.8 | 33.3 | | 116.9 | | |
| | | Z | 9.76 | 98.8 | 33.1 | | 128.1 | | |
| 10575-AAA | IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps, 90pc duty cycle) | X | 10.53 | 71.8 | 24.1 | 8.59 | 140.2 | ±1.7 % | ±4.7 % |
| | | Y | 10.12 | 70.2 | 23.3 | | 106.9 | | |
| | | Z | 10.31 | 70.8 | 23.6 | | 119.3 | | |
| 10583-AAB | IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps, 90pc duty cycle) | X | 10.55 | 71.9 | 24.1 | 8.59 | 140.7 | ±1.4 % | ±4.7 % |
| | | Y | 10.01 | 69.7 | 23.0 | | 109.4 | | |
| | | Z | 10.33 | 70.8 | 23.6 | | 119.4 | | |
| 10591-AAB | IEEE 802.11n (HT Mixed, 20MHz, MCS0, 90pc duty cycle) | X | 10.61 | 71.7 | 24.0 | 8.63 | 142.4 | ±1.4 % | ±4.7 % |
| | | Y | 10.04 | 69.4 | 22.7 | | 110.8 | | |
| | | Z | 10.41 | 70.7 | 23.5 | | 120.8 | | |
| 10599-AAB | IEEE 802.11n (HT Mixed, 40MHz, MCS0, 90pc duty cycle) | X | 10.70 | 70.7 | 23.4 | 8.79 | 102.9 | ±1.4 % | ±4.7 % |
| | | Y | 10.60 | 69.8 | 22.9 | | 116.5 | | |
| | | Z | 10.98 | 71.0 | 23.6 | | 128.0 | | |
| 10607-AAB | IEEE 802.11ac WiFi (20MHz, MCS0, 90pc duty cycle) | X | 10.72 | 72.0 | 24.3 | 8.64 | 142.1 | ±1.7 % | ±4.7 % |
| | | Y | 10.03 | 69.4 | 22.8 | | 110.2 | | |
| | | Z | 10.48 | 70.9 | 23.7 | | 121.0 | | |
| 10616-AAB | IEEE 802.11ac WiFi (40MHz, MCS0, 90pc duty cycle) | X | 10.73 | 70.7 | 23.5 | 8.82 | 103.0 | ±1.4 % | ±4.7 % |
| | | Y | 10.55 | 69.6 | 22.8 | | 116.4 | | |
| | | Z | 11.04 | 71.1 | 23.7 | | 128.5 | | |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 10626-AAB | IEEE 802.11ac WiFi (80MHz, MCS0, 90pc duty cycle) | X | 10.86 | 70.2 | 22.9 | 8.83 | 106.8 | ±1.4 % | ± 4.7 % |
| | | Y | 10.78 | 69.6 | 22.7 | | 119.8 | | |
| | | Z | 11.41 | 71.4 | 23.7 | | 133.4 | | |
| 10648-AAA | CDMA2000 (1x Advanced) | X | 12.74 | 100.0 | 34.1 | 3.45 | 144.2 | ±1.9 % | ± 4.7 % |
| | | Y | 8.46 | 88.8 | 29.9 | | 115.0 | | |
| | | Z | 13.18 | 99.5 | 34.0 | | 124.5 | | |

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

# 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 0108**

**Client** Motorola Solutions MY

**Certificate No: D450V3-1053_Oct18**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D450V3 - SN:1053 |
| Calibration procedure(s) | QA CAL-15.v8<br>Calibration procedure for dipole validation kits below 700 MHz |
| Calibration date: | October 19, 2018 |

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

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

Calibration Equipment used (M&TE critical for calibration)

| Primary Standards | ID # | Cal Date (Certificate No.) | Scheduled Calibration |
|---|---|---|---|
| Power meter NRP | SN: 104778 | 04-Apr-18 (No. 217-02672/02673) | Apr-19 |
| Power sensor NRP-Z91 | SN: 103244 | 04-Apr-18 (No. 217-02672) | Apr-19 |
| Power sensor NRP-Z91 | SN: 103245 | 04-Apr-18 (No. 217-02673) | Apr-19 |
| Reference 20 dB Attenuator | SN: 5277 (20x) | 04-Apr-18 (No. 217-02682) | Apr-19 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 04-Apr-18 (No. 217-02683) | Apr-19 |
| Reference Probe EX3DV4 | SN: 3877 | 30-Dec-17 (No. EX3-3877_Dec17) | Dec-18 |
| DAE4 | SN: 654 | 05-Jul-18 (No. DAE4-654_Jul18) | Jul-19 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Power meter E4419B | SN: GB41293874 | 12-Jun-18 (No. 217-02285/02284) | In house check: Jun-20 |
| Power sensor E4412A | SN: MY41498087 | 12-Jun-18 (No. 217-02285) | In house check: Jun-20 |
| Power sensor E4412A | SN: 000110210 | 12-Jun-18 (No. 217-02284) | In house check: Jun-20 |
| RF generator HP 8648C | SN: US3642U01700 | 04-Aug-99 (in house check Jun-18) | In house check: Jun-20 |
| Network Analyzer Agilent E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-18) | In house check: Oct-19 |

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

Issued: October 19, 2018

**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 0108

**Glossary:**

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

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

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
c) IEC 62209-2, "Procedure to determine the Specific Absorption Rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", March 2010
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

**Additional Documentation:**

e) 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 | V52.10.2 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | ELI4 Flat Phantom | Shell thickness: 2 ± 0.2 mm |
| **Distance Dipole Center - TSL** | 15 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 450 MHz ± 1 MHz | |

## Head TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 43.5 | 0.87 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 44.1 ± 6 % | 0.87 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 cm³ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 1.14 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **4.57 W/kg ± 18.1 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 0.762 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **3.05 W/kg ± 17.6 % (k=2)** |

## Body TSL parameters

The following parameters and calculations were applied.

| | Temperature | Permittivity | Conductivity |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 56.7 | 0.94 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 55.5 ± 6 % | 0.92 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 cm³ (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 | **4.53 W/kg ± 18.1 % (k=2)** |

| **SAR averaged over 10 cm³ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 0.753 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **3.05 W/kg ± 17.6 % (k=2)** |

## Appendix (Additional assessments outside the scope of SCS 0108)

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 57.6 Ω - 4.4 jΩ |
| Return Loss | - 21.7 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 55.1 Ω - 7.0 jΩ |
| Return Loss | - 21.7 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.351 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 | December 16, 2005 |

## DASY5 Validation Report for Head TSL

Date: 19.10.2018

Test Laboratory: SPEAG, Zurich, Switzerland

**DUT: Dipole 450 MHz; Type: D450V3; Serial: D450V3 - SN:1053**

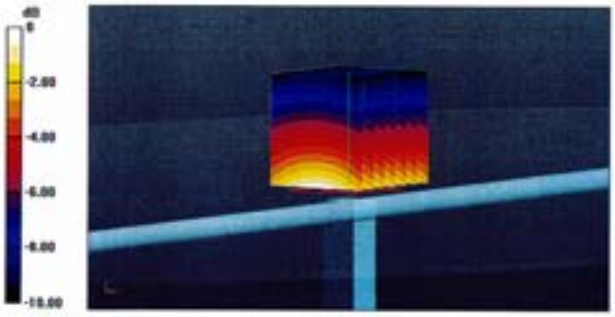
Communication System: UID 0 - CW; Frequency: 450 MHz
Medium parameters used: f = 450 MHz; $\sigma$ = 0.87 S/m; $\varepsilon_r$ = 44.1; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(10.5, 10.5, 10.5) @ 450 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 05.07.2018
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

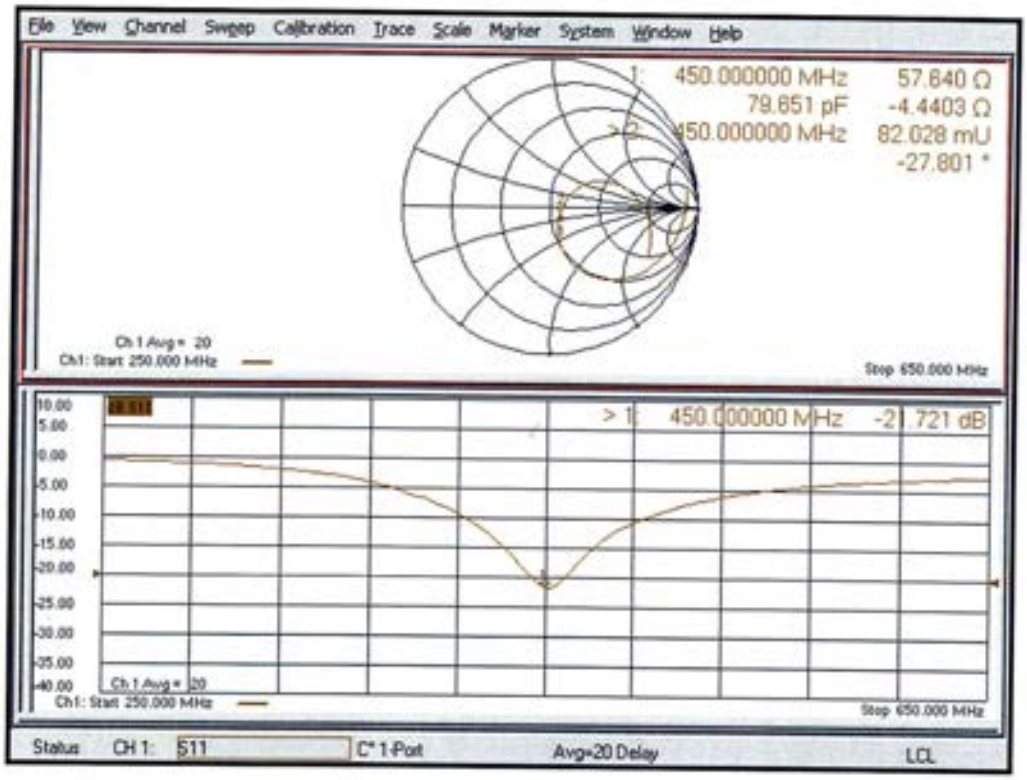
### Dipole Calibration for Head Tissue/d=15mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 38.89 V/m; Power Drift = -0.00 dB
Peak SAR (extrapolated) = 1.74 W/kg
**SAR(1 g) = 1.14 W/kg; SAR(10 g) = 0.762 W/kg**
Maximum value of SAR (measured) = 1.52 W/kg




0 dB = 1.52 W/kg = 1.82 dBW/kg

**Impedance Measurement Plot for Head TSL**



## DASY5 Validation Report for Body TSL

Date: 19.10.2018

Test Laboratory: SPEAG, Zurich, Switzerland

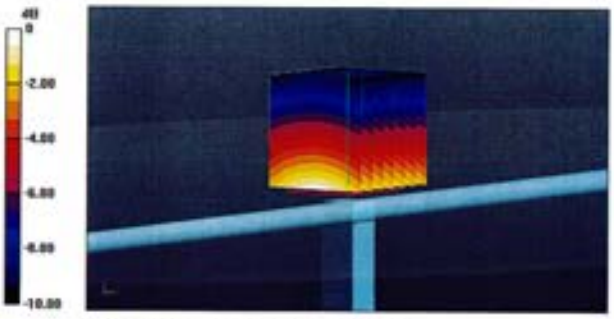
**DUT: Dipole 450 MHz; Type: D450V3; Serial: D450V3 - SN:1053**

Communication System: UID 0 - CW; Frequency: 450 MHz
Medium parameters used: f = 450 MHz; $\sigma$ = 0.92 S/m; $\varepsilon_r$ = 55.5; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

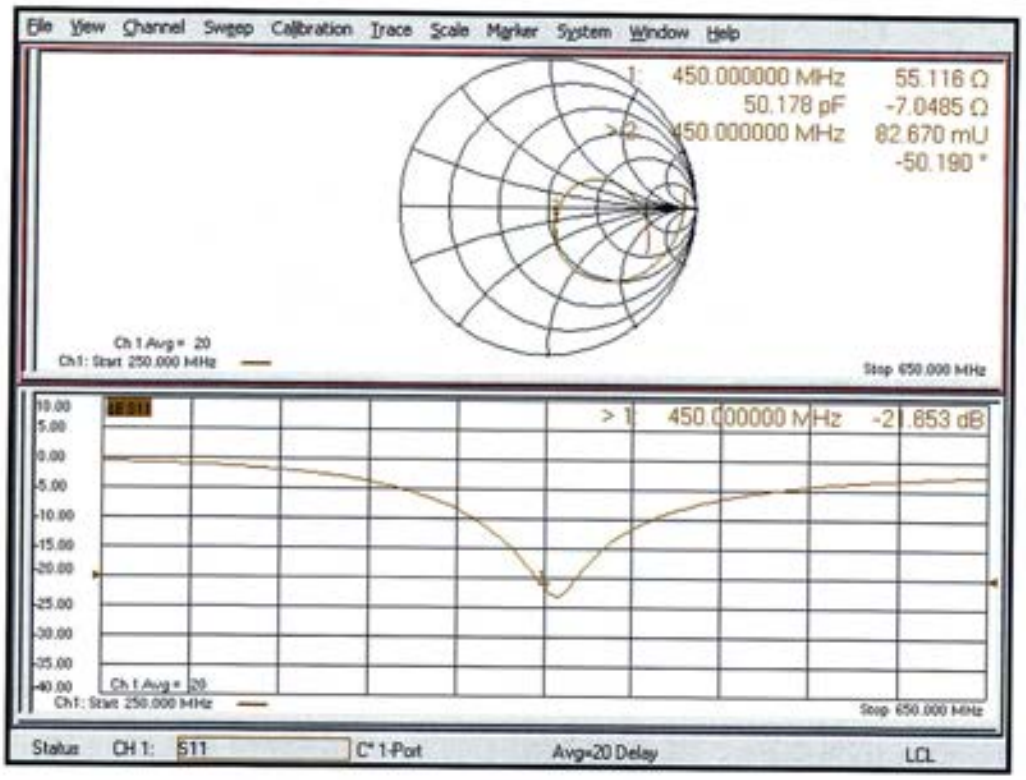
- Probe: EX3DV4 - SN3877; ConvF(10.8, 10.8, 10.8) @ 450 MHz; Calibrated: 30.12.2017
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 05.07.2018
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.10.2(1495); SEMCAD X 14.6.12(7450)

**Dipole Calibration for Body Tissue/d=15mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:**
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 41.78 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 1.72 W/kg
**SAR(1 g) = 1.12 W/kg; SAR(10 g) = 0.753 W/kg**
Maximum value of SAR (measured) = 1.50 W/kg




0 dB = 1.50 W/kg = 1.76 dBW/kg

**Impedance Measurement Plot for Body TSL**



# Dipole Data

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

The table below includes dipole impedance and return loss measurement data measured by Motorola Solutions' EME lab. The results meet requirements stated in KDB 865664.

| **Dipole D450V3 (SN 1053)** | **Head** | | | **Body** | | |
|---|---|---|---|---|---|---|
| | **Impedance** | | **Return Loss** | **Impedance** | | **Return Loss** |
| **Date Measured** | **real Ω** | **imag jΩ** | **dB** | **real Ω** | **imag jΩ** | **dB** |
| 11/08/2018 | 53.78 | -7.39 | -21.97 | 49.27 | -7.93 | -21.94 |
| 11/10/2019 | 53.95 | -6.72 | -22.49 | 49.84 | -7.37 | -22.74 |