# Element Materials Technology

**Pro9 Headset**

**SAR Evaluation Report: ELEM0101 Rev. 1, Issue Date: December 3, 2020**

**Evaluated to the following SAR specification:**

**FCC 2.1093:2020**

NVLAP LAB CODE: 200881-0

# CERTIFICATE OF TEST

**Last Date of Test: May 27, 2020**
**Element Materials Technology**
**EUT: Pro9 Headset**

## Applicable Standard

| Test Description | Specification | Test Method | Pass/Fail |
|---|---|---|---|
| SAR Evaluation | FCC 2.1093:2020 | FCC KDB 865664 D01 v01r04<br>FCC KDB 865664 D02 v01r02<br>FCC KDB 447498 D01 v06<br>IEEE Std 1528:2013 | Pass |

## Highest SAR Values:

| Frequency Bands (GHz) | Head (W/kg) | Limit (W/kg) | Exposure Environment |
|---|---|---|---|
| | 1g | 1g | |
| 1.920-1.930 | 0.0205 | 1.6 | General Population |

## Deviations From Test Standards

None

## Approved By:

*Don Facteau, Systems Architect*

# REVISION HISTORY

| Revision Number | Description | Date (yyyy-mm-dd) | Page Number |
| --- | --- | --- | --- |
| 01 | Changed header from Body to Head in the SAR values table | 2020-11-30 | 2 |

# ACCREDITATIONS AND AUTHORIZATIONS

element
2019.03.08

## United States

**FCC** - Designated by the FCC as a Telecommunications Certification Body (TCB). Certification chambers, Open Area Test Sites, and conducted measurement facilities are listed with the FCC.

**A2LA** - Accredited by A2LA to ISO / IEC 17065 as a product certifier. This allows Element to certify transmitters to FCC and IC specifications.

**NVLAP** - Each laboratory is accredited by NVLAP to ISO 17025

## Canada

**ISED** - Recognized by Innovation, Science and Economic Development Canada as a Certification Body (CB) and as a CAB for the acceptance of test data.

## European Union

**European Commission** – Within Element, we have a EU Notified Body validated for the EMCD and RED Directives.

## Australia/New Zealand

**ACMA** - Recognized by ACMA as a CAB for the acceptance of test data.

## Korea

**MSIT / RRA** - Recognized by KCC's RRA as a CAB for the acceptance of test data.

## Japan

**VCCI** - Associate Member of the VCCI. Conducted and radiated measurement facilities are registered.

## Taiwan

**BSMI** – Recognized by BSMI as a CAB for the acceptance of test data.

**NCC** - Recognized by NCC as a CAB for the acceptance of test data.

## Singapore

**IDA** – Recognized by IDA as a CAB for the acceptance of test data.

## Israel

**MOC** – Recognized by MOC as a CAB for the acceptance of test data.

## Hong Kong

**OFCA** – Recognized by OFCA as a CAB for the acceptance of test data.

## Vietnam

**MIC** – Recognized by MIC as a CAB for the acceptance of test data.

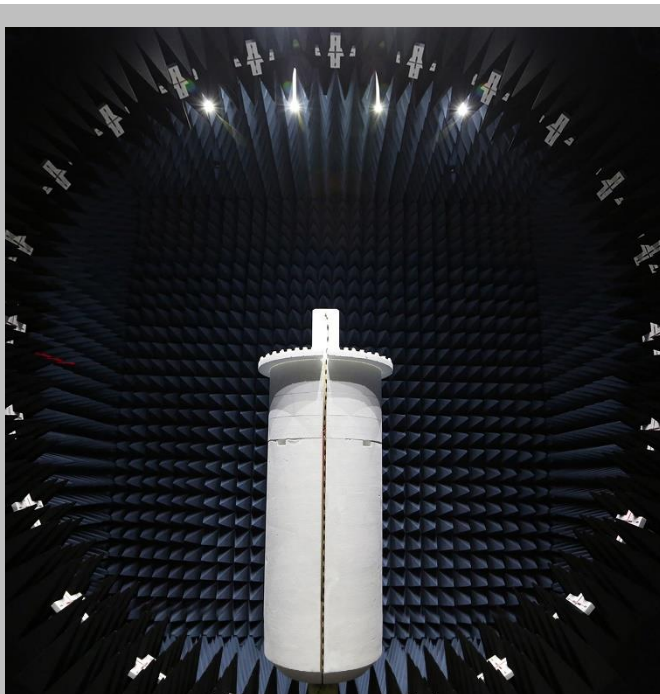
## SCOPE

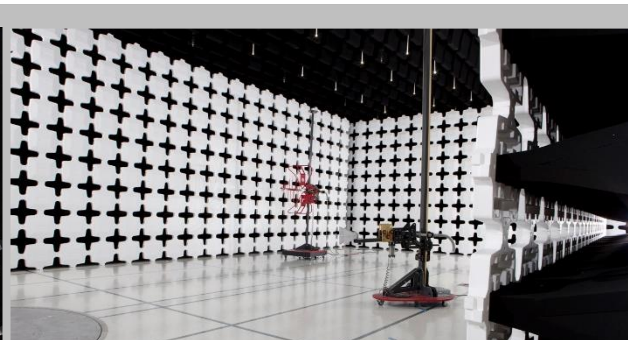
For details on the Scopes of our Accreditations, please visit:
https://www.nwemc.com/emc-testing-accreditations

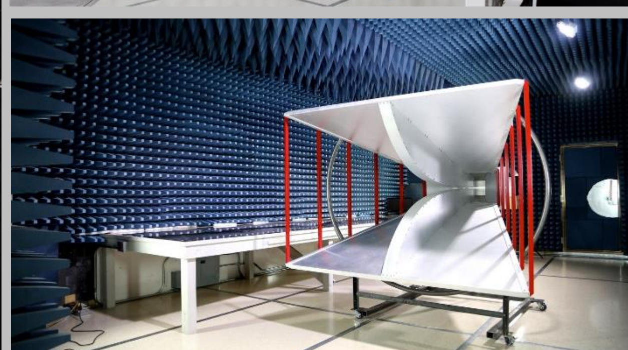
# FACILITIES

element
2019.03.08

| California<br>Labs OC01-17<br>41 Tesla<br>Irvine, CA 92618<br>(949) 861-8918 | Minnesota<br>Labs MN01-10<br>9349 W Broadway Ave.<br>Brooklyn Park, MN 55445<br>(612)-638-5136 | Oregon<br>Labs EV01-12<br>6775 NE Evergreen Pkwy #400<br>Hillsboro, OR 97124<br>(503) 844-4066 | Texas<br>Labs TX01-09<br>3801 E Plano Pkwy<br>Plano, TX 75074<br>(469) 304-5255 | Washington<br>Labs NC01-05<br>19201 120th Ave NE<br>Bothell, WA 98011<br>(425)984-6600 |
|---|---|---|---|---|
| **NVLAP** | | | | |
| NVLAP Lab Code: 200676-0 | NVLAP Lab Code: 200881-0 | NVLAP Lab Code: 200630-0 | NVLAP Lab Code:201049-0 | NVLAP Lab Code: 200629-0 |
| **Innovation, Science and Economic Development Canada** | | | | |
| 2834B-1, 2834B-3 | 2834E-1, 2834E-3 | 2834D-1 | 2834G-1 | 2834F-1 |
| **BSMI** | | | | |
| SL2-IN-E-1154R | SL2-IN-E-1152R | SL2-IN-E-1017 | SL2-IN-E-1158R | SL2-IN-E-1153R |
| **VCCI** | | | | |
| A-0029 | A-0109 | A-0108 | A-0201 | A-0110 |
| **Recognized Phase I CAB for ISED, ACMA, BSMI, IDA, KCC/RRA, MIC, MOC, NCC, OFCA** | | | | |
| US0158 | US0175 | US0017 | US0191 | US0157 |







# PRODUCT DESCRIPTION

## Client and Equipment Under Test (EUT) Information

| | |
|---|---|
| **Company Name:** | Quail Digital |
| **Address:** | 92 Lots Road |
| **City, State, Zip:** | London, SW10 0QD, United Kingdom |
| **Test Requested By:** | Alex Toohie of Element Materials Technology, Hull |
| **Model:** | Pro9 Headset |
| **First Date of Test:** | May 21, 2020 |
| **Last Date of Test:** | May 27, 2020 |
| **Receipt Date of Samples:** | May 15, 2020 |
| **Equipment Design Stage:** | Production |
| **Equipment Condition:** | No Damage |
| **Purchase Authorization:** | Verified |

## Information Provided by the Party Requesting the Test

**Functional Description of the EUT:**

Pro9 Headset is a multi-channel headset designed for single and dual lane drive-thru, curb-side ordering and in-restaurant table service, all from the same headset. And, its range will cover kitchen, seating on two floors, drive-thru lanes, drive-to bays and parking lot.

The device contains the following radio:
DECT RFP 1.92-1.93GHz

**Location of transmit antenna(s):**

**DECT Antennas**

# PRODUCT DESCRIPTION

2014-12-10

## Testing Locations:

For clarity, the sides of the EUT are referred right and left side, with a boom that can be rotated 180 degrees to be used in both positions.

The EUT can have two orientations exposed to the human head. The antenna is located along the headset frame of the headset near the human head. Left and right orientation tested. The microphone and boom arm of the EUT was rotated into its intended use position for each EUT orientation tested.

## Testing Objective:

To demonstrate compliance of DECT radio with the SAR requirements of FCC 2.1093:2020.

## Scaling:

**Max power**

Per FCC KDB 447498, the measured SAR values were scaled to the maximum tune-up tolerance limit. The results are referred to as the “Reported SAR” values. The following formula was used to calculate the linear SAR scaling factor:

SAR scaling factor = 10^((Tune-up Tolerance Power (dBm) - Measured Power (dBm)) / 10)

A summary of scaling factors is as follows:

| Antenna | Frequency (MHz) | Channel | Max Measured OP (dBm) | Declared Tune-Up OP (dBm) | Scaling Factor |
|---|---|---|---|---|---|
| Ant 0 | 1925 | 25 | 19.2 | 20 | 1.20 |
| Ant 1 | 1925 | 25 | 18.9 | 20 | 1.29 |

**Duty Cycle**

All EUTs were operating at 8% duty cycle for this test. This matches the firmware limited maximum duty cycle that the EUT can use in the field. No scaling factor was applied for duty cycle. Extra care was taken to ensure measurements were properly captured.

## Simultaneous Transmissions:

The EUT is not capable of simultaneous transmissions.

# CONFIGURATIONS

## Configuration ELEM0101- 1

| EUT | | | |
|---|---|---|---|
| **Description** | **Manufacturer** | **Model/Part Number** | **Serial Number** |
| Pro9 Headset | QuailDigital | Q-P9 HS | 0321600040 |

| Cables | | | | | |
|---|---|---|---|---|---|
| **Cable Type** | **Shield** | **Length (m)** | **Ferrite** | **Connection 1** | **Connection 2** |
| Ribbon Cable | No | 0.3 m | No | Pro9 Headset | Unterminated |

## Configuration ELEM0101- 2

| EUT | | | |
|---|---|---|---|
| **Description** | **Manufacturer** | **Model/Part Number** | **Serial Number** |
| Pro9 Headset | QuailDigital | Q-P9 HS | 0321600029 |

| Cables | | | | | |
|---|---|---|---|---|---|
| **Cable Type** | **Shield** | **Length (m)** | **Ferrite** | **Connection 1** | **Connection 2** |
| Ribbon Cable | No | 0.3 m | No | Pro9 Headset | Unterminated |

# MODIFICATIONS

2018-07-17

## Equipment Modifications

| Item | Date | Test | Modification | Note | Disposition of EUT |
|---|---|---|---|---|---|
| 1 | 2020-05-21 | SAR Evaluation | Tested as delivered to Test Station. | No EMI suppression devices were added or modified during this test. | EUT remained at Element following the test. |
| 2 | 2020-05-27 | Output Power | Tested as delivered to Test Station. | No EMI suppression devices were added or modified during this test. | Scheduled testing was completed. |

# TISSUE – EQUIVALENT LIQUID DESCRIPTION

## Characterization of tissue-equivalent liquid dielectric properties

The measured values must be within ±10% of the target values provided SAR error compensation algorithms documented in IEEE Std 1528-2013 section E.3.2.2 are implemented for upward correction purposes only. The temperature variation in the liquid during SAR measurements must be within ± 2 °C of that recorded when the dielectric properties were measured.

The dielectric parameters of the tissue-equivalent liquids were measured using the SPEAG DAKS:200 dielectric assessment kit. The dielectric measurements were made across the frequency range of the liquid. The attached data sheets show that the dielectric parameters of the liquid were within the required tolerances.

## Target values of dielectric parameters

Per KDB 865664 D01 v01r04, Appendix A:

The head tissue dielectric parameters recommended by IEEE Std 1528-2013 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in IEEE Std 1528 are derived from tissue dielectric parameters computed from the 4-Cole-Cole equations described above and extrapolated according to the head parameters specified in IEEE Std 1528."

Linear interpolation is used for determining target dielectric parameters for values between those listed.

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

($\varepsilon_r$ = relative permittivity, $\sigma$ = conductivity and $\rho$ = 1000 kg/m$^3$)

# TISSUE – EQUIVALENT LIQUID DESCRIPTION

## Composition of Ingredients for Liquid Tissue Phantoms

Element uses broadband tissue equivalent liquids prepared by SPEAG and confirmed by Element to be within +/- 10% of target values. SAR error compensation algorithms documented in IEEE Std 1528-2013 are implemented for upward correction purposes only.

By percent weight, the approximate compositions of the broadband tissue are listed below. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation:

| Material | Percent Weight |
|---|---|
| Ethanediol | 1.0 - 4.9% |
| Sodium Petroleum Sulfonate | <2.9% |
| Hexylene Glycol | <2.9% |
| Alkoxylated Alcohol | <2.0% |
| Mineral Oils | <20% |
| Deionized Water | Fill to volume |

The exact liquid recipes are proprietary to the tissue equivalent liquid manufacturer.

## SAR Correction Formula for Deviation from Target Dielectric Values

A correction formula is automatically applied by the measurement software to SAR data to account for the deviation from the target dielectric values. The correction formula only scales measured values upward. The SAR system manufacturer has been contacted and has verified Element's implementation and understanding of the SAR correction formula. The correction is calculated following IEEE Std 1528-2013 Annex E.3. Where SAR correction is considered, there will be a note stating "SAR corrected for target medium." The equation is as follows:

$$\Delta SAR = c_\varepsilon \Delta\varepsilon_r + c_\sigma \Delta\sigma$$

Where the values for, $\Delta\varepsilon_r$ and $\Delta\sigma$ and are the percent the permittivity and conductivity respectively are away from ideal values and where $\Delta SAR$ is the percent the measured SAR value is corrected.

When 1 g peak spatial-average SAR measurements are taken:

$$c_\varepsilon = -7.854 \times 10^{-4} f^3 + 9.402 \times 10^{-3} f^2 - 2.742 \times 10^{-2} f - 0.2026$$
$$c_\sigma = 9.804 \times 10^{-3} f^3 - 8.661 \times 10^{-2} f^2 + 2.981 \times 10^{-2} f + 0.7829$$

Where *f* is the frequency in GHz.

When 10 g peak spatial-average SAR measurements are taken:

$$c_\varepsilon = 3.456 \times 10^{-3} f^3 - 3.531 \times 10^{-2} f^2 + 7.675 \times 10^{-2} f - 0.1860$$
$$c_\sigma = 4.479 \times 10^{-3} f^3 - 1.586 \times 10^{-2} f^2 - 0.1972 f + 0.7717$$

Where *f* is the frequency in GHz.

# TISSUE – EQUIVALENT LIQUID

| Date: | 05/21/2020 | Temperature: | 23°C |
|---|---|---|---|
| Tissue: | HBBL600-10000V6 | Liquid Temperature: | 23.4°C |
| Tested By: | Marcelo Aguayo, Kyle McMullan | Relative Humidity: | 51% |
| Job Site: | MN11 | Bar. Pressure: | 1018 mb |

## TEST SPECIFICATIONS

| Specification: | Method: |
|---|---|
| FCC 2.1093:2020 | FCC KDB 865664 D01 v01r04<br>FCC KDB 865664 D02 v01r02<br>FCC KDB 447498 D01 v06<br>IEEE Std 1528:2013 |

## RESULTS

| | Actual Values | | Target Values | | Deviation (%) | |
|---|---|---|---|---|---|---|
| Frequency(MHz) | Relative Perm. | Conductivity | Relative Perm. | Frequency(MHz) | Relative Perm. | Conductivity |
| 1900 | 40.96 | 1.46 | 40 | 1.40 | 2.40 | 4.29 |

| Freq (MHz) | Relative Perm. | Cond. (S/m) |
|---|---|---|
| 400 | 44.64 | 0.82 |
| 450 | 44.35 | 0.84 |
| 500 | 44.15 | 0.85 |
| 550 | 43.94 | 0.87 |
| 600 | 43.79 | 0.89 |
| 650 | 43.61 | 0.90 |
| 700 | 43.51 | 0.92 |
| 750 | 43.33 | 0.93 |
| 800 | 43.16 | 0.95 |
| 850 | 42.97 | 0.97 |
| 900 | 42.83 | 0.99 |
| 950 | 42.73 | 1.01 |
| 1000 | 42.58 | 1.03 |
| 1050 | 42.52 | 1.05 |
| 1100 | 42.39 | 1.07 |
| 1150 | 42.27 | 1.08 |
| 1200 | 42.15 | 1.11 |
| 1250 | 42.01 | 1.13 |
| 1300 | 41.93 | 1.15 |
| 1350 | 41.82 | 1.17 |
| 1400 | 41.69 | 1.19 |
| 1450 | 41.67 | 1.22 |
| 1500 | 41.64 | 1.24 |
| 1550 | 41.55 | 1.27 |
| 1600 | 41.47 | 1.29 |
| 1650 | 41.45 | 1.32 |
| 1700 | 41.32 | 1.35 |
| 1750 | 41.22 | 1.37 |
| 1800 | 41.10 | 1.40 |
| 1850 | 41.00 | 1.43 |
| 1900 | 40.96 | 1.46 |
| 1950 | 40.87 | 1.49 |
| 2000 | 40.80 | 1.52 |
| 2050 | 40.72 | 1.56 |
| 2100 | 40.70 | 1.59 |
| 2150 | 40.62 | 1.62 |
| 2200 | 40.55 | 1.65 |
| 2250 | 40.50 | 1.69 |

| Freq (MHz) | Relative Perm. | Cond. (S/m) |
|---|---|---|
| 2300 | 40.46 | 1.72 |
| 2350 | 40.44 | 1.76 |
| 2400 | 40.32 | 1.80 |
| 2450 | 40.25 | 1.83 |
| 2500 | 40.19 | 1.88 |
| 2550 | 40.14 | 1.91 |
| 2600 | 40.02 | 1.95 |
| 2650 | 39.95 | 1.99 |
| 2700 | 39.90 | 2.03 |
| 2750 | 39.79 | 2.07 |
| 2800 | 39.75 | 2.12 |
| 2850 | 39.67 | 2.15 |
| 2900 | 39.61 | 2.20 |
| 2950 | 39.57 | 2.24 |
| 3000 | 39.47 | 2.27 |
| 3050 | 39.32 | 2.32 |
| 3100 | 39.24 | 2.36 |
| 3150 | 39.15 | 2.40 |
| 3200 | 39.08 | 2.44 |
| 3250 | 39.01 | 2.49 |
| 3300 | 38.92 | 2.53 |
| 3350 | 38.85 | 2.57 |
| 3400 | 38.73 | 2.62 |
| 3450 | 38.69 | 2.66 |
| 3500 | 38.58 | 2.70 |
| 3550 | 38.51 | 2.74 |
| 3600 | 38.47 | 2.79 |
| 3650 | 38.38 | 2.83 |
| 3700 | 38.28 | 2.88 |
| 3750 | 38.20 | 2.93 |
| 3800 | 38.17 | 2.97 |
| 3850 | 38.06 | 3.02 |
| 3900 | 38.03 | 3.06 |
| 3950 | 37.93 | 3.12 |
| 4000 | 37.86 | 3.16 |
| 4050 | 37.80 | 3.22 |
| 4100 | 37.80 | 3.27 |
| 4150 | 37.74 | 3.31 |

| Freq (MHz) | Relative Perm. | Cond. (S/m) |
|---|---|---|
| 4200 | 37.63 | 3.37 |
| 4250 | 37.56 | 3.41 |
| 4300 | 37.47 | 3.48 |
| 4350 | 37.43 | 3.53 |
| 4400 | 37.31 | 3.59 |
| 4450 | 37.18 | 3.63 |
| 4500 | 37.11 | 3.69 |
| 4550 | 37.05 | 3.75 |
| 4600 | 36.94 | 3.81 |
| 4650 | 36.84 | 3.87 |
| 4700 | 36.77 | 3.92 |
| 4750 | 36.65 | 3.98 |
| 4800 | 36.56 | 4.03 |
| 4850 | 36.33 | 4.01 |
| 4900 | 36.02 | 4.09 |
| 4950 | 36.47 | 4.19 |
| 5000 | 36.12 | 4.23 |
| 5050 | 36.04 | 4.25 |
| 5100 | 36.28 | 4.35 |
| 5150 | 36.14 | 4.40 |
| 5200 | 36.00 | 4.44 |
| 5250 | 35.71 | 4.48 |
| 5300 | 35.50 | 4.75 |
| 5350 | 35.53 | 4.75 |
| 5400 | 35.95 | 4.69 |
| 5450 | 35.50 | 4.82 |
| 5500 | 35.57 | 4.86 |
| 5550 | 35.41 | 4.86 |
| 5600 | 35.25 | 4.91 |
| 5650 | 35.13 | 4.99 |
| 5700 | 34.87 | 5.14 |
| 5750 | 34.77 | 5.10 |
| 5800 | 34.90 | 5.10 |
| 5850 | 34.86 | 5.21 |
| 5900 | 34.52 | 5.16 |
| 5950 | 34.30 | 5.26 |
| 6000 | 34.22 | 5.34 |

# TISSUE – EQUIVALENT LIQUID

| | | | |
|---|---|---|---|
| Date: | 05/20/2020 | Temperature: | 22°C |
| Tissue: | HBBL600-10000V6 | Liquid Temperature: | 20.4°C |
| Tested By: | Marcelo Aguayo, Kyle McMullan | Relative Humidity: | 41% |
| Job Site: | MN11 | Bar. Pressure: | 1019 mb |

## TEST SPECIFICATIONS

| Specification: | Method: |
|---|---|
| FCC 2.1093:2020 | FCC KDB 865664 D01 v01r04<br>FCC KDB 865664 D02 v01r02<br>FCC KDB 447498 D01 v06<br>IEEE Std 1528:2013 |

## RESULTS

| | Actual Values | | Target Values | | Deviation (%) | |
|---|---|---|---|---|---|---|
| Frequency(MHz) | Relative Perm. | Conductivity | Relative Perm. | Frequency(MHz) | Relative Perm. | Conductivity |
| 1900 | 41.90 | 1.47 | 40 | 1.40 | 4.75 | 5.00 |

| Freq (MHz) | Relative Perm. | Cond. (S/m) |
|---|---|---|
| 400 | 45.71 | 0.78 |
| 450 | 45.40 | 0.79 |
| 500 | 45.05 | 0.81 |
| 550 | 44.86 | 0.82 |
| 600 | 44.68 | 0.84 |
| 650 | 44.53 | 0.85 |
| 700 | 44.40 | 0.87 |
| 750 | 44.23 | 0.89 |
| 800 | 44.06 | 0.91 |
| 850 | 43.85 | 0.93 |
| 900 | 43.76 | 0.95 |
| 950 | 43.68 | 0.96 |
| 1000 | 43.58 | 0.99 |
| 1050 | 43.44 | 1.01 |
| 1100 | 43.33 | 1.03 |
| 1150 | 43.23 | 1.05 |
| 1200 | 43.12 | 1.07 |
| 1250 | 42.97 | 1.10 |
| 1300 | 42.95 | 1.12 |
| 1350 | 42.80 | 1.15 |
| 1400 | 42.71 | 1.17 |
| 1450 | 42.63 | 1.20 |
| 1500 | 42.55 | 1.23 |
| 1550 | 42.46 | 1.26 |
| 1600 | 42.35 | 1.29 |
| 1650 | 42.28 | 1.31 |
| 1700 | 42.14 | 1.34 |
| 1750 | 42.09 | 1.37 |
| 1800 | 42.00 | 1.40 |
| 1850 | 41.95 | 1.43 |
| 1900 | 41.90 | 1.47 |
| 1950 | 41.81 | 1.49 |
| 2000 | 41.74 | 1.53 |
| 2050 | 41.64 | 1.57 |
| 2100 | 41.62 | 1.60 |
| 2150 | 41.55 | 1.64 |
| 2200 | 41.48 | 1.67 |
| 2250 | 41.41 | 1.71 |

| Freq (MHz) | Relative Perm. | Cond. (S/m) |
|---|---|---|
| 2300 | 41.35 | 1.74 |
| 2350 | 41.28 | 1.78 |
| 2400 | 41.18 | 1.83 |
| 2450 | 41.09 | 1.87 |
| 2500 | 41.04 | 1.91 |
| 2550 | 40.99 | 1.95 |
| 2600 | 40.84 | 1.99 |
| 2650 | 40.76 | 2.03 |
| 2700 | 40.69 | 2.08 |
| 2750 | 40.57 | 2.11 |
| 2800 | 40.50 | 2.17 |
| 2850 | 40.40 | 2.21 |
| 2900 | 40.32 | 2.26 |
| 2950 | 40.25 | 2.30 |
| 3000 | 40.18 | 2.34 |
| 3050 | 40.00 | 2.39 |
| 3100 | 39.91 | 2.43 |
| 3150 | 39.81 | 2.48 |
| 3200 | 39.75 | 2.52 |
| 3250 | 39.65 | 2.57 |
| 3300 | 39.56 | 2.61 |
| 3350 | 39.47 | 2.65 |
| 3400 | 39.34 | 2.71 |
| 3450 | 39.30 | 2.76 |
| 3500 | 39.19 | 2.80 |
| 3550 | 39.11 | 2.85 |
| 3600 | 39.05 | 2.89 |
| 3650 | 38.94 | 2.94 |
| 3700 | 38.85 | 2.99 |
| 3750 | 38.75 | 3.04 |
| 3800 | 38.73 | 3.10 |
| 3850 | 38.62 | 3.15 |
| 3900 | 38.56 | 3.19 |
| 3950 | 38.45 | 3.24 |
| 4000 | 38.40 | 3.30 |
| 4050 | 38.28 | 3.36 |
| 4100 | 38.24 | 3.41 |
| 4150 | 38.18 | 3.46 |

| Freq (MHz) | Relative Perm. | Cond. (S/m) |
|---|---|---|
| 4200 | 38.09 | 3.52 |
| 4250 | 37.99 | 3.57 |
| 4300 | 37.89 | 3.64 |
| 4350 | 37.84 | 3.68 |
| 4400 | 37.75 | 3.75 |
| 4450 | 37.62 | 3.80 |
| 4500 | 37.53 | 3.86 |
| 4550 | 37.46 | 3.92 |
| 4600 | 37.36 | 3.97 |
| 4650 | 37.21 | 4.03 |
| 4700 | 37.16 | 4.09 |
| 4750 | 37.05 | 4.15 |
| 4800 | 36.91 | 4.21 |
| 4850 | 36.95 | 4.24 |
| 4900 | 36.35 | 4.29 |
| 4950 | 36.53 | 4.40 |
| 5000 | 36.29 | 4.41 |
| 5050 | 36.38 | 4.52 |
| 5100 | 36.40 | 4.54 |
| 5150 | 36.41 | 4.58 |
| 5200 | 36.22 | 4.65 |
| 5250 | 36.08 | 4.77 |
| 5300 | 36.01 | 4.85 |
| 5350 | 35.48 | 4.93 |
| 5400 | 35.82 | 5.07 |
| 5450 | 35.78 | 5.11 |
| 5500 | 35.94 | 5.06 |
| 5550 | 35.61 | 5.10 |
| 5600 | 35.50 | 5.12 |
| 5650 | 35.32 | 5.22 |
| 5700 | 35.31 | 5.39 |
| 5750 | 35.04 | 5.36 |
| 5800 | 35.22 | 5.39 |
| 5850 | 34.94 | 5.39 |
| 5900 | 34.95 | 5.40 |
| 5950 | 34.90 | 5.45 |
| 6000 | 34.57 | 5.59 |

# SAR SYSTEM VERIFICATION DESCRIPTION

WSSV.2017.1.31

## REQUIREMENT

Per IEEE 1528, Section 8.2.1, “System checks are performed prior to compliance tests and the results must always be within ± 10% of the target value corresponding to the test frequency, liquid, and the source used. The target values are 1 g or 10 g averaged SAR values measured on systems having current system validation and calibration status, and using the system check setup as shown in Figure 14. These target values should be determined using a standard source.”

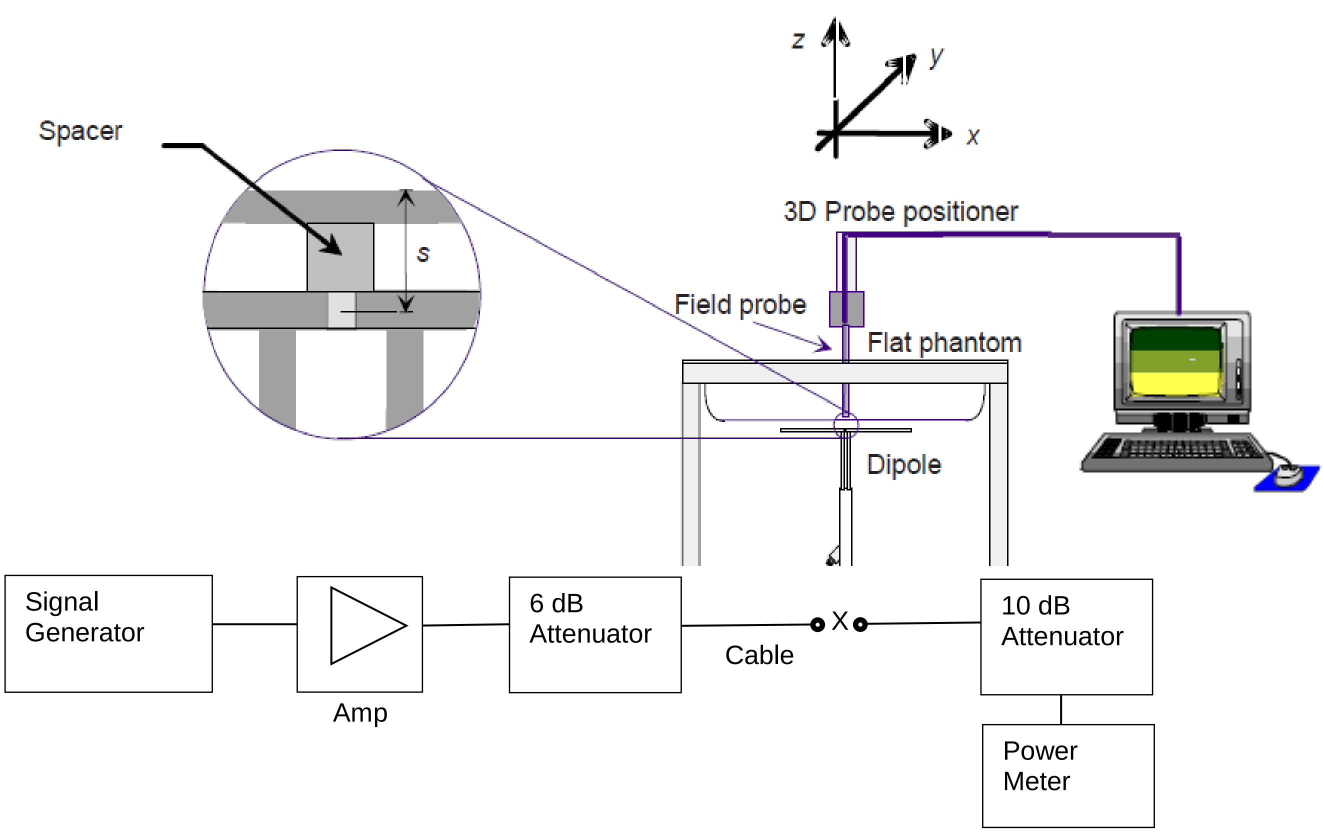
## TEST DESCRIPTION

Within 24 hours of a measurement, then every 72 hours thereafter, Element used the system validation kit (calibrated reference dipole) to test whether the system was operating within its specifications. The validation was performed in the indicated bands by making SAR measurements of the reference dipole with the phantom filled with the tissue-equivalent liquid. First, a signal generator and power amplifier were used to produce a 100mW level as measured with a power meter at the antenna terminals of the dipole (X). Then, the reference dipole was positioned below the bottom of the phantom and centered with its axis parallel to the longest side of the phantom. A low loss and low relative permittivity spacer was used to establish the correct distance between the center axis of the reference dipole and the liquid.

For the reference dipoles, the spacing distance s is given by:

s = 15mm, +/- 0.2mm for 300MHz ≤ f ≥ 1000 MHz:
s = 10mm, +/- 0.2mm for 1000MHz ≤ f ≥ 6000MHz

The measured 1 g and 10 g spatial average SAR values were normalized to a 1W dipole input power for comparison to the calibration data. The results are summarized in the attached table. The deviation is less than 10% in all cases, indicating that the system performance check was within tolerance.



# SAR SYSTEM VERIFICATION

WSSV.2016.12.19

## TEST SPECIFICATIONS

| Specification: | Method: |
|---|---|
| FCC 2.1093:2020 | FCC KDB 865664 D01 v01r04<br>FCC KDB 865664 D02 v01r02<br>FCC KDB 447498 D01 v06<br>IEEE Std 1528:2013 |

## RESULTS

| Date | Liquid part number and frequency | Conducted Power into the Dipole (dBm) | Correction Factor | Measured | | Normalized to 1W | | Target (Normalized to 1W) Get from Dipole Calibration Certificate | | % Difference | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | 1g | 10g | 1g | 10g | 1g | 10g | 1g | 10g |
| 5/20/20 | HBBL600-10000V6 (1900 MHz) | 20.00 | 10.00 | 3.91 | 2.02 | 39.10 | 20.20 | 41.40 | 21.5 | -5.55 | -6.05 |

# SAR SYSTEM VERIFICATION

element
WSSV.2016.12.19

| Tested By: | Marcelo Aguayo | Room Temperature (°C): | 22°C |
|---|---|---|---|
| Date: | 5/20/2020 | Liquid Temperature (°C): | 20.4°C |
| | | Humidity (%RH): | 41 % |
| | | Bar. Pressure (mb): | 1019 mb |
| | | | |

**1900MHz System Check Rev2 5-20-20**

**DUT: Dipole 1900 MHz D1900V2; Type: D1900V2; Serial: D1900V2 - SN:xxx**

Communication System: UID 0, CW (0); Communication System Band: D1900 (1900.0 MHz); Frequency: 1900 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.466 S/m; $\varepsilon_r$ = 41.901; $\rho$ = 1000 kg/m$^3$ , Medium parameters used: $\sigma$ = 0 S/m, $\varepsilon_r$ = 1; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: EX3DV4 - SN3746; ConvF(7.59, 7.59, 7.59) @ 1900 MHz; Calibrated: 11/19/2019
    - Modulation Compensation:
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), Sensor-Surface: 0mm (Fix Surface), z = 31.0, 101.0
- Electronics: DAE4 Sn1237; Calibrated: 2/4/2020
- Phantom: SAM with CRP; Type: SAM; Serial:
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

**System Check/System Check/Zoom Scan (7x7x7) (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 62.00 V/m; Power Drift = -0.25 dB
Peak SAR (extrapolated) = 7.44 W/kg
**SAR(1 g) = 3.91 W/kg; SAR(10 g) = 2.02 W/kg** (SAR corrected for target medium)
Maximum value of SAR (measured) = 6.19 W/kg

**System Check/System Check/Area Scan (61x101x1):** Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 6.21 W/kg

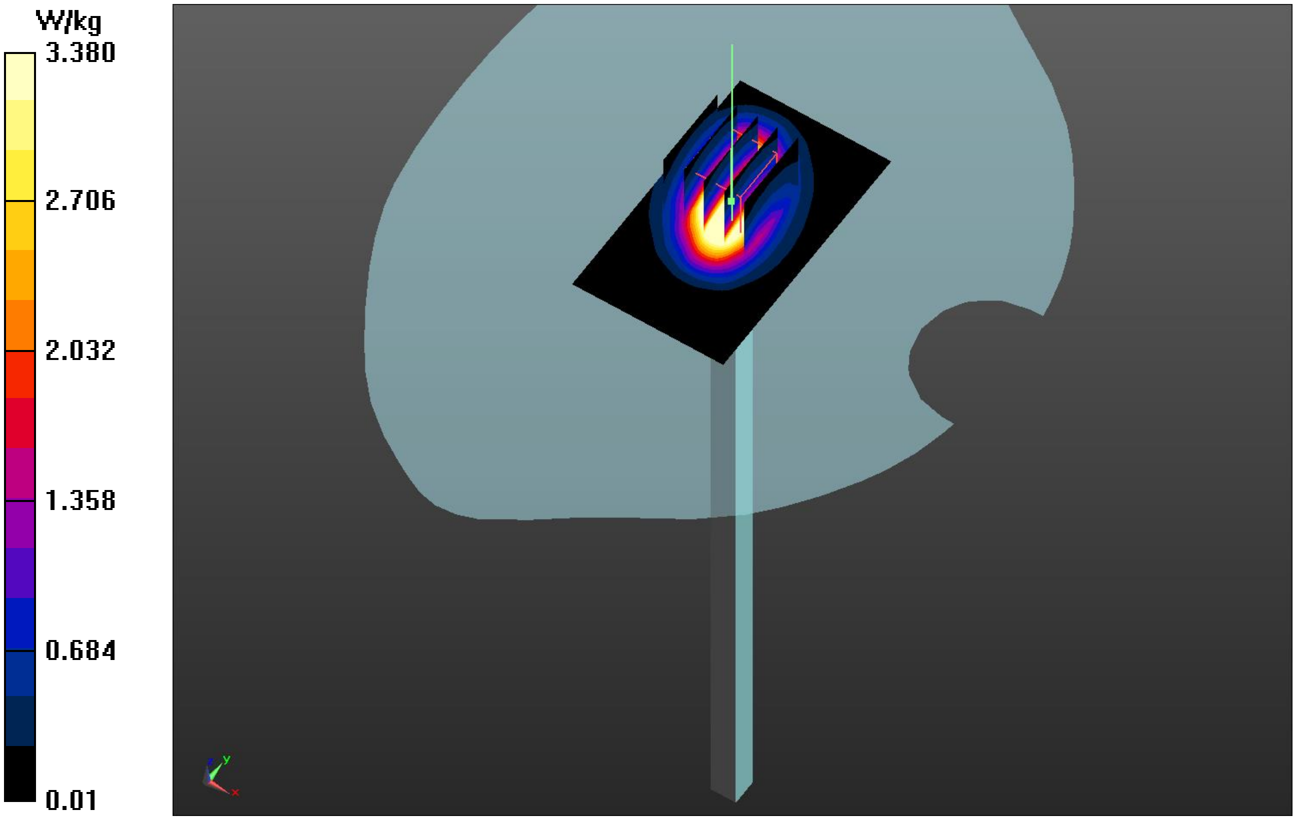
**System Check/System Check/Z Scan (1x1x21):** Measurement grid: dx=20mm, dy=20mm, dz=5mm
Maximum value of Total (measured) = 59.96 V/m

**System Check/System Check/Z Scan (1x1x21):** Measurement grid: dx=20mm, dy=20mm, dz=5mm
Maximum value of SAR (measured) = 5.27 W/kg

Kyle McMullan

Approved By

# SAR SYSTEM VERIFICATION



# OUTPUT POWER

| EUT: | Pro9 Headset | Work Order: | ELEM0101 |
|---|---|---|---|
| Serial Number: | 0321600040 | Date: | 2020/05/27 |
| Customer: | Element Materials Technology | Temperature: | 21.9 °C |
| Attendees: | None | Relative Humidity: | 61% RH |
| Customer Project: | None | Bar. Pressure: | 1012 mbar |
| Tested By: | Kyle McMullan | Job Site: | MN11 |
| Power: | Battery | Configuration: | ELEM101-1 |

## TEST SPECIFICATIONS

| Specification: | Method: |
|---|---|
| FCC 2.1093:2020 | FCC KDB 447498 D01 V06<br>FCC KDB 865664 D01 v01r04<br>FCC KDB 865664 D02 v01r02<br>IEEE Std 1528:2013 |

## COMMENTS

1 dB of insertion loss declared by customer. This has been added to max measured OP value.

## DEVIATIONS FROM TEST STANDARD

None

## RESULTS

Channels tested per the formula given in KDB 447498 section 4.1 g)

$$N_c = Round\left\{\left[100\left(f_{high} - f_{low}\right)/f_c\right]^{0.5} \times \left(f_c/100\right)^{0.2}\right\},$$

The value of $f_{high}$ is 1930 MHz, the value of $f_{low}$ is 1920 MHz, and $f_c$ is 1925 MHz. The value of $N_c$ is calculated as 1.

| Antenna | Frequency (MHz) | Channel | Max Measured OP (dBm) | Declared Tune-Up OP (dBm) | Scaling Factor |
|---|---|---|---|---|---|
| Ant 0 | 1925 | 25 | 19.2 | 20 | 1.20 |
| Ant 1 | 1925 | 25 | 18.9 | 20 | 1.29 |

SAR Scaling factor performed according to the equation:

SAR scaling factor = 10^((Tune-up Tolerance Power (dBm) - Measured Power (dBm)) / 10)

# SAR TEST DATA

| EUT: | Pro9 Headset | Work Order: | ELEM0101 |
|---|---|---|---|
| Customer: | Element Materials Technology | Job Site: | MN11 |
| Attendees: | None | Customer Project: | None |

### TEST SPECIFICATIONS

| Specification: | Method: |
|---|---|
| FCC 2.1093:2020 | FCC KDB 865664 D01 v01r04<br>FCC KDB 865664 D02 v01r02<br>FCC KDB 447498 D01 v06<br>IEEE Std 1528:2013 |

## COMMENTS

None

## DEVIATIONS FROM TEST STANDARD

None

## RESULTS

| Test Config. | Radio Type | Antenna | Transmit Frequency (MHz) | Transmit Channel | EUT Position | SAR Drift During Test (dB) | Measured 1g SAR Level (mW/g) | Measured 10g SAR Level (mW/g) | SAR Scaling Factor | Scaled 1g SAR Level (mW/g) | Scaled 10g SAR Level (mW/g) | Test# |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Head** | **DECT** | **0** | **1925** | **25** | **Right** | **-0.32** | **0.0171** | **0.0037** | **1.2** | **0.0205** | **0.0044** | **1900 MHz Head RIGHT ANT 0** |
| Head | DECT | 1 | 1925 | 25 | Right | -0.15 | 0.0022 | 0.0003 | 1.2 | 0.0026 | 0.0004 | 1900 MHz Head RIGHT ANT 1 |
| **Head** | **DECT** | **0** | **1925** | **25** | **Left** | **-0.01** | **0.0130** | **0.0066** | **1.29** | **0.0168** | **0.0085** | **1900 MHz Head LEFT ANT 0** |
| Head | DECT | 1 | 1925 | 25 | Left | 0.32 | 0.0028 | 0.0009 | 1.29 | 0.0036 | 0.0012 | 1900 MHz Head LEFT ANT 1 |

# SAR TEST DATA

element
WSTD.2020.04.14.0

| | | | |
|---|---|---|---|
| Tested By: | Kyle McMullan | Room Temperature (°C): | 23°C |
| Date: | 5/21/2020 | Liquid Temperature (°C): | 23.4°C |
| Serial Number: | 0321600029 | Humidity (%RH): | 51% |
| Configuration: | ELEM0101-2 | Bar. Pressure (mb): | 1018 mb |
| Comments: | None | | |

**1900 MHz Head LEFT ANT 0**

**DUT: Pro9 Headset; Type: Unknown; Serial: Q801950024**

Communication System: UID 0, CW (0); Communication System Band: D1950 (1950.0 MHz); Frequency: 1925 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used (interpolated): f = 1925 MHz; $\sigma$ = 1.473 S/m; $\varepsilon_r$ = 40.919; $\rho$ = 1000 kg/$m^3$
Phantom section: Left Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: EX3DV4 - SN3746; ConvF(7.59, 7.59, 7.59) @ 1925 MHz; Calibrated: 11/19/2019
  - Modulation Compensation:
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 1.0, 31.0
- Electronics: DAE4 Sn1237; Calibrated: 2/4/2020
- Phantom: SAM with CRP; Type: SAM; Serial:
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

**Head/Cheek/Reference scan (51x21x1):** Interpolated grid: dx=3.000 mm, dy=3.000 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.00135 W/kg

**Head/Cheek/Zoom Scan (6x6x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 2.951 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 0.0180 W/kg
**SAR(1 g) = 0.013 W/kg; SAR(10 g) = 0.00666 W/kg** (SAR corrected for target medium)

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.0155 W/kg

**Head/Cheek/Area scan (41x41x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

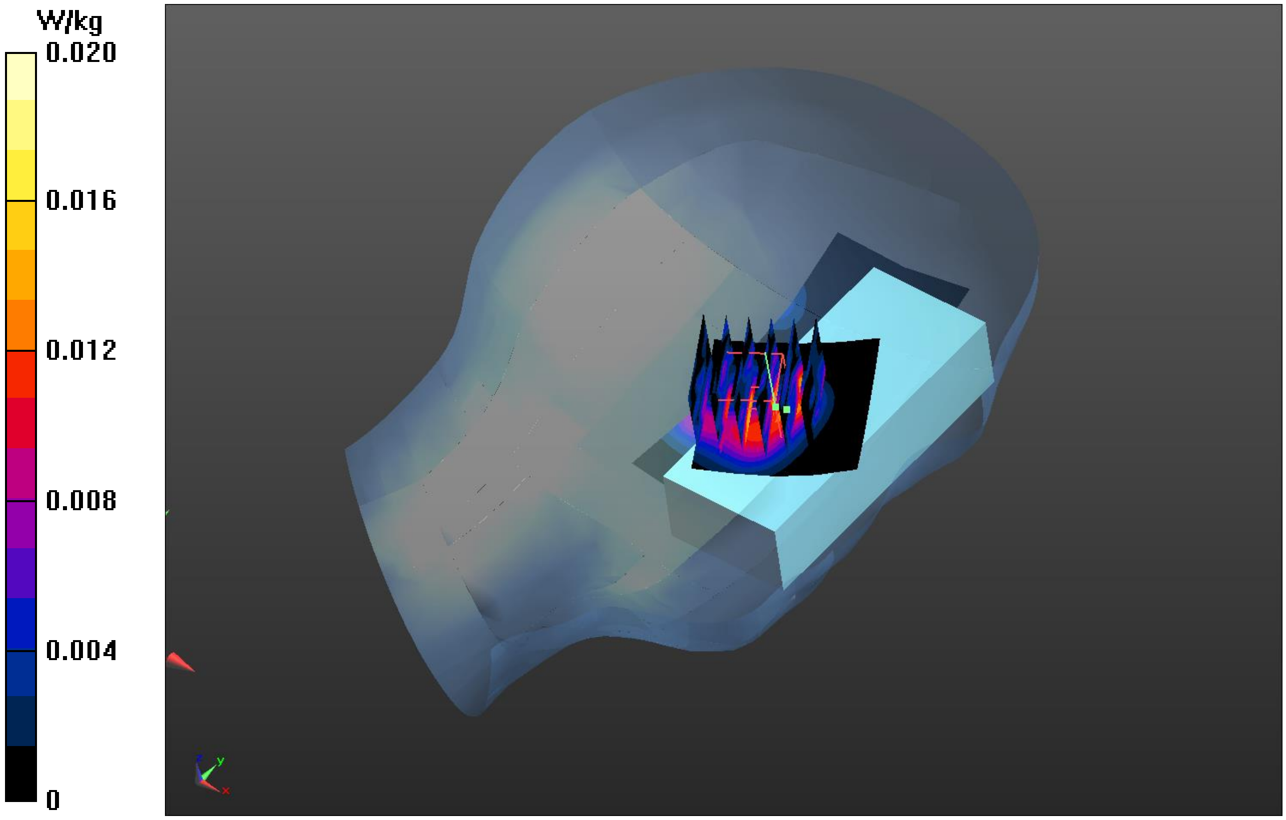
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.0232 W/kg

Kyle McMullan

Approved By

# SAR TEST DATA

**1900 MHz Head LEFT ANT 0**



# SAR TEST DATA

| | | | |
|---|---|---|---|
| Tested By: | Kyle McMullan | Room Temperature (°C): | 23°C |
| Date: | 5/21/2020 | Liquid Temperature (°C): | 23.4°C |
| Serial Number: | 0321600029 | Humidity (%RH): | 51% |
| Configuration: | ELEM0101-2 | Bar. Pressure (mb): | 1018 mb |
| Comments: | None | | |

**1900 MHz Head RIGHT ANT 0**

**DUT: Pro9 Headset; Type: Unknown; Serial: Q801950024**

Communication System: UID 0, CW (0); Communication System Band: D1950 (1950.0 MHz); Frequency: 1925 MHz;Communication System PAR: 0 dB; PMF: 1
Medium parameters used (interpolated): f = 1925 MHz; $\sigma$ = 1.473 S/m; $\varepsilon_r$ = 40.919; $\rho$ = 1000 kg/m$^3$
Phantom section: Right Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY Configuration:

- Probe: EX3DV4 - SN3746; ConvF(7.59, 7.59, 7.59) @ 1925 MHz; Calibrated: 11/19/2019
  - Modulation Compensation:
- Sensor-Surface: 1.4mm (Mechanical Surface Detection), z = 1.0, 31.0
- Electronics: DAE4 Sn1237; Calibrated: 2/4/2020
- Phantom: SAM with CRP; Type: SAM; Serial:
- DASY52 52.10.2(1504); SEMCAD X 14.6.12(7470)

**Head/Cheek/Reference scan (51x21x1):** Interpolated grid: dx=3.000 mm, dy=3.000 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.0217 W/kg

**Head/Cheek/Zoom Scan (5x5x7)/Cube 0:** Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 3.832 V/m; Power Drift = -0.32 dB
Peak SAR (extrapolated) = 0.0270 W/kg
**SAR(1 g) = 0.017 W/kg; SAR(10 g) = 0.00373 W/kg** (SAR corrected for target medium)

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.0235 W/kg

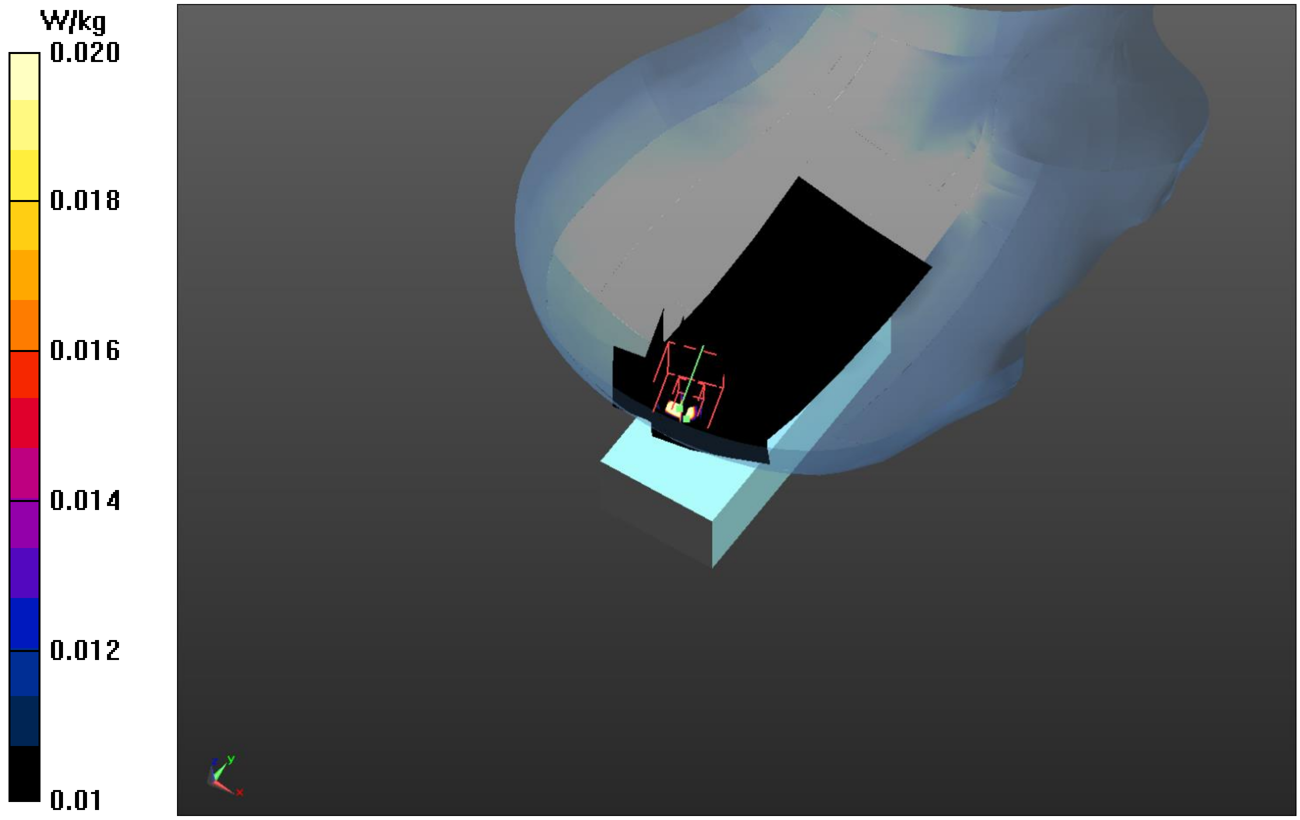
**Head/Cheek/Area scan (41x41x1):** Interpolated grid: dx=1.500 mm, dy=1.500 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 0.0399 W/kg

Approved By

# SAR TEST DATA

**1900 MHz Head RIGHT ANT 0**



# SYSTEM AND TEST SITE DESCRIPTION

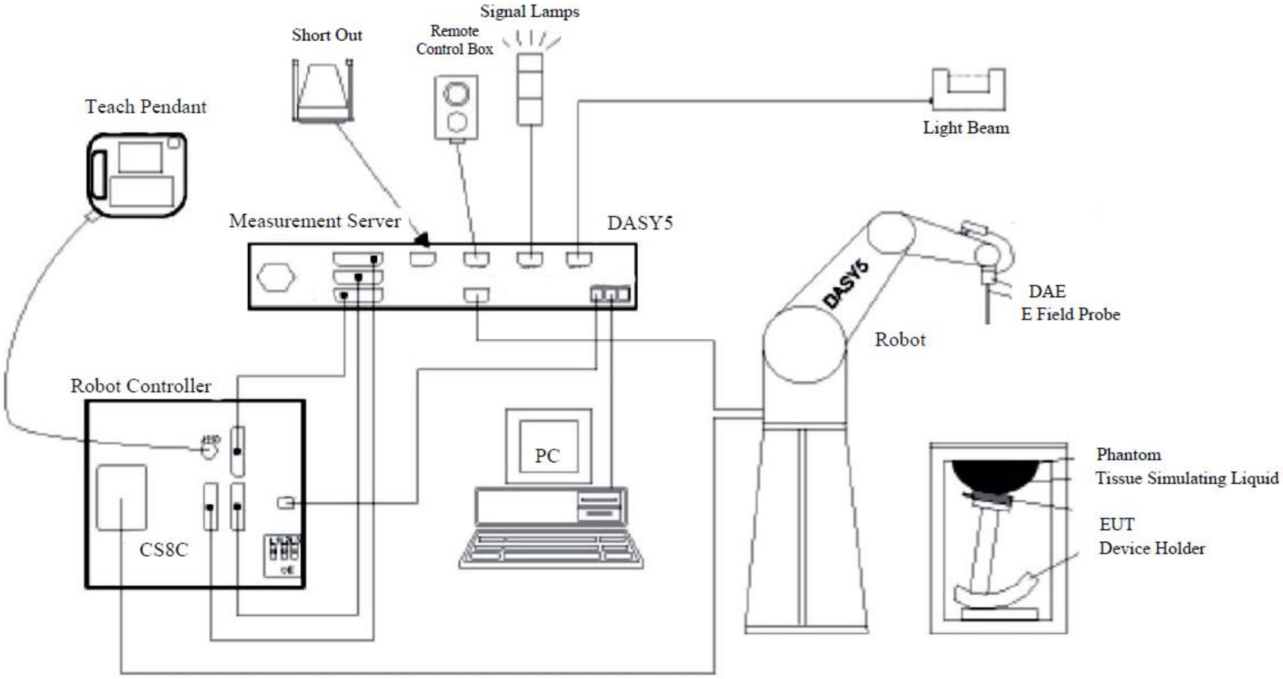
WSTD.2017.1.31

## SAR MEASUREMENT SYSTEM

**Schmid & Partner Engineering AG, DASY52**

Element selected the leader in SAR evaluation systems to provide the measurement tools for this evaluation. SPEAG's DASY52 is the fastest and most accurate scanner on the market. It is fully compatible with all world-wide standards for transmitters operating at the ear or within 20cm of the body. It provides full compatibility with IEC 62209-1, IEC 62209-2, IEEE 1528 as well as national adaptations such as FCC OET-65c and Korean Std. MIC #2000-93

The DASY52 system for performing compliance tests consists of the following items:



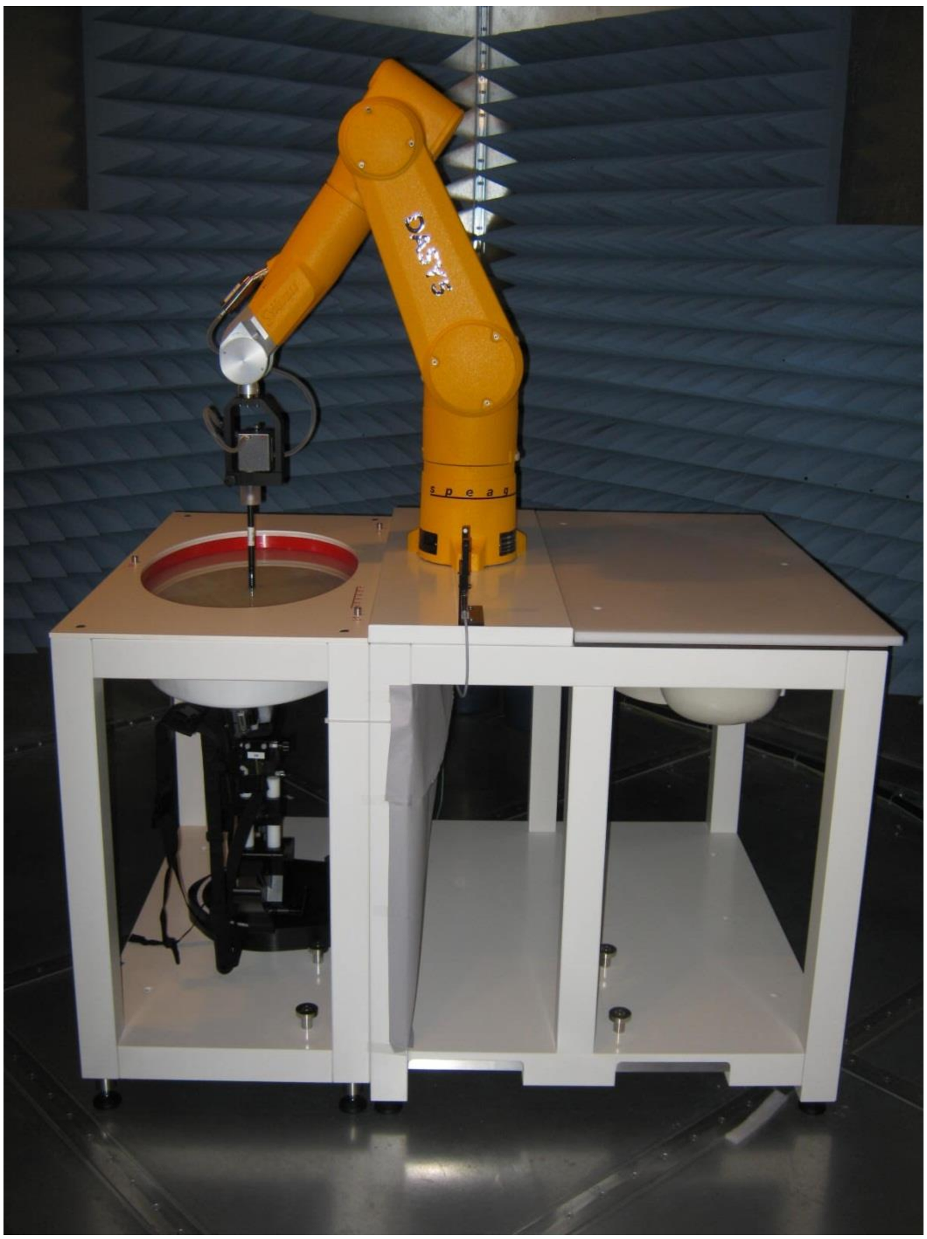

- A standard high precision 6-axis robot (Staubli TX=RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom, oval flat phantom, device holder, tissue simulating liquids, and validation dipole kits.

# SYSTEM AND TEST SITE DESCRIPTION

WSTD.2017.1.31

## TEST SITE

| Element |
|---|
| The SAR measurement system is located in a semi-anechoic chamber. This provides an ambient free environment that also eliminates reflections.<br><br>The chamber is 12 ft wide by 16 ft long x 8 ft high. A dedicated HVAC unit provides +/- 1 degree C temperature control. |



# TEST EQUIPMENT

WSEQ.2016.12.19

## TEST EQUIPMENT

| Description | Manufacturer | Model | ID | Last Cal. | Interval |
|---|---|---|---|---|---|
| Amplifier | Mini Circuits | ZHL-5W-2G-S+ | TRZ | NCR [1] | 0 mo |
| Amplifier | Mini Circuits | ZVE-3W-83+ | TTA | NCR [1] | 0 mo |
| Antenna - Dipole | SPEAG | D1900V2 | ADO | 11/13/2019 | 12 mo |
| Dielectric Assessment Kit | SPEAG | DAKS:200 | IPR | 4/25/2019 | 36 mo |
| Generator - Signal | Agilent | V2920A | TIH | NCR | 0 mo |
| Power Sensor | Agilent | N8481A | SQN | 7/13/2019 | 12 mo |
| Power Meter | Agilent | N1913A | SQL | 7/13/2019 | 12 mo |
| Probe - Dielectric | SPEAG | DAKS-3.5 | IPRA | 11/12/2019 | 36 mo |
| Probe - SAR | SPEAG | EX3DV4 | SAG | 11/19/2019 | 12 mo |
| SAR - Tissue Test Solution | SPEAG | HBBL600-10000V6 | SALN | At start of testing | |
| SAR Test System | Staeubli | DAYS5 | SAK | NCR | 0 mo |
| SAR Test System | SPEAG | QD OVA 001 BB | SAC | NCR | 0 mo |
| Thermometer | Omega Engineering, Inc. | HH311 | DUI | 2/15/2018 | 36 mo |
| DAE | SPEAG | SD 000 D04 EJ | SAH | 12/11/2019 | 12 mo |
| Phantom Twin SAM (Head) | SPEAG | QD000P40CC | SAB | None | None |
| Light Beam Unit | SPEAG | SE UKS 030 AA | SAD | None | None |

Note 1: The output of the signal generator / amplifier is verified with the calibrated power meter listed above.

# MEASUREMENT UNCERTAINTY

## MEASUREMENT UNCERTAINTY BUDGETS PER IEEE 1528:2013

### 300-3000 MHz Range

| Uncertainty Component | Tolerance (+/- %) | Probability Distribution | Divisor | $c_i$ (1g) | $c_i$ (10g) | $u_i$ (1g) (+/-%) | $u_i$ (10g) (+/-%) | $v_i$ |
|---|---|---|---|---|---|---|---|---|
| **Measurement System** | | | | | | | | |
| Probe calibration (k=1) | 5.5 | normal | 1 | 1 | 1 | 5.5 | 5.5 | ∞ |
| Axial isotropy | 4.7 | rectangular | 1.732 | 0.707 | 0.707 | 1.9 | 1.9 | ∞ |
| Hemispherical isotropy | 9.6 | rectangular | 1.732 | 0.707 | 0.707 | 3.9 | 3.9 | ∞ |
| Boundary effect | 1.0 | rectangular | 1.732 | 1 | 1 | 0.6 | 0.6 | ∞ |
| Linearity | 4.7 | rectangular | 1.732 | 1 | 1 | 2.7 | 2.7 | ∞ |
| System detection limits | 1.0 | rectangular | 1.732 | 1 | 1 | 0.6 | 0.6 | ∞ |
| Readout electronics | 0.3 | normal | 1 | 1 | 1 | 0.3 | 0.3 | ∞ |
| Response time | 0.8 | rectangular | 1.732 | 1 | 1 | 0.5 | 0.5 | ∞ |
| Integration time | 2.6 | rectangular | 1.732 | 1 | 1 | 1.5 | 1.5 | ∞ |
| RF ambient conditions - noise | 1.7 | rectangular | 1.732 | 1 | 1 | 1.0 | 1.0 | ∞ |
| RF Ambient Reflections | 0.0 | rectangular | 1.732 | 1 | 1 | 0.0 | 0.0 | ∞ |
| Probe positioner mechanical tolerance | 0.4 | rectangular | 1.732 | 1 | 1 | 0.2 | 0.2 | ∞ |
| Probe positioner with respect to phantom shell | 2.9 | rectangular | 1.732 | 1 | 1 | 1.7 | 1.7 | ∞ |
| Extrapolation, interpolation, and integration algorithms for max. SAR evaluation | 1.0 | rectangular | 1.732 | 1 | 1 | 0.6 | 0.6 | ∞ |
| **Test Sample Related** | | | | | | | | |
| Device Positioning | 2.9 | normal | 1 | 1 | 1 | 2.9 | 2.9 | 145 |
| Device Holder | 3.6 | normal | 1 | 1 | 1 | 3.6 | 3.6 | 5 |
| Power Drift | 5.0 | rectangular | 1.732 | 1 | 1 | 2.9 | 2.9 | ∞ |
| **Phantom and tissue parameters** | | | | | | | | |
| Phantom Uncertainty - shell thickness tolerances | 4.0 | rectangular | 1.732 | 1 | 1 | 2.3 | 2.3 | ∞ |
| Liquid conductivity - deviation from target values | 5.0 | rectangular | 1.732 | 0.64 | 0.43 | 1.8 | 1.2 | ∞ |
| Liquid conductivity - measurement uncertainty | 6.5 | normal | 1 | 0.64 | 0.43 | 4.2 | 2.8 | ∞ |
| Liquid permittivity - deviation from target values | 5.0 | rectangular | 1.732 | 0.6 | 0.49 | 1.7 | 1.4 | ∞ |
| Liquid permittivity - measurement uncertainty | 3.2 | normal | 1 | 0.6 | 0.49 | 1.9 | 1.6 | ∞ |
| Combined Standard Uncertainty | | RSS | | | | 11.2 | 10.6 | 387 |
| Expanded Measurement Uncertainty (95% Confidence/ | | normal (k=2) | | | | 22.5 | 21.2 | |

ADO

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

**S** **Schweizerischer Kalibrierdienst**
**C** **Service suisse d'étalonnage**
**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** **Element**

**Certificate No: D1900V2-5d131_Nov19**

# CALIBRATION CERTIFICATE

| | |
|---|---|
| Object | D1900V2 - SN:5d131 |
| Calibration procedure(s) | QA CAL-05.v11<br>Calibration Procedure for SAR Validation Sources between 0.7-3 GHz |
| Calibration date: | November 13, 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: 5058 (20k) | 04-Apr-19 (No. 217-02894) | Apr-20 |
| Type-N mismatch combination | SN: 5047.2 / 06327 | 04-Apr-19 (No. 217-02895) | Apr-20 |
| Reference Probe EX3DV4 | SN: 7349 | 29-May-19 (No. EX3-7349_May19) | May-20 |
| DAE4 | SN: 601 | 30-Apr-19 (No. DAE4-601_Apr19) | Apr-20 |

| Secondary Standards | ID # | Check Date (in house) | Scheduled Check |
|---|---|---|---|
| Power meter E4419B | SN: GB39512475 | 30-Oct-14 (in house check Feb-19) | In house check: Oct-20 |
| Power sensor HP 8481A | SN: US37292783 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| Power sensor HP 8481A | SN: MY41092317 | 07-Oct-15 (in house check Oct-18) | In house check: Oct-20 |
| RF generator R&S SMT-06 | SN: 100972 | 15-Jun-15 (in house check Oct-18) | In house check: Oct-20 |
| Network Analyzer Agilent E8358A | SN: US41080477 | 31-Mar-14 (in house check Oct-19) | In house check: Oct-20 |

| | Name | Function | Signature |
|---|---|---|---|
| Calibrated by: | Leif Klysner | Laboratory Technician | |
| Approved by: | Katja Pokovic | Technical Manager | |

Issued: November 15, 2019

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

**S** Schweizerischer Kalibrierdienst
**C** Service suisse d'étalonnage
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 | V52.10.3 |
| **Extrapolation** | Advanced Extrapolation | |
| **Phantom** | Modular Flat Phantom | |
| **Distance Dipole Center - TSL** | 10 mm | with Spacer |
| **Zoom Scan Resolution** | dx, dy, dz = 5 mm | |
| **Frequency** | 1900 MHz ± 1 MHz | |

## Head TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Head TSL parameters** | 22.0 °C | 40.0 | 1.40 mho/m |
| **Measured Head TSL parameters** | (22.0 ± 0.2) °C | 41.3 ± 6 % | 1.38 mho/m ± 6 % |
| **Head TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Head TSL

| **SAR averaged over 1 cm$^3$ (1 g) of Head TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 10.2 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **41.4 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm$^3$ (10 g) of Head TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.32 W/kg |
| SAR for nominal Head TSL parameters | normalized to 1W | **21.5 W/kg ± 16.5 % (k=2)** |

## Body TSL parameters

The following parameters and calculations were applied.

| | **Temperature** | **Permittivity** | **Conductivity** |
|---|---|---|---|
| **Nominal Body TSL parameters** | 22.0 °C | 53.3 | 1.52 mho/m |
| **Measured Body TSL parameters** | (22.0 ± 0.2) °C | 54.2 ± 6 % | 1.49 mho/m ± 6 % |
| **Body TSL temperature change during test** | < 0.5 °C | ---- | ---- |

## SAR result with Body TSL

| **SAR averaged over 1 cm$^3$ (1 g) of Body TSL** | Condition | |
|---|---|---|
| SAR measured | 250 mW input power | 9.94 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **40.4 W/kg ± 17.0 % (k=2)** |

| **SAR averaged over 10 cm$^3$ (10 g) of Body TSL** | condition | |
|---|---|---|
| SAR measured | 250 mW input power | 5.24 W/kg |
| SAR for nominal Body TSL parameters | normalized to 1W | **21.2 W/kg ± 16.5 % (k=2)** |

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

### Antenna Parameters with Head TSL

| | |
|---|---|
| Impedance, transformed to feed point | 51.9 Ω + 6.1 jΩ |
| Return Loss | - 24.1 dB |

### Antenna Parameters with Body TSL

| | |
|---|---|
| Impedance, transformed to feed point | 47.7 Ω + 6.5 jΩ |
| Return Loss | - 23.1 dB |

### General Antenna Parameters and Design

| | |
|---|---|
| Electrical Delay (one direction) | 1.203 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 |

## DASY5 Validation Report for Head TSL

Date: 13.11.2019

Test Laboratory: SPEAG, Zurich, Switzerland

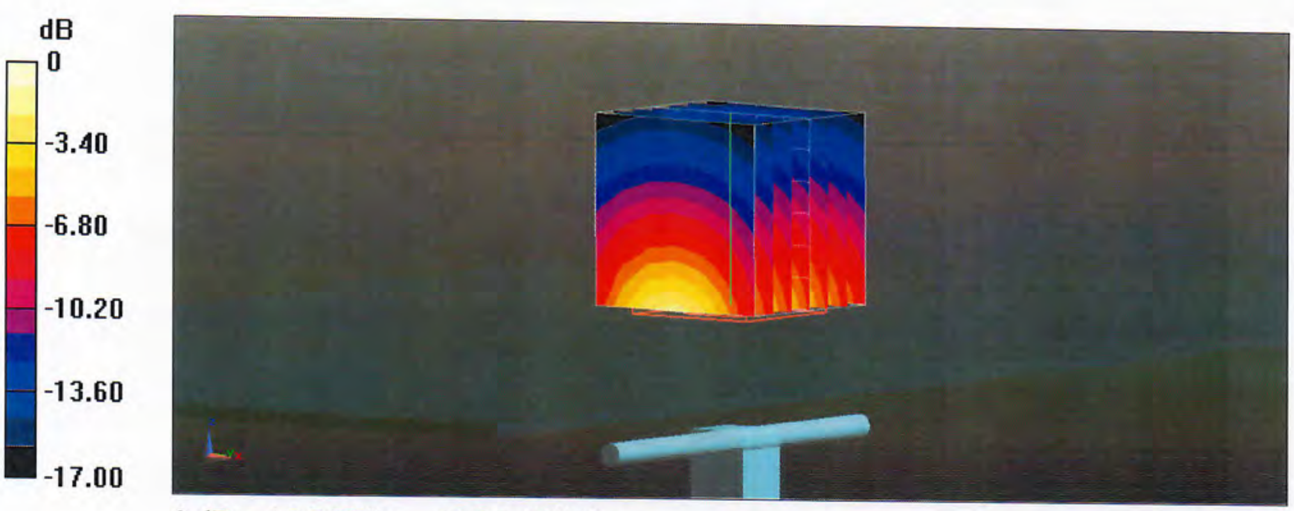
**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d131**

Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.38 S/m; $\varepsilon_r$ = 41.3; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

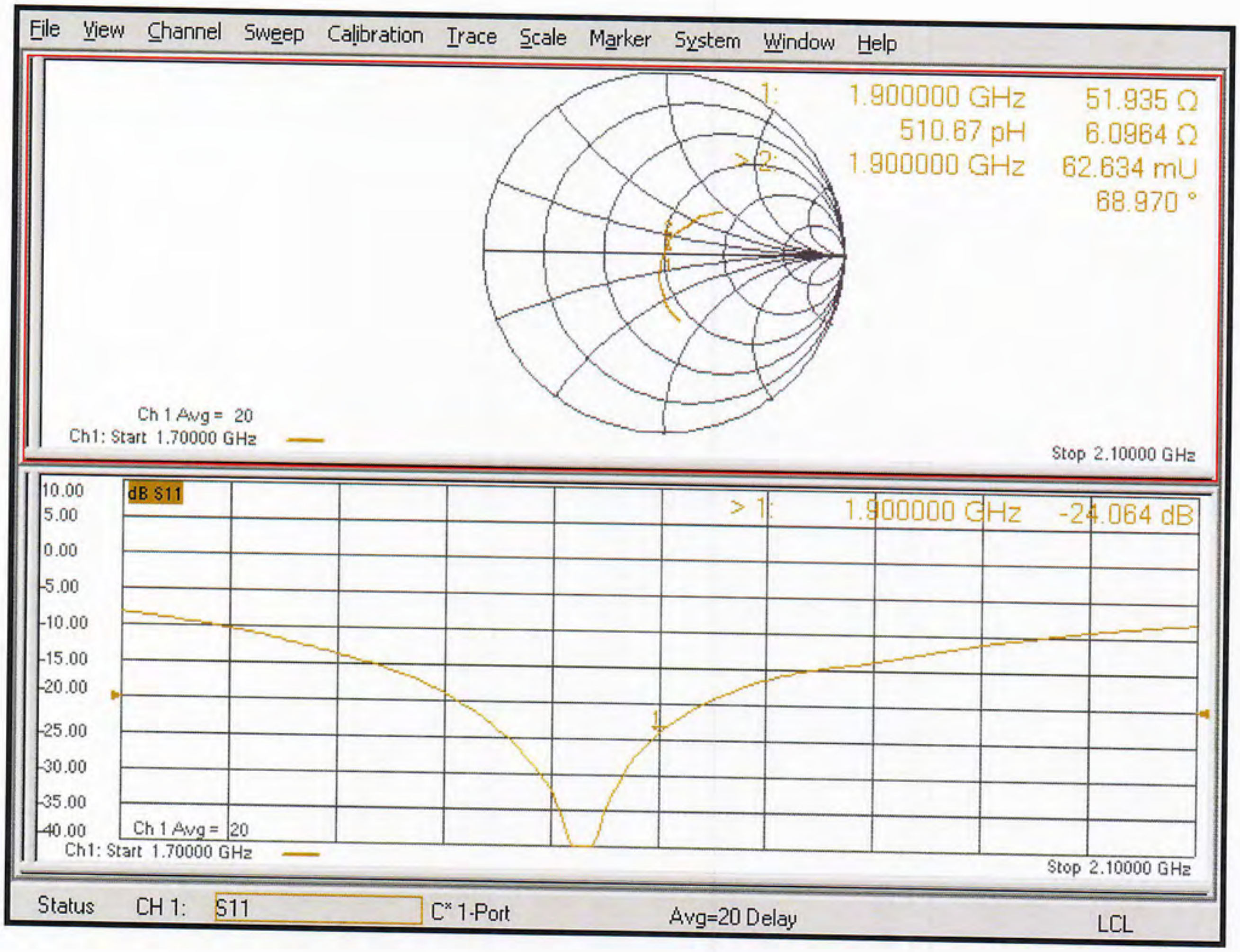
- Probe: EX3DV4 - SN7349; ConvF(8.44, 8.44, 8.44) @ 1900 MHz; Calibrated: 29.05.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.3(1513); SEMCAD X 14.6.13(7474)

**Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:**
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 111.0 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 18.9 W/kg
**SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.32 W/kg**
Smallest distance from peaks to all points 3 dB below = 9.5 mm
Ratio of SAR at M2 to SAR at M1 = 54.7%
Maximum value of SAR (measured) = 15.7 W/kg




0 dB = 15.7 W/kg = 11.96 dBW/kg

## Impedance Measurement Plot for Head TSL



## DASY5 Validation Report for Body TSL

Date: 13.11.2019

Test Laboratory: SPEAG, Zurich, Switzerland

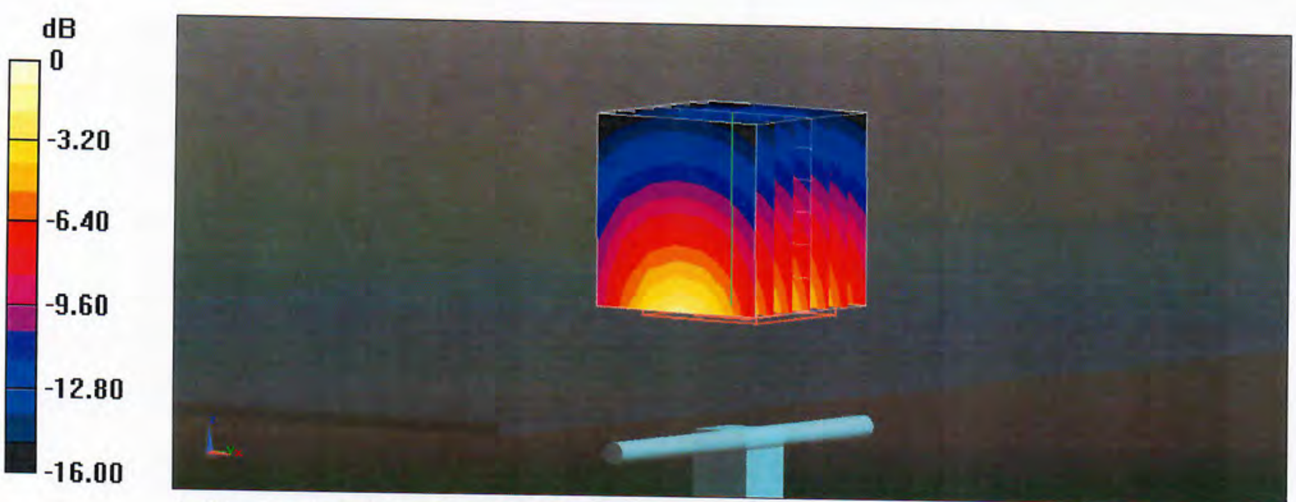
**DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d131**

Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; $\sigma$ = 1.49 S/m; $\varepsilon_r$ = 54.2; $\rho$ = 1000 kg/m$^3$
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

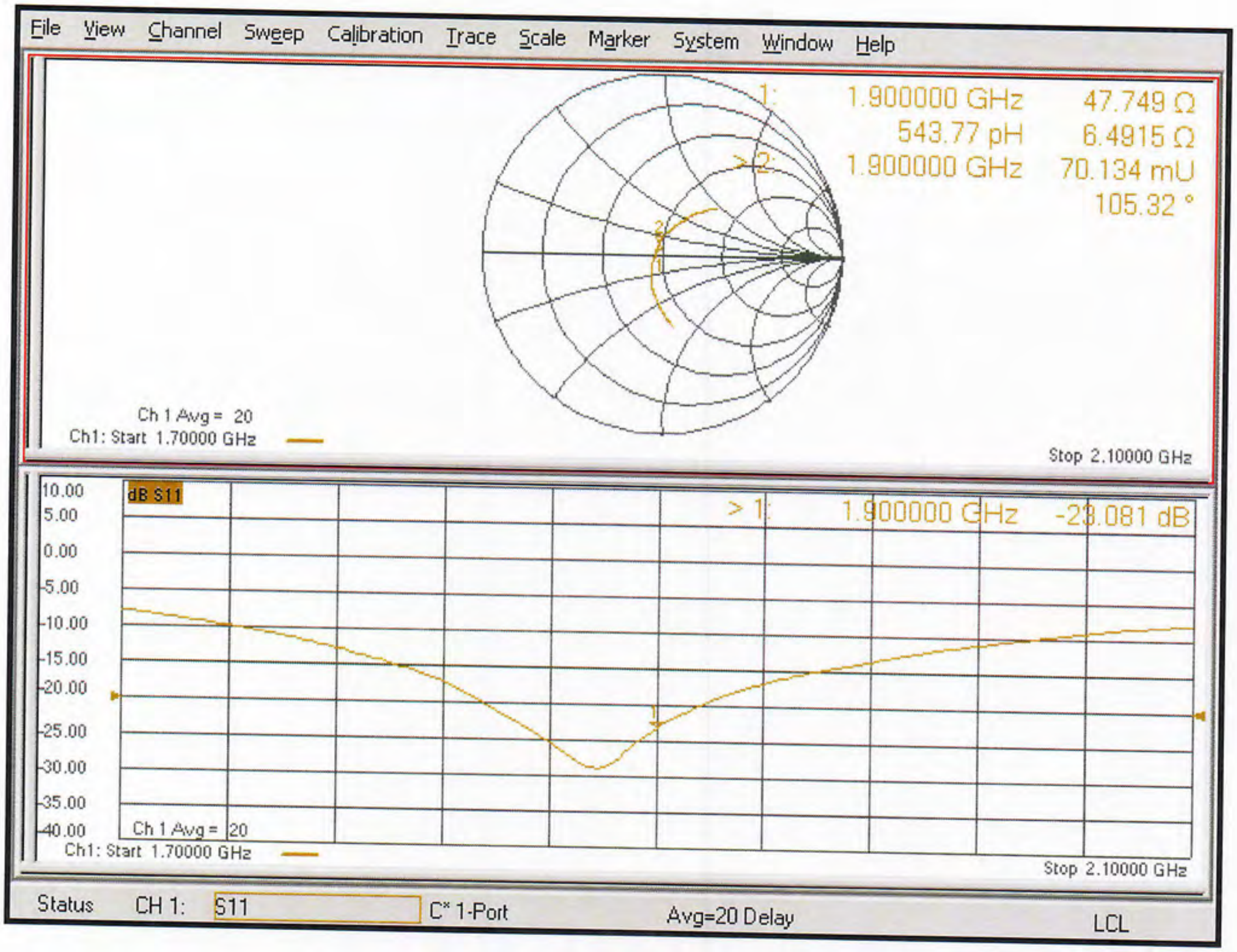
- Probe: EX3DV4 - SN7349; ConvF(8.42, 8.42, 8.42) @ 1900 MHz; Calibrated: 29.05.2019
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 30.04.2019
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.3(1513); SEMCAD X 14.6.13(7474)

**Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:**
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 105.4 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 17.8 W/kg
**SAR(1 g) = 9.94 W/kg; SAR(10 g) = 5.24 W/kg**
Smallest distance from peaks to all points 3 dB below = 9 mm
Ratio of SAR at M2 to SAR at M1 = 57%
Maximum value of SAR (measured) = 15.1 W/kg




0 dB = 15.1 W/kg = 11.79 dBW/kg

## Impedance Measurement Plot for Body TSL



SAG

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

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

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

**Accreditation No.: SCS 0108**

**Client** **Element**

**Certificate No: EX3-3746_Nov19**

# CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:3746

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: November 19, 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-19) | In house check: Oct-20 |

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

Issued: November 19,2019

## 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:3746

## Basic Calibration Parameters

| | Sensor X | Sensor Y | Sensor Z | Unc (k=2) |
|---|---|---|---|---|
| Norm ($\mu V/(V/m)^2$)[A] | 0.31 | 0.27 | 0.21 | ± 10.1 % |
| DCP (mV)[B] | 101.0 | 106.7 | 100.8 | |

## 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 | 180.3 | ±3.5 % | ± 4.7 % |
| | | Y | 0.0 | 0.0 | 1.0 | | 179.9 | | |
| | | Z | 0.0 | 0.0 | 1.0 | | 194.2 | | |

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:3746

## Other Probe Parameters

| | |
|---|---|
| Sensor Arrangement | Triangular |
| Connector Angle (°) | 100.1 |
| 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:3746

## Calibration Parameter Determined in Head Tissue Simulating Media

| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha [G] | Depth [G] (mm) | Unc (k=2) |
|---|---|---|---|---|---|---|---|---|
| 450 | 43.5 | 0.87 | 10.25 | 10.25 | 10.25 | 0.15 | 1.30 | ± 13.3 % |
| 750 | 41.9 | 0.89 | 9.32 | 9.32 | 9.32 | 0.43 | 1.02 | ± 12.0 % |
| 835 | 41.5 | 0.90 | 9.08 | 9.08 | 9.08 | 0.57 | 0.80 | ± 12.0 % |
| 900 | 41.5 | 0.97 | 8.82 | 8.82 | 8.82 | 0.47 | 0.89 | ± 12.0 % |
| 1750 | 40.1 | 1.37 | 7.95 | 7.95 | 7.95 | 0.40 | 0.86 | ± 12.0 % |
| 1900 | 40.0 | 1.40 | 7.59 | 7.59 | 7.59 | 0.29 | 0.86 | ± 12.0 % |
| 2300 | 39.5 | 1.67 | 7.28 | 7.28 | 7.28 | 0.37 | 0.90 | ± 12.0 % |
| 2450 | 39.2 | 1.80 | 7.02 | 7.02 | 7.02 | 0.40 | 0.90 | ± 12.0 % |
| 2550 | 39.1 | 1.91 | 6.78 | 6.78 | 6.78 | 0.43 | 0.90 | ± 12.0 % |
| 5200 | 36.0 | 4.66 | 5.15 | 5.15 | 5.15 | 0.40 | 1.80 | ± 13.1 % |
| 5300 | 35.9 | 4.76 | 4.97 | 4.97 | 4.97 | 0.40 | 1.80 | ± 13.1 % |
| 5500 | 35.6 | 4.96 | 4.55 | 4.55 | 4.55 | 0.40 | 1.80 | ± 13.1 % |
| 5600 | 35.5 | 5.07 | 4.51 | 4.51 | 4.51 | 0.40 | 1.80 | ± 13.1 % |
| 5800 | 35.3 | 5.27 | 4.49 | 4.49 | 4.49 | 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 ($\varepsilon$ and $\sigma$) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ($\varepsilon$ and $\sigma$) 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:3746

## Calibration Parameter Determined in Body Tissue Simulating Media

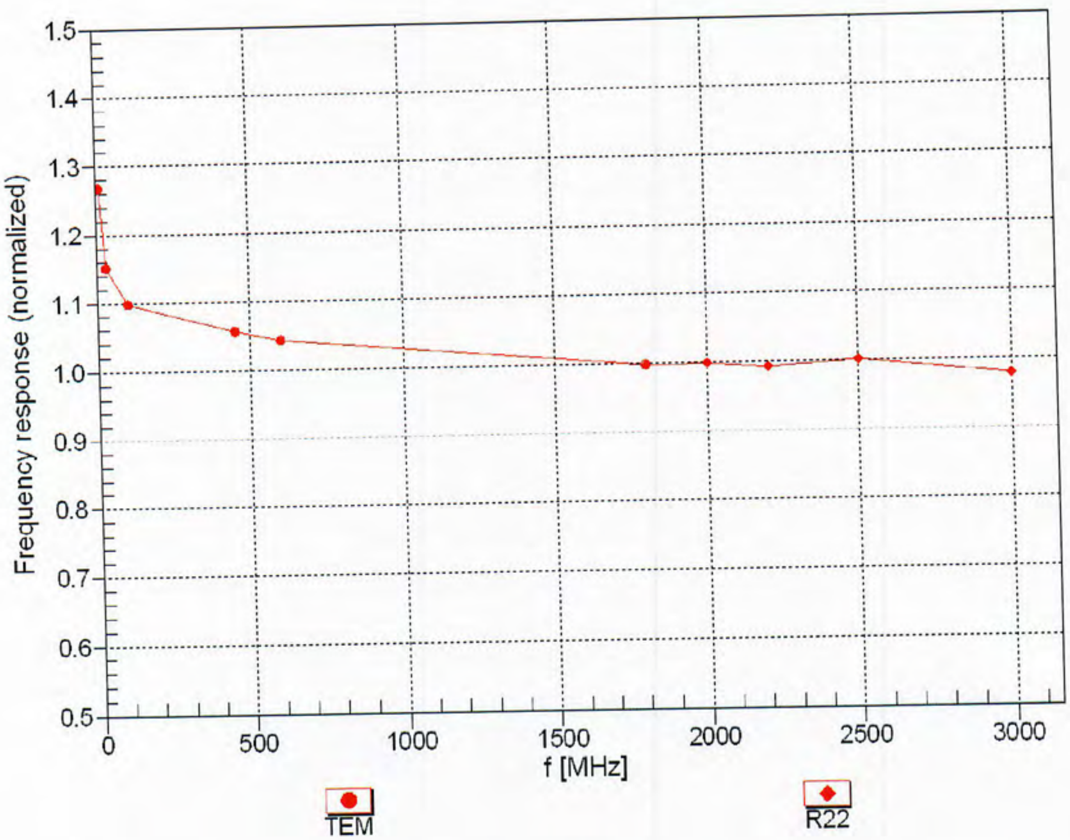
| f (MHz) [C] | Relative Permittivity [F] | Conductivity (S/m) [F] | ConvF X | ConvF Y | ConvF Z | Alpha [G] | Depth [G] (mm) | Unc (k=2) |
|---|---|---|---|---|---|---|---|---|
| 450 | 56.7 | 0.94 | 10.37 | 10.37 | 10.37 | 0.08 | 1.20 | ± 13.3 % |
| 750 | 55.5 | 0.96 | 9.30 | 9.30 | 9.30 | 0.45 | 0.87 | ± 12.0 % |
| 835 | 55.2 | 0.97 | 9.06 | 9.06 | 9.06 | 0.51 | 0.80 | ± 12.0 % |
| 900 | 55.0 | 1.05 | 8.96 | 8.96 | 8.96 | 0.38 | 0.80 | ± 12.0 % |
| 1750 | 53.4 | 1.49 | 7.67 | 7.67 | 7.67 | 0.41 | 0.86 | ± 12.0 % |
| 1900 | 53.3 | 1.52 | 7.44 | 7.44 | 7.44 | 0.40 | 0.86 | ± 12.0 % |
| 2300 | 52.9 | 1.81 | 7.42 | 7.42 | 7.42 | 0.46 | 0.90 | ± 12.0 % |
| 2450 | 52.7 | 1.95 | 7.33 | 7.33 | 7.33 | 0.36 | 0.90 | ± 12.0 % |
| 2550 | 52.6 | 2.09 | 7.13 | 7.13 | 7.13 | 0.35 | 0.96 | ± 12.0 % |
| 5200 | 49.0 | 5.30 | 4.28 | 4.28 | 4.28 | 0.50 | 1.90 | ± 13.1 % |
| 5300 | 48.9 | 5.42 | 4.19 | 4.19 | 4.19 | 0.50 | 1.90 | ± 13.1 % |
| 5500 | 48.6 | 5.65 | 3.78 | 3.78 | 3.78 | 0.50 | 1.90 | ± 13.1 % |
| 5600 | 48.5 | 5.77 | 3.70 | 3.70 | 3.70 | 0.50 | 1.90 | ± 13.1 % |
| 5800 | 48.2 | 6.00 | 3.77 | 3.77 | 3.77 | 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 ($\varepsilon$ and $\sigma$) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters ($\varepsilon$ and $\sigma$) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

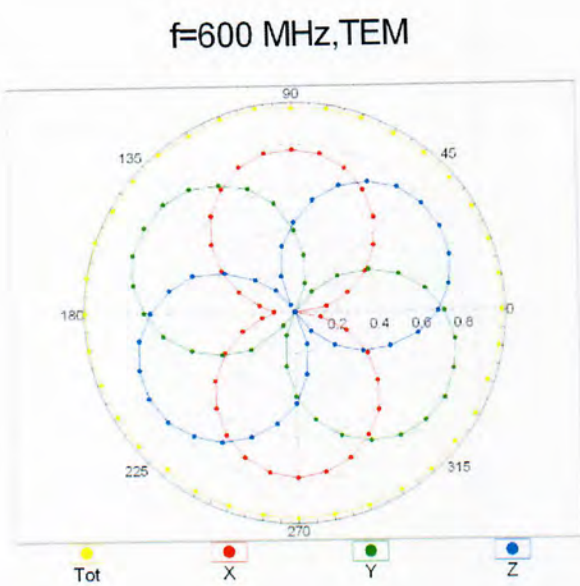
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from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

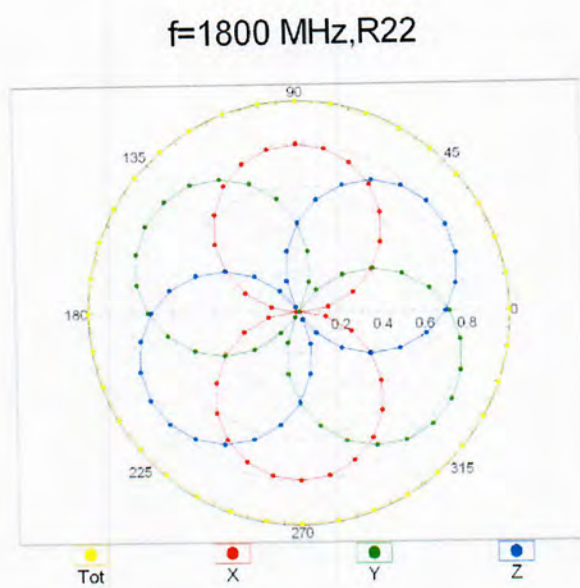
# Frequency Response of E-Field
## (TEM-Cell:ifi110 EXX, Waveguide: R22)

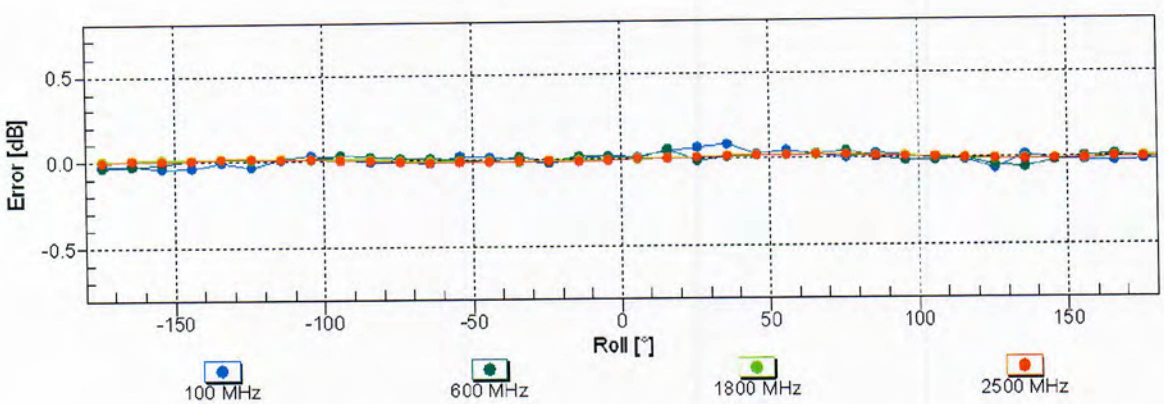



**Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)**

# Receiving Pattern (ϕ), ϑ = 0°

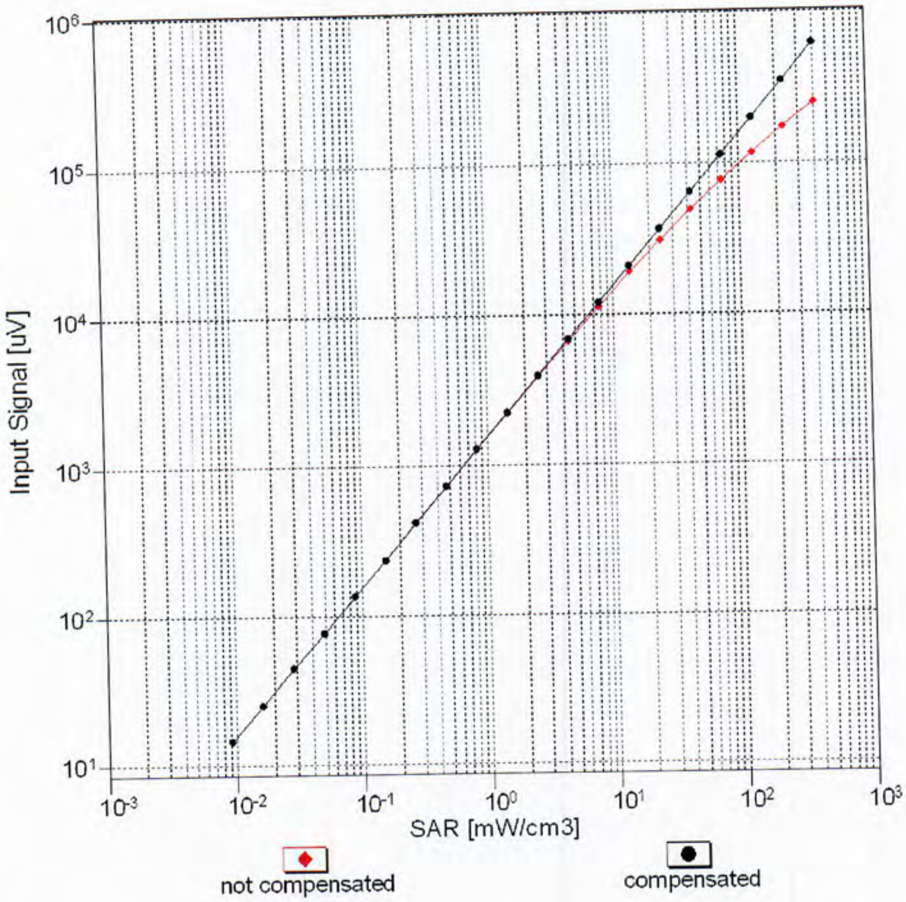


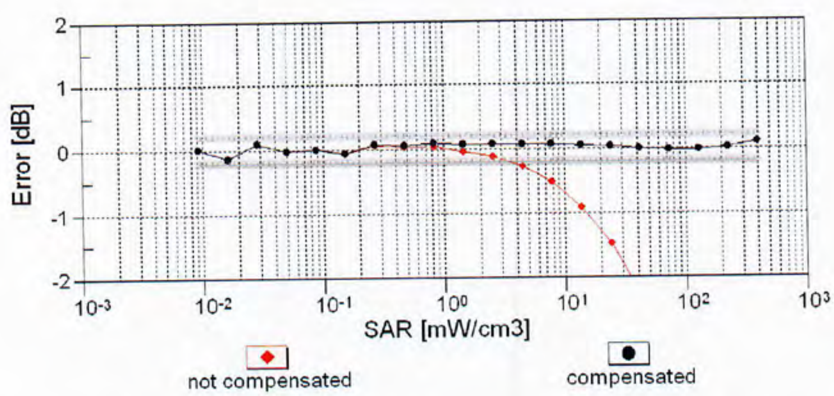




**Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)**

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

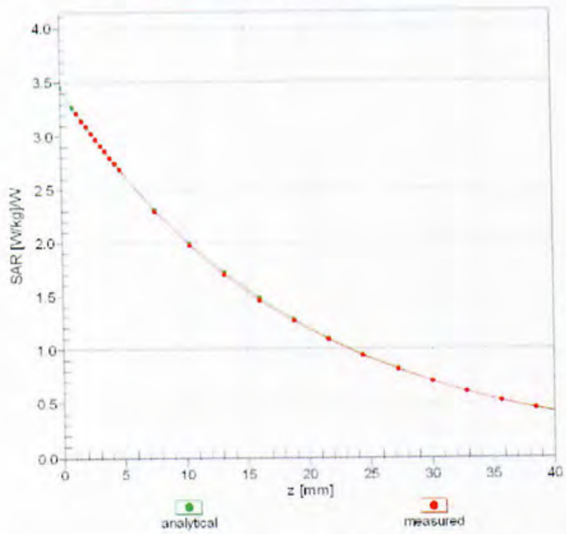


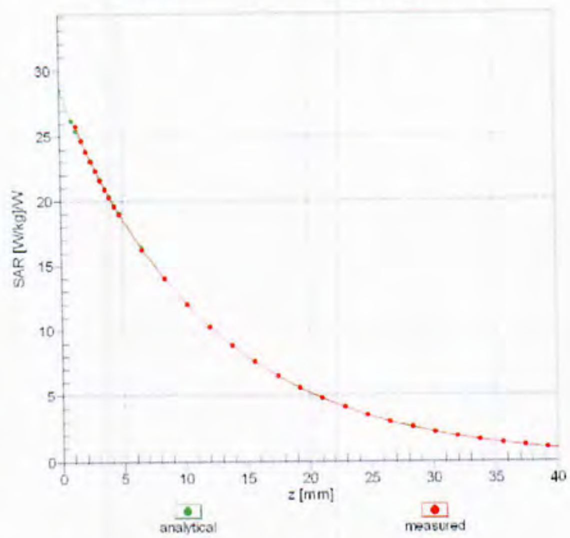

**Uncertainty of Linearity Assessment: ± 0.6% (k=2)**

# Conversion Factor Assessment

f = 835 MHz,WGLS R9 (H_convF)

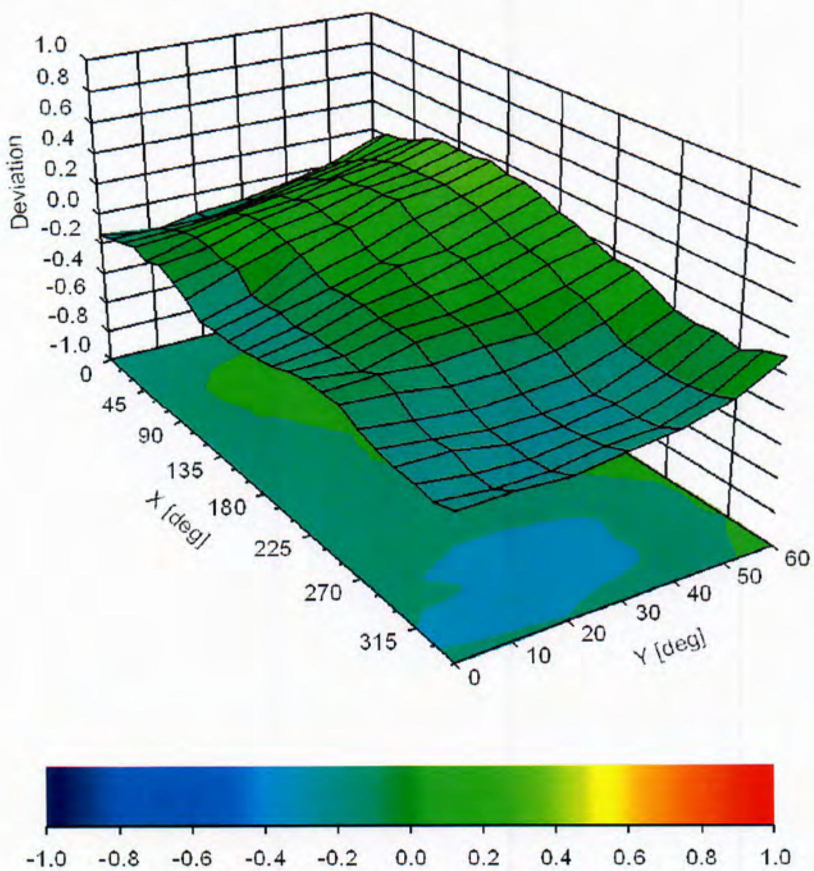



f = 1900 MHz,WGLS R22 (H_convF)




# Deviation from Isotropy in Liquid

**Error (ϕ, ϑ), f = 900 MHz**




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