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Dosimetric Assessment
Test Report

for the

Listen Technologies Corporation
ListenTalk

FCC ID: OMDLK1-001

Tested and Evaluated In Accordance With
IEEE 1528:2013, KDB 447498

Prepared for

Listen Technologies Corporation
Guy Leishman
14912 Heritagecrest Way
Bluffdale, UT 84065-4818

Engineering Statement: The measurements shown in this report were made in accordance with the procedures specified in Supplement C to OET Bulletin 65 of the Federal Communications Commission (FCC) Guidelines [FCC 2001] and Industry Canada RSS-102 for controlled exposure. I assume full responsibility for the accuracy and completeness of these measurements, and for the qualifications of all persons taking them. It is further stated that upon the basis of the measurements made, the equipment evaluated is capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in ANSI/IEEE Std. C95.1-1999.

SAR Evaluation
Certificate of Compliance

APPLICANT: Listen Technologies Corporation

Applicant Name and Address: Guy Leishman
14912 Heritagecrest Way
Bluffdale, UT 84065-4818

Test Location: MET Laboratories, Inc.
3162 Belick Street
Santa Clara, CA 95054
USA

EUT:	ListenTalk	
Test Dates:	December 11th – December 13th	
RF exposure environment:	Uncontrolled Exposure/General Population	
RF exposure category:	Portable	
Power supply:	Internal battery	
Antenna:	Internal	
Production/prototype:	Production	
Modes of operation tested:	DECT	
Modulation tested:	TDMA	
Duty Cycle tested:	DECT → 8.3%	
TX Range:	1920MHz – 1930MHz	
Max SAR Measured	**SAR 1g (W/kg)**	
	Phantom Body Section (0cm)	0.05

John Mason,
Director, Electromagnetic Compatibility Lab

Table of Contents

List of Figures

List of Tables

1 INTRODUCTION

This measurement report demonstrates that ListenTalk unit as described within this report complies with the Specific Absorption Rate (SAR) RF exposure requirements specified in ANSI/IEEE Std. C95.1-1999, FCC 47 CFR §2.1093 for the Uncontrolled Exposure/General population environment. The test procedures described in IEEE 1528:2013, KDB 447498 and KDB 594280 were employed.

A description of the device under test, device operating configuration and test conditions, measurement and site description, methodology and procedures used in the evaluation, equipment used, detailed summary of the test results and the various provisions of the rules are included in this dosimetric assessment test report.

1.1 SAR DEFINITION

Specific Absorption Rate (SAR) is defined as the time derivative (rate) of the incremental energy (*dU*) absorbed by (dissipated in) an incremental mass (*dm*) contained in a volume element (*dV*) of a given density (ρ). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Fig. 1.1).

$$SAR = \frac{d}{dt}\left(\frac{dU}{dm}\right) = \frac{d}{dt}\left(\frac{dU}{\rho dv}\right)$$

SAR is expressed in units of Watts per Kilogram (W/kg).

$$SAR = \sigma E^2 / \rho$$

where:

σ - conductivity of the tissue - simulant material (S/m)
ρ - mass density of the tissue - simulant material (kg/m3)
E - Total RMS electric field strength (V/m)

NOTE: The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relations to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflecting surfaces, and whether conductive contact is made by the organism with a ground plane.

1.2 DESCRIPTION OF DEVICE UNDER TEST (EUT)

Applicant:	Listen Technologies Corporation
Description of Test Item:	The ListenTalk device is a hand held DECT unit that communicates to other ListenTalk units (one or many) using a headset or internal microphone for the audio. It has a PTT button for two communications. Most applications will be for tour groups in a portable setting
Supply Voltage:	3.7 Li-Ion battery
Antenna Type(s) Tested:	Integral
Accessories:	None
Modes of Operation:	DECT
Duty Cycles:	8.3%
Application Type:	Evaluation for aggregated SAR levels
Exposure Category:	Uncontrolled Exposure/General Population
FCC and IC Rule Part(s):	FCC 47 CFR §2.1093
Standards:	IEEE 1528:2013, KDB 447498 and KDB 594280

Table 1: Description of device under test.

1.3 SAR MEASUREMENT SYSTEM

MET Laboratories, Inc SAR measurement facility utilizes the DASY4 Professional Dosimetric Assessment System (DASY™) manufactured by Schmid & Partner Engineering AG (SPEAG™) of Zurich, Switzerland for performing SAR compliance tests. The DASY4 measurement system is comprised of the measurement server, robot controller, computer, near-field probe, probe alignment sensor, specific anthropomorphic mannequin (SAM) phantom, and various planar phantoms for brain and/or body SAR evaluations. The robot is a six-axis industrial robot performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF). The Cell controller system contain the power supply, robot controller, teach pendant (Joystick), and remote control, is used to drive the robot motors. The Staubli robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. is connected to the Electro-optical coupler (EOC). The EOC performs the conversion from the optical into digital electric signal of the DAE and transfers data to the DASY4 measurement server. The DAE4 utilizes a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16-bit AD-converter and a command decoder and control logic unit.

Transmission to the DASY4 measurement server is accomplished through an optical downlink for data and status information and an optical uplink for commands and clock lines. The mechanical probe-mounting device includes two different sensor systems for frontal and sidewise probe contacts. The sensor systems are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer.

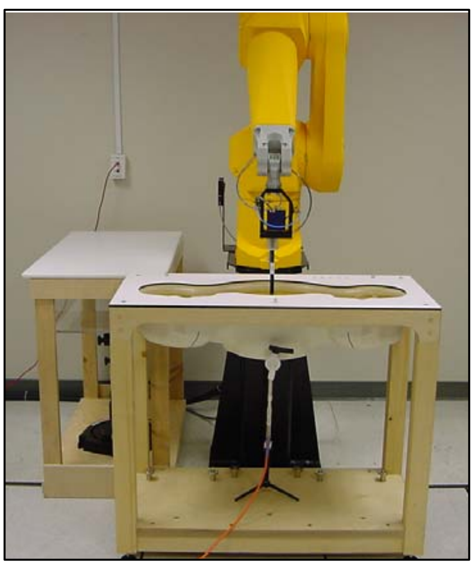

Figure 1: Staubli Robotic Arm

2 ListenTalk Antenna Analysis

ListenTalk comprises of two antennas. The reported gain of the antenna 0 is 1.8 dBi and antenna 1 is 0 dBi. Antennas are not working simultaneous.

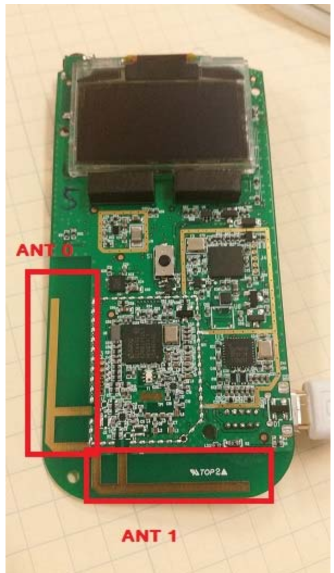

Figure 2: ListenTalk antenna placement.

3 SAR MEASUREMENT SUMMARY – FCC

SAR HEAD MEASUREMENT RESULTS							
Channel #	Frequency (MHz)	mode	Position	Antenna	Power Drift %	Measured SAR 1g (W/kg)	Worst case tune-up corrected SAR 1g (W/kg)
25	1925	DECT	Front	0	4.183	0.039	0.049
25	1925	DECT	Back	0	3.8	0.013	0.0163
25	1925	DECT	Front	1	3.08	0.04	0.05
25	1925	DECT	Back	1	4.688	0.011	0.0138

Table 2: DECT SAR body measurement results

Note 1: Power drift correction is only applicable if it is more than 5%
Note 2: Worst case tune up tolerance corrected SAR
= [(Target Power + 1dBm) in mW / (Measured Power in mW)] x DC corrected SAR

1925 MHz Front (Antenna 0)

Measured Power = 14.74 dBm = 29.78 mW
Target = 14.74 dBm + 1dBm = 15.74 dBm = 37.5 mW
Worst case tune up tolerance corrected SAR = [37.5 mW / (29.78 mW)] x 0.039 = 0.049

1925 MHz Back (Antenna 0)

Measured Power = 14.74 dBm = 29.78 mW
Target = 14.74 dBm + 1dBm = 15.74 dBm = 37.5 mW
Worst case tune up tolerance corrected SAR = [37.5 mW / (29.78 mW)] x 0.013 = 0.0163

1925 MHz Front (Antenna 1)

Measured Power = 14.74 dBm = 29.78 mW
Target = 14.74 dBm + 1dBm = 15.74 dBm = 37.5 mW
Worst case tune up tolerance corrected SAR = [37.5 mW / (29.78 mW)] x 0.04 = 0.05

2437 MHz Back (Antenna 1)

Measured Power = 14.74 dBm = 29.78 mW
Target = 14.74 dBm + 1dBm = 15.74 dBm = 37.5 mW
Worst case tune up tolerance corrected SAR = [37.5 mW / (29.78 mW)] x 0.011 = 0.0138

4 CONDUCTED POWER MEASUREMENT SUMMARY

So according to the KDB 447498, channels with the highest output conducted power were tested for SAR first. If the SAR number was greater than 1.2 W/kg then the next highest power channel was test for SAR. Below are the measured conducted output powers from the EUT for the DECT channels.

As highlighted below, channels were selected. Since the SAR value was less than 1.2 W/kg, further testing for other modes was not necessary.

The main goal of SAR test reduction method as prescribed in KDB 447498 is to save time and not test unnecessarily for a very large number of channels.

DECT (TDMA)	
Channels	**23/25/27**
Power (dBm)	14.7/14.74/14.68

Table 3: DECT conducted power measurements

Note 1: Cable loss and duty cycle correction factors are negligible.

5 DETAILS OF SAR EVALUATION

The ListenTalk was determined to be compliant for localized Specific Absorption Rate based on the test provisions and conditions described below.

1. The EUT was tested for SAR on the body section of the phantom at 0 cm separation distance.

2. DECT signals were supplied to the antennas of each module at a power lever equal to that of normal operation.

3. Spectrum analyzer was used to measure the conducted output power before the SAR tests. The power drift measurement routine of the SAR system was used to determine if the power of the EUT stayed within the allowable limits.

4. The dielectric parameters of the simulated head fluid were measured prior to the evaluation using an 85070D Dielectric Probe Kit and an 8722D Network Analyzer.

5. The fluid and air temperature was measured prior to and after each SAR evaluation to ensure the temperature remained within ±2^{o}C of the temperature of the fluid when the dielectric properties were measured.

6. During the SAR evaluations if a distribution produced several hotspots over the course of the area scan, each hotspot was evaluated separately.

Figure 2: ListenTalk

5.1 FLOWCHART OF THE RECOMMENDED PRACTICES AND PROCEDURES

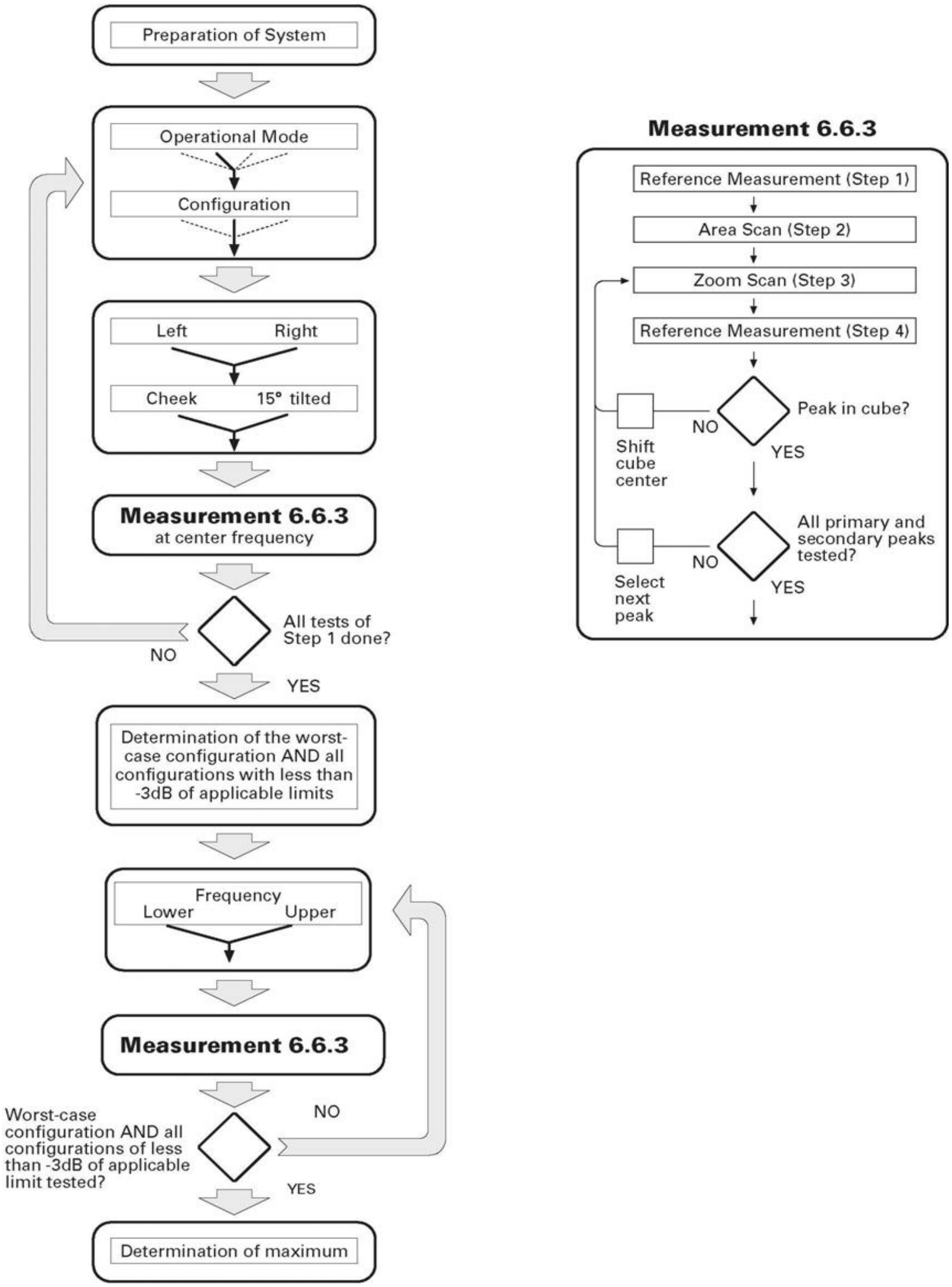

Figure 3: Flowchart of the recommended practices and procedures

5.2 EAR REFERENCE POINTS

Figure 12.1 shows the front, back and side views of the SAM Twin Phantom. The point M is the reference point for the center of the mouth, LE is the left ear reference point (ERP), and RE is the right ERP. The ERPs are 15mm posterior to the entrance to the ear canal (EEC) along the B-M line (Back-Mouth), as shown in Figure 12.2. The plane passing through the two ear canals and M is defined as the Reference Plane. The line N-F (Neck-Front) is perpendicular to the reference plane and passing through the RE (or LE) is called the Reference Pivoting. Line B-M is perpendicular to the N-F line. Both N-F and B-M lines are marked on the external phantom shell to facilitate handset positioning.

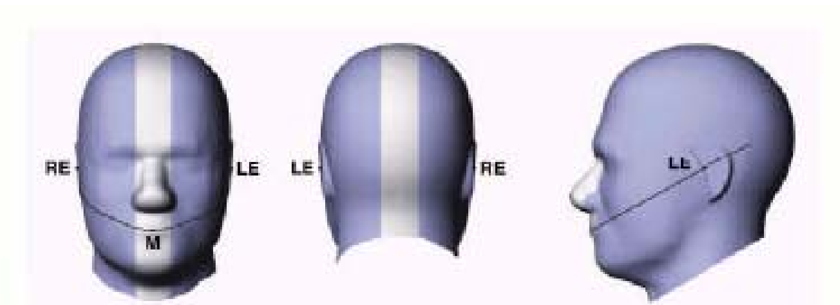

Figure 4: Front, back and side view of SAM Twin Phantom

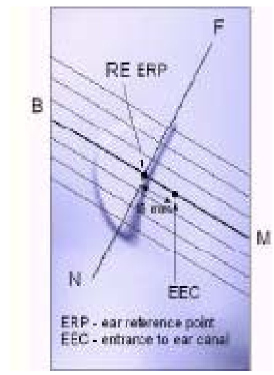

Figure 5: Side view of ERPs

5.3 EVALUATION PROCEDURES

The evaluation was performed in the head area of the phantom in both left and right sides. The SAR was determined by a pre-defined procedure within the DASY4 software. Upon completion of a reference check, the exposed region of the phantom was scanned near the inner surface with a grid spacing of 10mm x 10mm.

An area scan was determined as follows:

Based on the defined area scan grid, a more detailed grid is created to increase the points by a factor of 10. The interpolation function then evaluates all field values between corresponding measurement points.

A linear search is applied to find all the candidate maxima. Subsequently, all maxima are removed that are >2 dB from the global maximum. The remaining maxima are then used to position the cube scans.

A 1g and 10g spatial peak SAR was determined as follows:

For frequencies ≤4.5GHz a 32mm x 32mm x 34mm (7x7x7 data points) zoom scan was assessed at the position where the greatest V/m was detected. For frequencies ≥4.5GHz a 28mm x 28mm x 24mm (7x7x9 data points) zoom scan was assessed at the position where the greatest V/m was detected. The data at the surface was extrapolated since the distance from the probes sensors to the surface is 3.9cm. A least squares fourth-order polynomial was used to generate points between the probe detector and the inner surface of the phantom.

Interpolated data is used to calculate the average SAR over 1g and 10g cubes by spatially discretizing the entire measured cube. The volume used to determine the averaged SAR is a 1mm grid (42875 interpolated points).

Z-Scan was determined as follows:

The Z-scan measures points along a vertical straight line. The line runs along a line normal to the inner surface of the phantom surface.

5.4 DATA EVALUATION PROCEDURES

The DASY4 post processing software (SEMCAD) automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe Parameters:	- Sensitivity	$Norm_i$, a_{i0}, a_{i1}, a_{i2}
	- Conversion Factor	$ConvF_i$
	- Dipole Compression Point	dcp_i
Device parameters:	- Frequency	f
	- Crest factor	cf
Media parameters:	- Conductivity	σ
	- Density	ρ

These parameters must be set correctly in the software. They can be found in the component documents or can be imported into the software from the configuration files issued for the DASY components. In the direct measuring mode of the multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used. The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC - transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

with V_i = Compensated signal of channel i (i = x, y, z)
U_i = Input signal of channel i (i = x, y, z)
cf = Crest factor of exciting field (DASY parameter)
dcp_i = Diode compression point (DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

$$\text{E} - \text{fieldprobes}: \qquad E_i = \sqrt{\frac{V_1}{Norm_i \cdot ConvF}}$$

$$\text{H} - \text{fieldprobes}: \qquad H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1} f + a_{i2} f^2}{f}$$

With V_i = Compensated signal of channel i (i = x, y, z)
$Norm_i$ = Sensor sensitivity of channel i (i = x, y, z)
μV/(V/m)^2 for E-field probes
$ConvF$ = Sensitivity enhancement in solution
a_{ij} = Sensor sensitivity factors for H-field probes

f = Carrier frequency (GHz)
E_i = Electric field strength of channel i in V/m
H_i = Magnetic field strength of channel i in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

The primary field data are used to calculate the derived field units.

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1'000}$$

with SAR = local specific absorption rate in mW/g
E_{tot} = total field strength in V/m
σ = conductivity in [mho/m] or [Siemens/m]
ρ = equivalent tissue density in g/cm3

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid.

The power flow density is calculated assuming the excitation field as a free space field.

$$P_{pwe} = \frac{E_{tot}^2}{3770} \quad \text{or} \quad P_{pwe} = H_{tot}^2 \cdot 37.7$$

With P_{pwe} = Equivalent power density of a plane wave in mW/cm2
E_{tot} = total electric field strength in V/m
H_{tot} = total magnetic field strength in A/m

5.5 SAR SAFETY LIMITS

EXPOSURE LIMITS	SAR 1g (W/kg)	
	(General Population / Uncontrolled Exposure Environment)	(Occupational / Controlled Exposure Environment)
Spatial Average (averaged over the whole body)	0.08	0.4
Spatial Peak (hands/wrists/feet/ankles averaged over 1g)	1.60	8.0

Table 4: SAR safety limits for FCC.

Notes:

1. Uncontrolled exposure environments are locations where there is potential exposure of individuals who have no knowledge or control of their potential exposure.

2. Controlled exposure environments are locations where there is potential exposure of individuals who have knowledge of their potential exposure and can exercise control over their exposure.

6 SYSTEM PERFORMANCE CHECK

Prior to the SAR evaluation a system check was performed in the planar section of the SAM phantom at required frequencies. The dielectric parameters of the simulated brain fluid and body were measured prior to the system performance check using an 85070D Dielectric Probe Kit and an 8722D Network Analyzer. A forward power of 250 mW for below 3 GHz and 100 mW for above 5GHz was applied to the dipoles and the system was verified to a tolerance of ±10%. All results were normalized to 1W.

Test Date	Fluid Type (MHz)	SAR 1g (W/kg)		Permittivity Constant εr		Conductivity σ (mho/m)	
		Calibrated Target	Measured	IEEE Target	Measured	IEEE Target	Measured
12/11/2017	1950	9.88±10%	10.1	53.3±5%	51.981	1.52±5%	1.584

Table 5: System performance and head simulating fluid parameter check results

Note1: The ambient temperature, 23°C, and the fluid temperatures, 22°C were measured prior to the fluid parameter check and the system performance check and kept consistent during the measurement periods.
Note2: Fluid Depth was ≥15 cm.

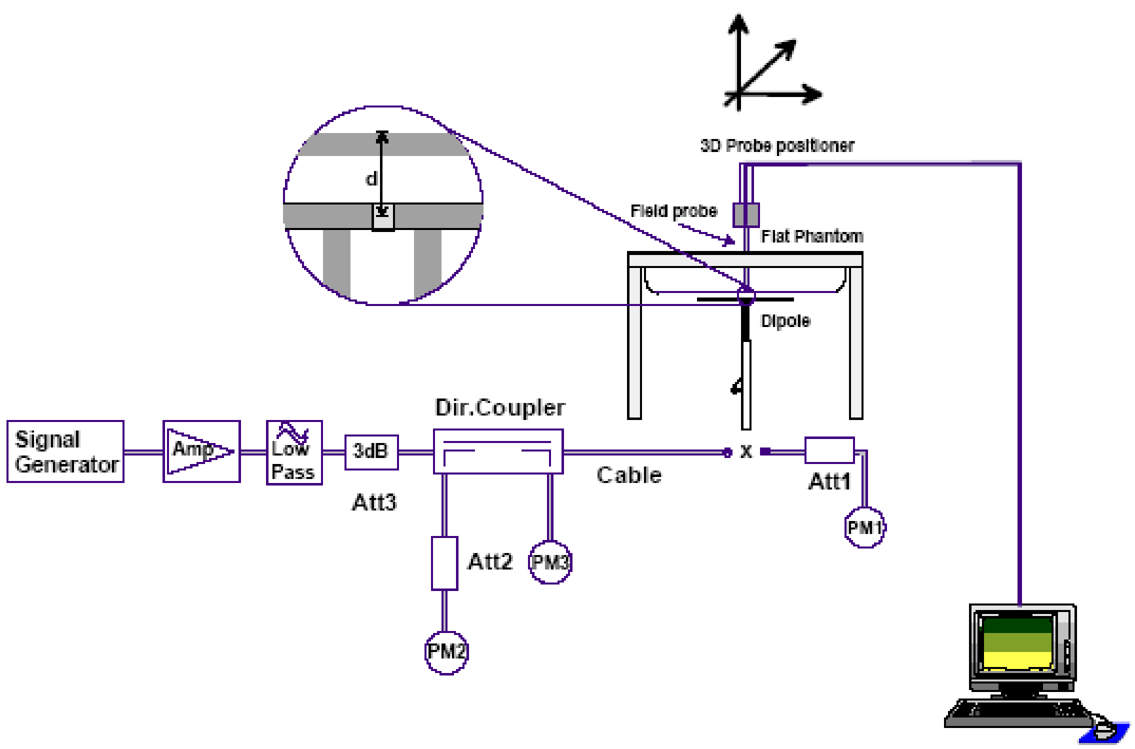

Figure 6: System performance check components

7 SIMULATED EQUIVALENT TISSUE

For the measurement of the field distribution inside the SAM phantom with DASY4, the depth of tissue-equivalent liquid must be ≥15 cm with ≤ 0.5 cm variation for measurements ≤3 GHz and ≥10 cm with ≤ 0.5 cm variation for measurements >3 GHz. [9]

Below 3GHz fluids for body tissue simulation were prepared in-house.

Measured fluid dielectric parameters are tabulated in annex F of this report.

8 ROBOT SYSTEM SPECIFICATIONS

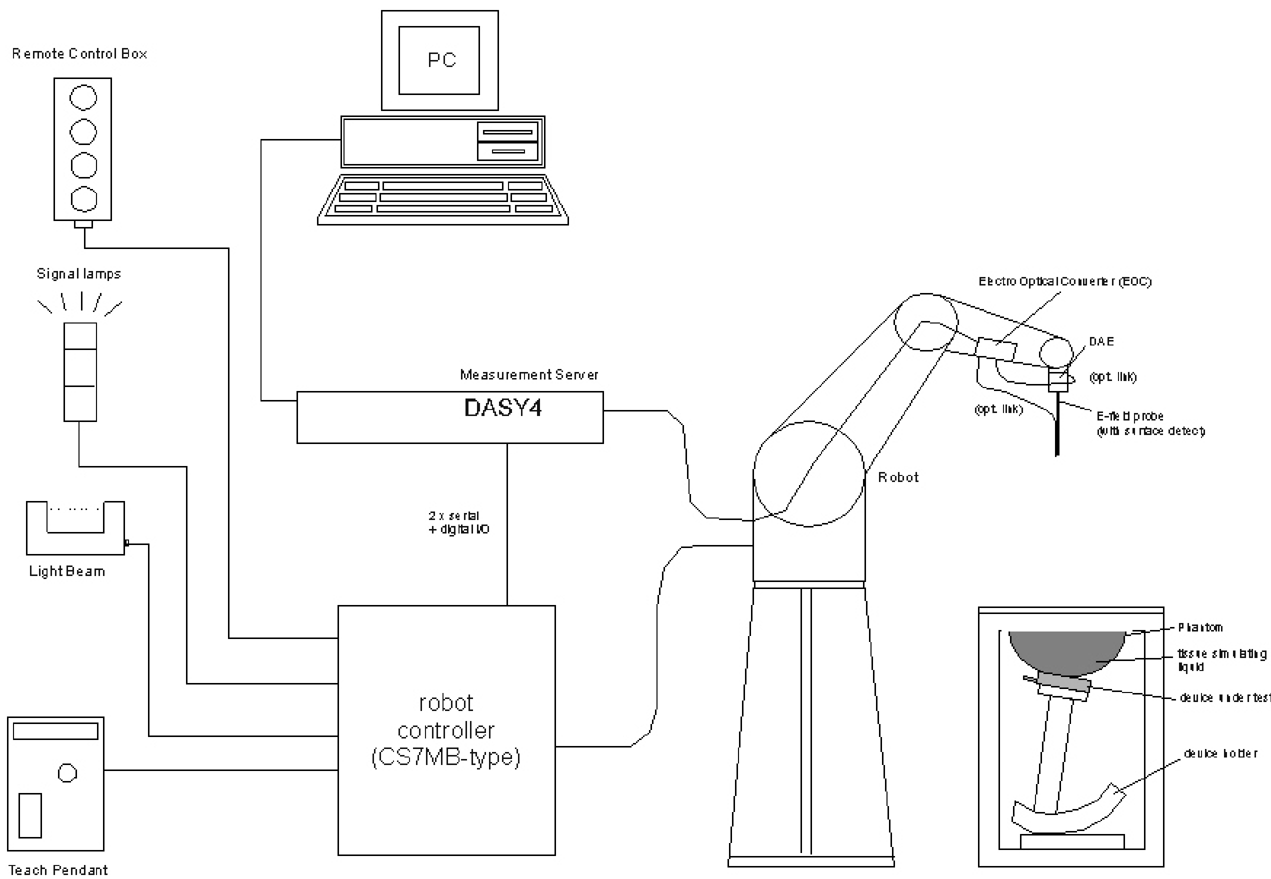

Figure 7: SAR Measurement System

8.1 Specifications

Positioner:

Robot: Staubli Unimation Corp. Robot Model: RX90

Repeatability: 0.02 mm
No. of axis: 6

8.2 Data Acquisition Electronic (DAE) System:

Cell Controller

Processor:	Compaq Evo Clock Speed: 2.4 GHz Operating System: Windows XP Professional

Data Converter

Features:	Signal Amplifier, multiplexer, A/D converter, and control logic
Software:	DASY4 software
Connecting Lines:	Optical downlink for data and status info. Optical uplink for commands and clock

Dasy4 Measurement Server

Function:	Real-time data evaluation for field measurements and surface detection
Hardware:	PC/104 166MHz Pentium CPU; 32 MB chipdisk; 64 MB RAM
Connections:	COM1, COM2, DAE, Robot, Ethernet, Service Interface

E-Field Probe

Model:	ET3DV6
Serial No.:	1793
Construction:	Triangular core fiber optic detection system
Frequency:	10 MHz to 6 GHz
Linearity:	± 0.2 dB (30 MHz to 3 GHz)

EX-Probe

Model:	EX3DV4
Serial No.	3511
Construction:	Triangular core
Frequency:	10 MHz to > 6 GHz
Linearity:	± 0.2 dB (30 MHz to 3 GHz)

8.3 Phantom(s):

Validation & Evaluation Phantom

Type:	SAM V4.0C
Shell Material:	Fiberglass
Thickness:	2.0 ±0.1 mm

Volume: Approx. 20 liters

8.4 RX90BL Robot

The Stäubli RX90BL Robot is a standard high precision 6-axis robot with an arm extension for accommodating the data acquisition electronics (DAE).

8.5 Robot Controller

The CS7MB Robot Controller system drives the robot motors. The system consists of a power supply, robot controller, and remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.

8.6 Light Beam Switch

The Light Beam Switch (Probe alignment tool) allows automatic "tooling" of the probe. During the process, the actual position of the probe tip with respect to the robot arm is measured as well as the probe length and the horizontal probe offset. The software then corrects all movements, so that the robot coordinates are valid for the probe tip. The repeatability of this process is better than 0.1 mm. If a position has been taught with an aligned probe, the same position will be reached with another aligned probe within 0.1 mm, even if the other probe has different dimensions. During probe rotations, the probe tip will keep its actual position.

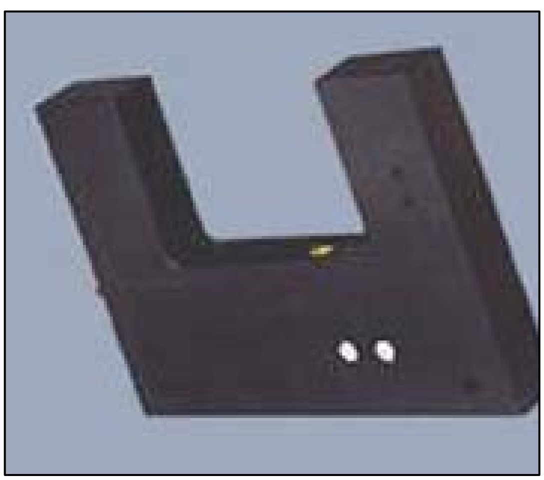

Figure 8: Light beam switch

8.7 Data Acquisition Electronics

The Data Acquisition Electronics consists of a highly sensitive electrometer grade preamplifier with auto-zeroing, a channel and gain switching multiplexer, a fast 16-bit A/D converter and a command decoder and control logic unit. Some of the task the DAE performs is signal amplification, signal multiplexing, A/D conversion, and offset measurements.

The DAE also contains the mechanical probe-mounting device, which contains two different sensor systems for frontal and sideways probe contacts used for probe collision detection and mechanical surface detection for controlling the distance between the probe and the inner surface of the phantom shell. Transmission from the DAE to the measurement server, via the EOC, is through an optical downlink for data and status information as well as an optical uplink for commands and the clock.

Figure 9: Data acquisition electronics

8.8 Electo-Optical Converter (EOC)

The Electro-Optical Converter performs the conversion between the optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC connects to, and transfers data to, the DASY4 measurement server. The EOC also contains the fiber optical surface detection system for controlling the distance between the probe and the inner surface of the phantom shell.

Figure 10: Electro optical converter

8.9 Measurement Server

The Measurement Server performs time critical tasks such as signal filtering, all real-time data evaluation for field measurements and surface detection, controls robot movements, and handles safety operation. The PC-operating system cannot interfere with these time critical processes. A watchdog supervises all connections, and disconnection of any of the cables to the measurement server will automatically disarm the robot and disable all program-controlled robot movements.

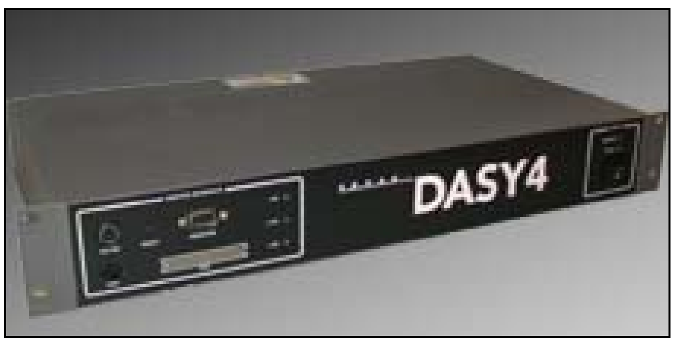

Figure 11: DASY4 measurement server

8.10 Dosimetric Probe

Dosimetric Probe is a symmetrical design with triangular core that incorporates three 3 mm long dipoles arranged so that the overall response is close to isotropic. The probe sensors are covered by an outer protective shell, which is resistant to organic solvents i.e. glycol. The probe is equipped with an optical multi-fiber line, ending at the front of the probe tip, for optical surface detection. This line connects to the EOC box on the robot arm and provides automatic detection of the phantom surface. The optical surface detection works in transparent liquids and on diffuse reflecting surfaces with a repeatability of better than ±0.1mm.

Figure 12: Electric field probe

8.11 SAM Phantom

The SAM (Specific Anthropomorphic Mannequin) twin phantom is a fiberglass shell phantom with 2mm shell thickness (except the ear region where shell thickness increases to 6mm) integrated into a wooden table. The shape of the shell corresponds to the phantom defined by SCC34-SC2. It enables the dosimetric evaluation of left hand, right hand phone usage as well as body mounted usage at the flat phantom region. The flat section is also used for system validation and the length and width of the flat section are at least 0.75 λO and 0.6 λO respectively at frequencies of 824 MHz and above (λO = wavelength in air).

Figure 13: Specific anthropomorphic mannequin twin phantom

Reference markings on the phantom top allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot. A white cover is provided to cover the phantom during off-periods preventing water evaporation and changes in the liquid parameters. Free space scans of devices on the cover are possible. The phantom is filled with a tissue simulating liquid to a depth of at least 15 cm at each ear reference point. The bottom plate of the wooden table contains three pair of bolts for locking the device holder.

8.12 Planar Phantom

The planar phantom is constructed of Plexiglas material with a 2.0 mm shell thickness for face-held and body-worn SAR evaluations of handheld radio transceivers. The planar phantom is mounted on the wooden table of the DASY4 system.

Figure 14: Planner phantom

8.13 Validation Planar Phantom

The validation planar phantom is constructed of Plexiglas material with a 6.0 mm shell thickness for system validations at 450MHz and below. The validation planar phantom is mounted on the wooden table of the DASY4 system.

8.14 Device Holder

The device holder is designed to cope with the different measurement positions in the three sections of the SAM phantom given in the standard. It has two scales, one for device rotation (with respect to the body axis) and one for device inclination (with respect to the line between the ear openings). The rotation center for both scales is the ear opening, thus the device needs no repositioning when changing the angles. The plane between the ear openings and the mouth tip has a rotation angle of 65°.

The DASY device holder has been made out of low-loss POM material having the following dielectric parameters: relative permittivity $\varepsilon = 3$ and loss tangent $\delta = 0.02$. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

The dielectric properties of the liquid conform to all the tabulated values [2-5]. Liquids are prepared according to Annex A and dielectric properties are measured according to Annex B.

Figure 15: Device holder

8.15 System Validation Kits

Power Capability: > 100 W (f < 1GHz); > 40 W (f > 1GHz)

Construction: Symmetrical dipole with l/4 balun Enables measurement of feed point impedance with NWA Matched for use near flat phantoms filled with brain simulating solutions Includes distance holder and tripod adaptor.

Frequency: 300, 450, 835, 1950, 2450 MHz, 5-6GHz

Return loss: >20 dB at specified validation position

Dimensions: 300 MHz Dipole: Length: 396mm; Overall Height: 430 mm; Diameter: 6 mm
450 MHz Dipole: Length: 270 mm; Overall Height: 347 mm; Diameter: 6 mm
835 MHz Dipole: Length: 161 mm; Overall Height: 270 mm; Diameter: 3.6 mm
1950 MHz Dipole: Length: 68 mm; Overall Height: 219 mm; Diameter: 3.6 mm
2450 MHz Dipole: Length: 51.5 mm; Overall Height: 300 mm; Diameter: 3.6 mm
5-6GHz Dipole: Length: 26.0 mm; Overall Height: 170 mm; Diameter: 3.6 mm

Figure 16: System validation using dipole antenna

9 TEST EQUIPMENT LIST

Test Equipment	Serial Number	Calibration Date	Calibration Due
DASY4 System Robot RX90	FO3/SX19A1/A/01	N/A	NA
EX3DV4	3722	9/22/2017	9/22/2018
DAE	584	9/18/2017	9/18/2018
1950MHz Dipole	1186	1/23/2017	1/23/2018
SAM Phantom V4.0C	N/A	N/A	NA
Keysight Vector Signal Generator	1S3905	4/25/2017	4/25/2019
EMCO Horn Antenna	1S2208	Functional Verification	
Agilent E4407B Spectrum Analyzer	1S2607	9/25/2017	3/25/2019
Agilent 8722D Network Analyzer	1S2272	4/20/2017	10/20/2018
Extech Power Supply (30 VDC)	4S3771	Functional Verification	
Mini-Circuits power amplifier	1S2447	Functional Verification	
Agilent power meter	1S2276	6/5/2017	12/5/2018
Mini-Circuits USB power sensor	1S3838	6/13/2017	12/13/2018
Krytar Directional Coupler (1-20Ghz)	1S2034	Functional Verification	
AR dual Directional Coupler (9Khz-1Ghz)	1S2542	Functional Verification	
Immersion Temperature Probe	1S3799	04/21/2017	10/21/2018

Table 6: Test equipment list details.

9.1 MEASUREMENT UNCERTANTIES

UNCERTAINTY ASSESSMENT 300MHz-3GHz

Error Description	Tol. ±%	Prob. Dist.	Div.	c_i 1g	c_i 10g	Std Unc ±% (1g)	Std Unc ±% (10g)	v_i or v_{eff}
Measurement System								
Probe calibration	4.8	N	1	1	1	4.8	4.8	N/A
Axial isotropy of the probe	4.7	R	√3	0.7	0.7	1.9	1.9	N/A
Spherical isotropy of the probe	9.6	R	√3	0.7	0.7	3.9	3.9	N/A
Boundary effects	1.0	R	√3	1	1	4.8	4.8	N/A
Probe linearity	4.7	R	√3	1	1	2.7	2.7	N/A
Detection limit	1.0	R	√3	1	1	0.6	0.6	N/A
Readout electronics	1.0	N	1	1	1	1.0	1.0	N/A
Response time	0.8	R	√3	1	1	0.5	0.5	N/A
Integration time	2.6	R	√3	1	1	0.8	0.8	N/A
RF ambient conditions	3.0	R	√3	1	1	0.43	0.43	N/A
Mech. constraints of robot	0.4	R	√3	1	1	0.2	0.2	N/A
Probe positioning	2.9	R	√3	1	1	1.7	1.7	N/A
Extrapolation & integration	1.0	R	√3	1	1	2.3	2.3	N/A
Test Sample Related								
Device positioning	2.9	N	1	1	1	2.23	2.23	145
Device holder uncertainty	3.6	N	1	1	1	5.0	5.0	5
Power drift	5.0	R	√3			2.9	2.9	N/A
Phantom and Setup								
Phantom uncertainty	4.0	R	√3	1	1	2.3	2.3	N/A
Liquid conductivity (target)	5.0	R	√3	0.64	0.43	1.8	1.2	N/A
Liquid conductivity (measured)	2.5	N	1	0.64	0.43	1.6	1.1	N/A
Liquid permittivity (target)	5.0	R	√3	0.6	0.5	1.7	1.4	N/A
Liquid permittivity (measured)	2.5	N	1	0.6	0.5	1.5	1.2	N/A
Combined Standard Uncertainty (k=1)		RSS				10.3	10.0	
Expanded Uncertainty (k=2) 95% Confidence Level						20.6	20.1	

Table 7: Worst-case uncertainty for DASY4 assessed according to IEEE P1528.

The budget is valid for the frequency range 300MHz to 3GHz and represents a worst-case analysis.

9.2 UNCERTAINTY FOR SYSTEM PERFORMANCE CHECK

Error Description	Tol. ±%	Prob. Dist.	Div.	c_i 1g	c_i 10g	Std Unc ±% (1g)	Std Unc ±% (10g)	v_i or v_{eff}
Measurement System								
Probe calibration	5.9	N	1	1	1	5.9	5.9	∞
Axial Isotropy	4.7	R	√3	1	1	2.7	2.7	∞
Hemispherical Isotropy	9.6	R	√3	0	0	0	0	∞
Boundary effects	1.0	R	√3	1	1	0.6	0.6	∞
Linearity	4.7	R	√3	1	1	2.7	2.7	∞
System Detection limit	1.0	R	√3	1	1	0.6	0.6	∞
Readout electronics	0.3	N	1	1	1	0.3	0.3	∞
Response time	0	R	√3	1	1	0	0	∞
Integration time	0	R	√3	1	1	0	0	∞
RF Ambient Noise	3.0	R	√3	1	1	1.7	1.7	∞
RF Ambient Reflections	3.0	R	√3	1	1	1.7	1.7	∞
Probe Positioner	0.4	R	√3	1	1	0.2	0.2	∞
Probe positioning	2.9	R	√3	1	1	1.7	1.7	∞
Algorithms for Max. SAR Eval.	1.0	R	√3	1	1	0.6	0.6	∞
Dipole								
Dipole Axis to Liquid Distance	2.0	R	√3	1	1	1.2	1.2	∞
Input power and SAR drift meas.	4.7	R	√3	1	1	2.7	2.7	∞
Phantom and Tissue Parameters								
Phantom uncertainty	4.0	R	√3	1	1	2.3	2.3	∞
Liquid conductivity (target)	5.0	R	√3	0.64	0.43	1.8	1.2	∞
Liquid conductivity (measured)	2.5	N	1	0.64	0.43	1.6	1.1	∞
Liquid permittivity (target)	5.0	R	√3	0.6	0.5	1.7	1.4	∞
Liquid permittivity (measured)	2.5	N	1	0.6	0.5	1.5	1.2	∞
Combined Standard Uncertainty						9.2	8.9	
Coverage Factor for 95%	kp=2							
Expanded Uncertainty						18.4	17.8	

Table 8: Uncertainty of a system performance check with DASY4 system.

The budget is valid for the frequency range 300MHz to 3GHz and represents a worst-case analysis.

10 REFERENCES

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11 EUT TEST SETUP PHOTOS

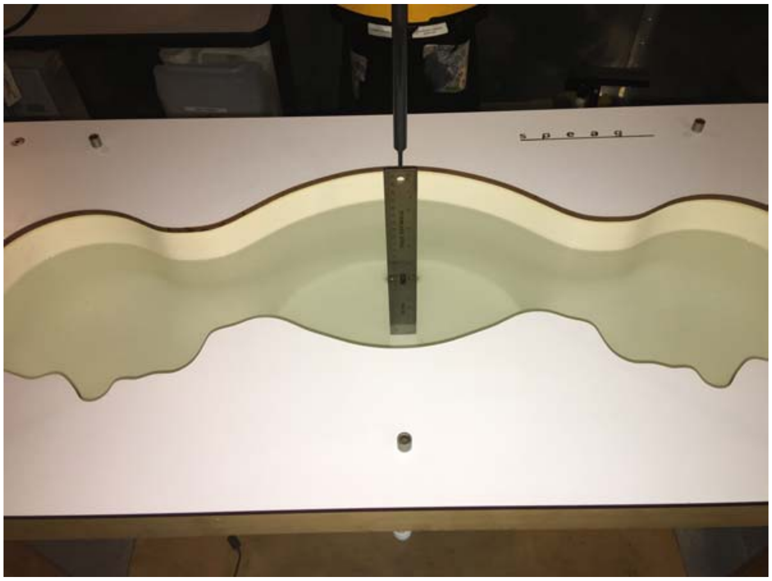


Figure 17: 1.95GHz Body tissue simulating fluid

Figure 18: Front body

Figure 19: Back body

ANNEX A 1.95 GHz SAR MEASUREMENT DATA

FCC_1925MHz_Ant 0_Front_ListenTalk

Date/Time: 12/12/2017 10:44:00 AM

DUT: ListenTalk LK-1;

Communication System: DECT; ; Frequency: 1925 MHz;Duty Cycle: 1:1
Medium: M1950 Medium parameters used: f = 1925 MHz; σ = 1.56 mho/m; ε_r = 52.1; ρ = 1000 kg/m^3
Phantom section: Flat Section

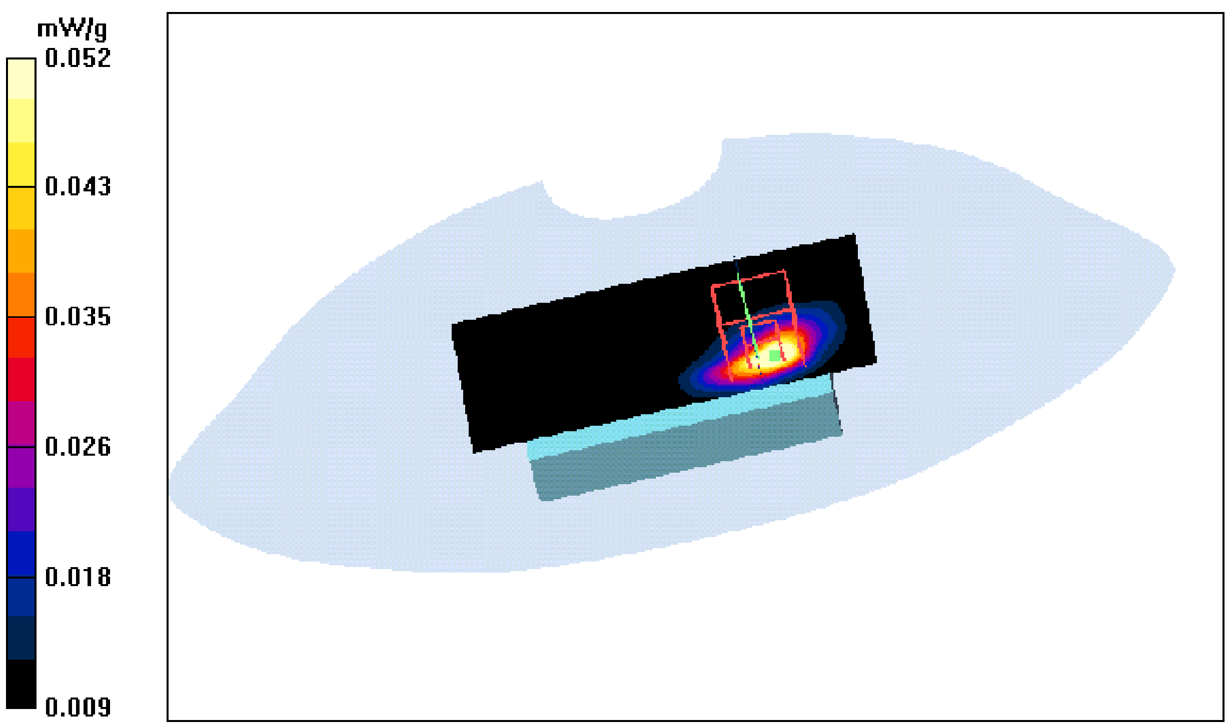
- Probe: EX3DV4 - SN3722; ConvF(7.59, 7.59, 7.59); Calibrated: 9/22/2017
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn584; Calibrated: 9/18/2017
- Phantom: SAM with CRP; Type: SAM; Serial: TP 1310
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

DECT/Area Scan (61x101x1):

Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (interpolated) = 0.067 mW/g

DECT/Zoom Scan (7x7x7) (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 2.55 V/m; Power Drift = 0.356 dB
Peak SAR (extrapolated) = 0.069 W/kg
SAR(1 g) = 0.039 mW/g;
Maximum value of SAR (measured) = 0.052 mW/g



FCC_1925MHz_Ant 0_Back_ListenTalk

Date/Time: 12/12/2017 12:12:09 PM

DUT: ListenTalk LK-1;

Communication System: DECT; ; Frequency: 1925 MHz;Duty Cycle: 1:1
Medium: M1950 Medium parameters used: f = 1925 MHz; σ = 1.56 mho/m; ε_r = 52.1; ρ = 1000 kg/m^3
Phantom section: Flat Section

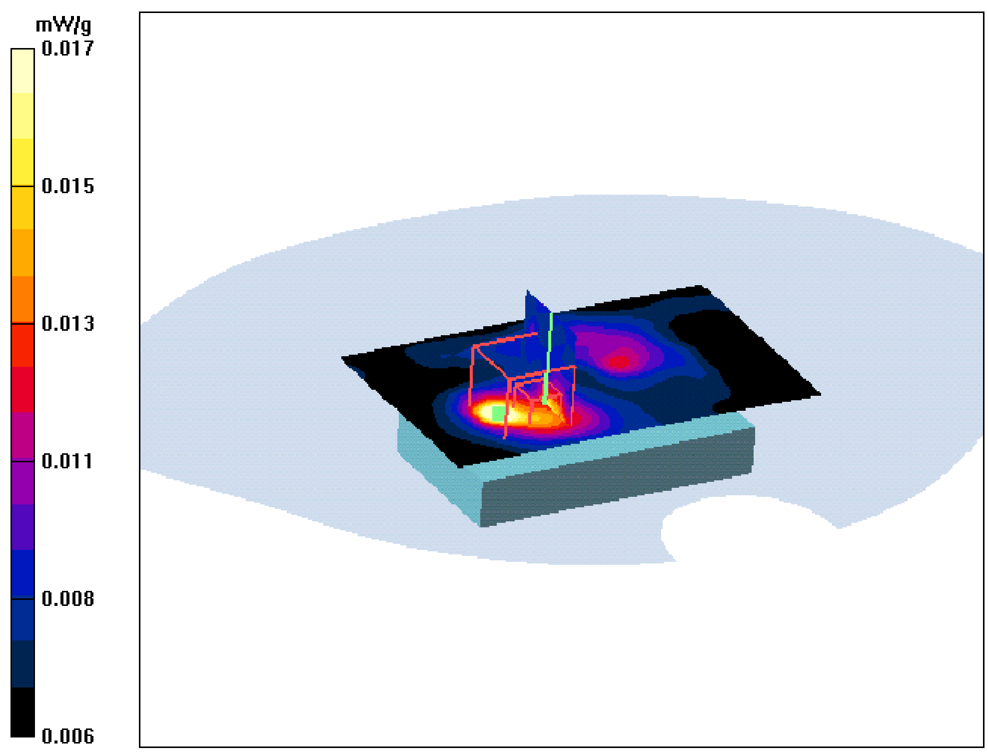
- Probe: EX3DV4 - SN3722; ConvF(7.59, 7.59, 7.59); Calibrated: 9/22/2017
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn584; Calibrated: 9/18/2017
- Phantom: SAM with CRP; Type: SAM; Serial: TP 1310
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

DECT/Area Scan (61x101x1):

Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (interpolated) = 0.021 mW/g

DECT/Zoom Scan (7x7x7) (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 2.61 V/m; Power Drift = -0.25 dB
Peak SAR (extrapolated) = 0.022 W/kg
SAR(1 g) = 0.013 mW/g;
Maximum value of SAR (measured) = 0.017 mW/g



FCC_1925MHz_Ant 1_Front_ListenTalk

Date/Time: 12/12/2017 11:17:47 AM

DUT: ListenTalk LK-1;

Communication System: DECT; ; Frequency: 1925 MHz;Duty Cycle: 1:1
Medium: M1950 Medium parameters used: f = 1925 MHz; σ = 1.56 mho/m; ε_r = 52.1; ρ = 1000 kg/m^3
Phantom section: Flat Section

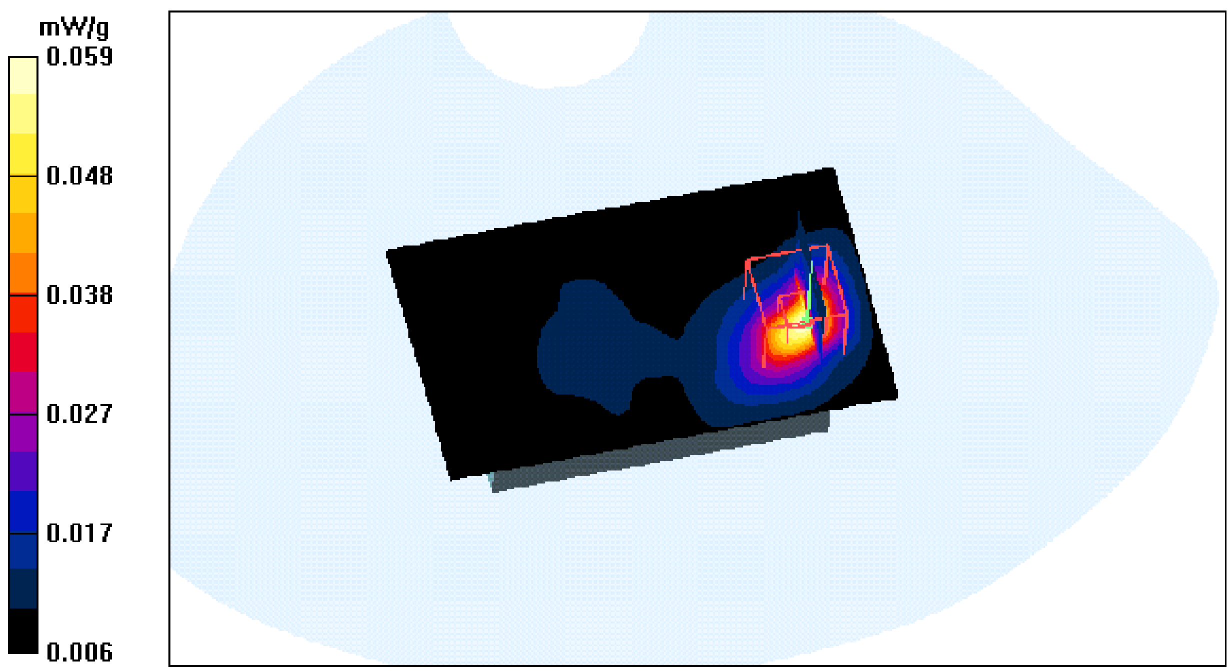
- Probe: EX3DV4 - SN3722; ConvF(7.59, 7.59, 7.59); Calibrated: 9/22/2017
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn584; Calibrated: 9/18/2017
- Phantom: SAM with CRP; Type: SAM; Serial: TP 1310
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

DECT/Area Scan (61x101x1):

Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (interpolated) = 0.059 mW/g

DECT/Zoom Scan (7x7x7) (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 2.46 V/m; Power Drift = 0.264 dB
Peak SAR (extrapolated) = 0.079 W/kg
SAR(1 g) = 0.040 mW/g;
Maximum value of SAR (measured) = 0.057 mW/g



FCC_1925MHz_Ant 1_Back_ListenTalk

Date/Time: 12/12/2017 11:42:43 AM

DUT: ListenTalk LK-1;

Communication System: DECT; ; Frequency: 1925 MHz;Duty Cycle: 1:1
Medium: M1950 Medium parameters used: f = 1925 MHz; σ = 1.56 mho/m; ε_r = 52.1; ρ = 1000 kg/m^3
Phantom section: Flat Section

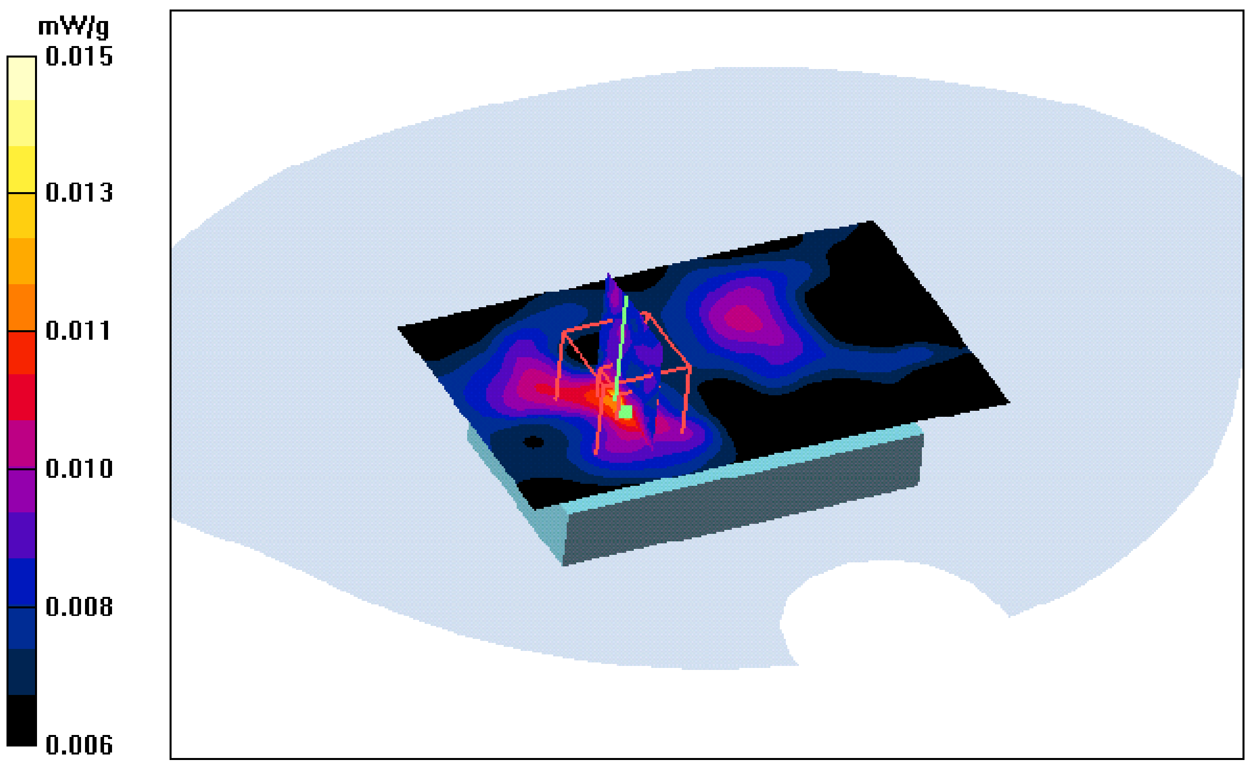
- Probe: EX3DV4 - SN3722; ConvF(7.59, 7.59, 7.59); Calibrated: 9/22/2017
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn584; Calibrated: 9/18/2017
- Phantom: SAM with CRP; Type: SAM; Serial: TP 1310
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

DECT/Area Scan (61x101x1):

Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (interpolated) = 0.012 mW/g

DECT/Zoom Scan (7x7x7) (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 2.22 V/m; Power Drift = 0.398 dB
Peak SAR (extrapolated) = 0.019 W/kg
SAR(1 g) = 0.011 mW/g;
Maximum value of SAR (measured) = 0.015 mW/g



ANNEX B 1.95 GHz SYSTEM PERFORMANCE CHECK

1950MHz Body Validation

Date/Time: 12/11/2017 3:58:59 PM

DUT: D1950;

Communication System: CW; ; Frequency: 1950 MHz;Duty Cycle: 1:1
Medium: M1950 Medium parameters used: f = 1950 MHz; σ = 1.58 mho/m; ε_r = 52; ρ = 1000 kg/m^3
Phantom section: Flat Section

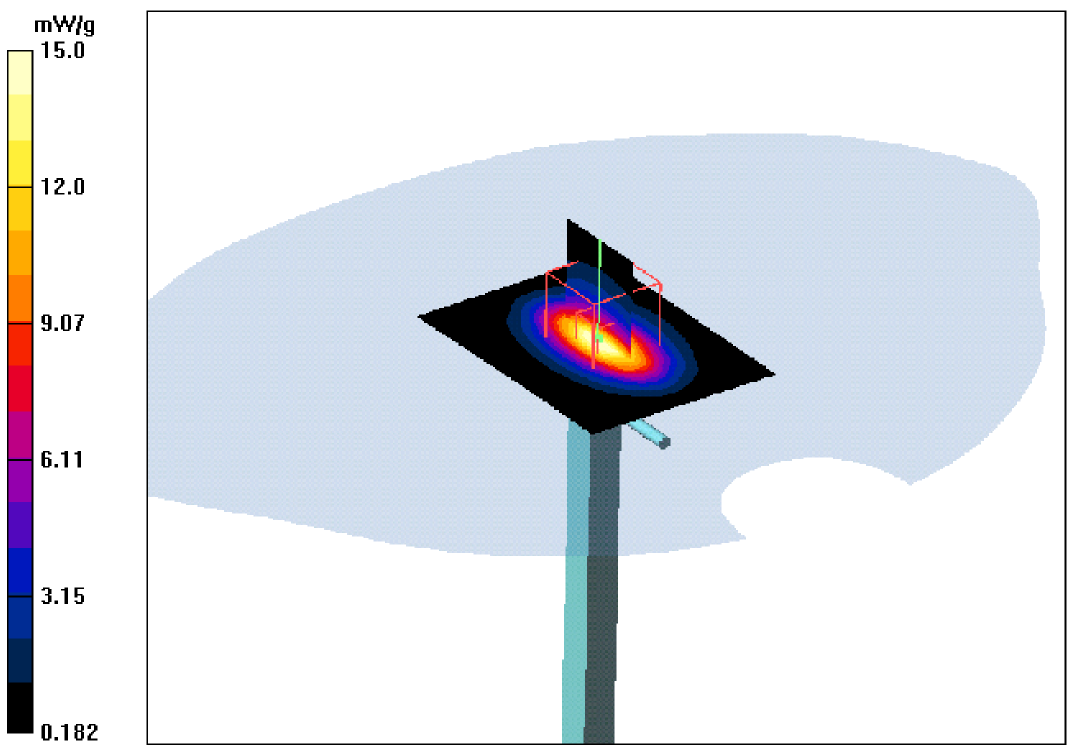
- Probe: EX3DV4 - SN3722; ConvF(7.59, 7.59, 7.59); Calibrated: 9/22/2017
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn584; Calibrated: 9/18/2017
- Phantom: SAM with CRP; Type: SAM; Serial: TP 1310
- Measurement SW: DASY4, V4.7 Build 71; Postprocessing SW: SEMCAD, V1.8 Build 184

d=10mm, Pin=250mW/Area Scan (81x61x1):

Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (interpolated) = 15.2 mW/g

d=10mm, Pin=250mW/Zoom Scan (7x7x7) (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 98.5 V/m; Power Drift = -0.087 dB
Peak SAR (extrapolated) = 19.6 W/kg
SAR(1 g) = 10.1 mW/g;
Maximum value of SAR (measured) = 15.0 mW/g



ANNEX C 1.95GHz DIPOLE CALIBRATION CERTIFICATE

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 MET Laboratories

Certificate No: D1950V3-1186_Jan17

CALIBRATION CERTIFICATE

Object	D1950V3 - SN:1186
Calibration procedure(s)	QA CAL-05.v9 Calibration procedure for dipole validation kits above 700 MHz
Calibration date:	January 23, 2017

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	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5058 (20k)	05-Apr-16 (No. 217-02292)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe EX3DV4	SN: 7349	31-Dec-16 (No. EX3-7349_Dec16)	Dec-17
DAE4	SN: 601	04-Jan-17 (No. DAE4-601_Jan17)	Jan-18

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter EPM-442A	SN: GB37480704	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-16)	In house check: Oct-18
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-16)	In house check: Oct-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

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

Issued: January 24, 2017

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

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

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Servizio svizzero di taratura
S Swiss Calibration Service

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

Accreditation No.: SCS 0108

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, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
c) 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	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1950 MHz ± 1 MHz	

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	53.4 ± 6 %	1.54 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	9.88 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**39.2 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.13 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**20.4 W/kg ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Body TSL

Impedance, transformed to feed point	44.7 Ω - 3.7 jΩ
Return Loss	- 23.3 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.196 ns

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	March 03, 2015

DASY5 Validation Report for Body TSL

Date: 23.01.2017

Test Laboratory: SPEAG, Zurich, Switzerland

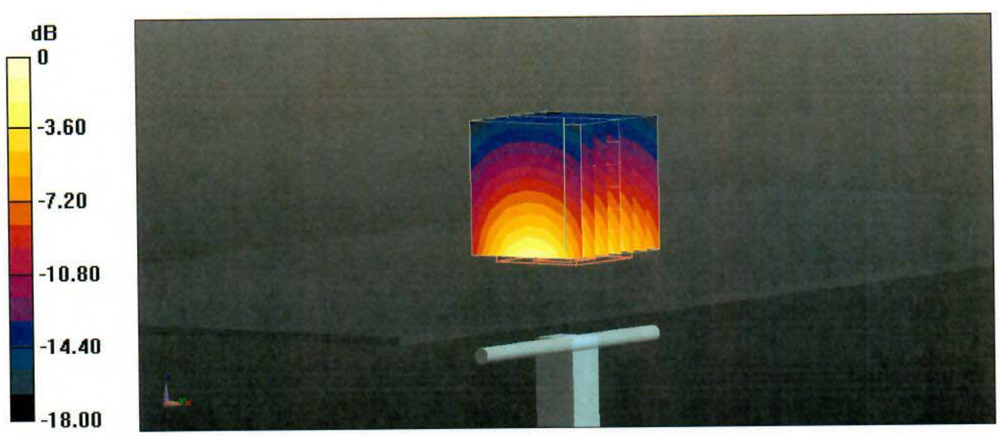
DUT: Dipole 1950 MHz; Type: D1950V3; Serial: D1950V3 - SN:1186

Communication System: UID 0 - CW; Frequency: 1950 MHz
Medium parameters used: f = 1950 MHz; $\sigma = 1.54$ S/m; $\varepsilon_r = 53.4$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

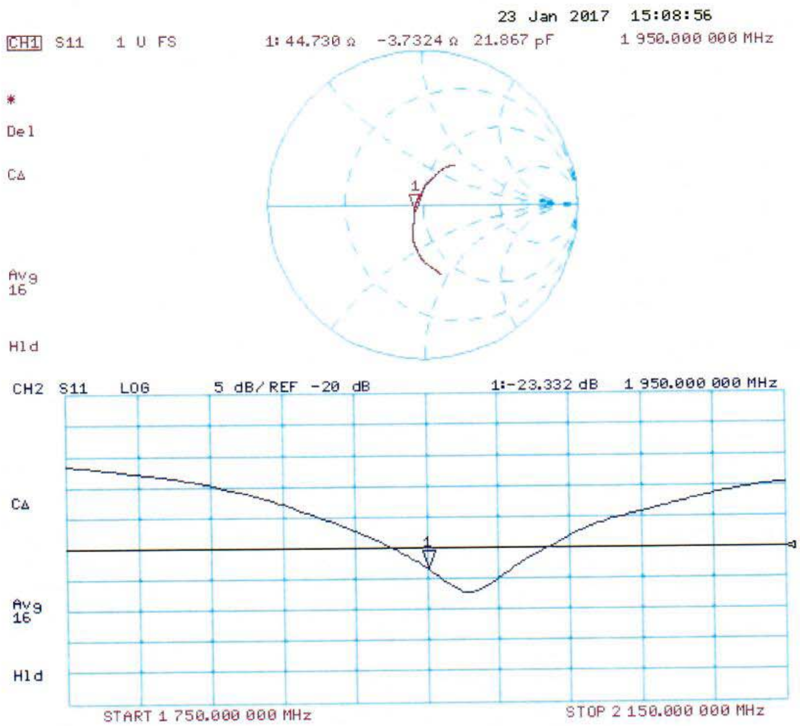
- Probe: EX3DV4 - SN7349; ConvF(8.15, 8.15, 8.15); Calibrated: 31.12.2016;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 04.01.2017
- Phantom: Flat Phantom 5.0 (back); Type: QD000P50AA; Serial: 1002
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7331)

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 = 102.9 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 18.0 W/kg
SAR(1 g) = 9.88 W/kg; SAR(10 g) = 5.13 W/kg
Maximum value of SAR (measured) = 15.0 W/kg



0 dB = 15.0 W/kg = 11.76 dBW/kg

Impedance Measurement Plot for Body TSL



ANNEX D PROBE CALIBRATION CERTIFICATE

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

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Accreditation No.: **SCS 0108**

Client **MET Laboratories**

Certificate No: **EX3-3722_Sep17**

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:3722
Calibration procedure(s)	QA CAL-01.v9, QA CAL-14.v4, QA CAL-23.v5, QA CAL-25.v6 Calibration procedure for dosimetric E-field probes
Calibration date:	September 22, 2017

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-17 (No. 217-02521/02522)	Apr-18
Power sensor NRP-Z91	SN: 103244	04-Apr-17 (No. 217-02521)	Apr-18
Power sensor NRP-Z91	SN: 103245	04-Apr-17 (No. 217-02525)	Apr-18
Reference 20 dB Attenuator	SN: S5277 (20x)	07-Apr-17 (No. 217-02528)	Apr-18
Reference Probe ES3DV2	SN: 3013	31-Dec-16 (No. ES3-3013_Dec16)	Dec-17
DAE4	SN: 660	7-Dec-16 (No. DAE4-660_Dec16)	Dec-17
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-16)	In house check: Jun-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-16)	In house check: Oct-17

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

Issued: September 22, 2017

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Certificate No: EX3-3722_Sep17 Page 1 of 11

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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).

Probe EX3DV4

SN:3722

Manufactured: August 14, 2009
Calibrated: September 22, 2017

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3722

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.52	0.49	0.56	± 10.1 %
DCP (mV)[B]	100.4	97.6	97.6	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	159.8	±2.5 %
		Y	0.0	0.0	1.0		146.9	
		Z	0.0	0.0	1.0		145.1	

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:3722

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)
750	41.9	0.89	9.52	9.52	9.52	0.47	0.80	± 12.0 %
900	41.5	0.97	8.88	8.88	8.88	0.35	0.97	± 12.0 %
1810	40.0	1.40	7.69	7.69	7.69	0.34	0.80	± 12.0 %
2000	40.0	1.40	7.69	7.69	7.69	0.37	0.80	± 12.0 %
2450	39.2	1.80	6.99	6.99	6.99	0.35	0.80	± 12.0 %
5200	36.0	4.66	5.14	5.14	5.14	0.35	1.80	± 13.1 %
5300	35.9	4.76	4.93	4.93	4.93	0.35	1.80	± 13.1 %
5500	35.6	4.96	4.85	4.85	4.85	0.35	1.80	± 13.1 %
5800	35.3	5.27	4.66	4.66	4.66	0.35	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. 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:3722

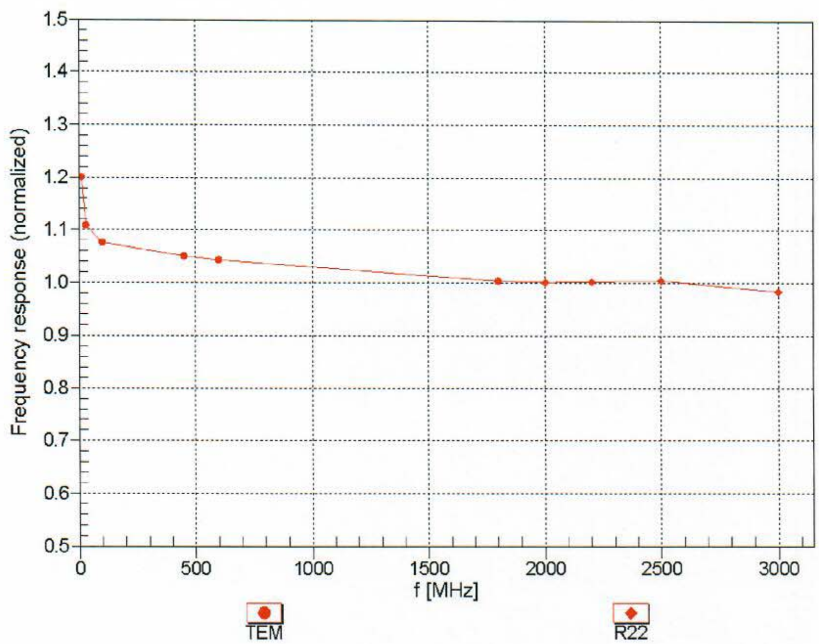
Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
750	55.5	0.96	9.20	9.20	9.20	0.42	0.81	± 12.0 %
900	55.0	1.05	9.12	9.12	9.12	0.45	0.80	± 12.0 %
1810	53.3	1.52	7.52	7.52	7.52	0.41	0.80	± 12.0 %
2000	53.3	1.52	7.59	7.59	7.59	0.31	0.94	± 12.0 %
2450	52.7	1.95	7.15	7.15	7.15	0.32	0.89	± 12.0 %
5200	49.0	5.30	4.51	4.51	4.51	0.40	1.90	± 13.1 %
5300	48.9	5.42	4.32	4.32	4.32	0.40	1.90	± 13.1 %
5500	48.6	5.65	4.04	4.04	4.04	0.40	1.90	± 13.1 %
5800	48.2	6.00	4.07	4.07	4.07	0.40	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. 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)

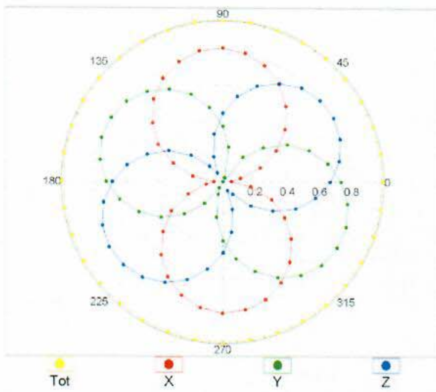


Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

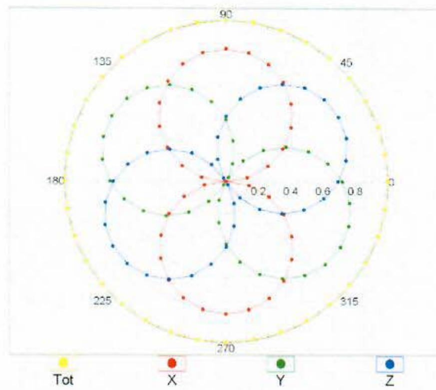
EX3DV4– SN:3722 September 22, 2017

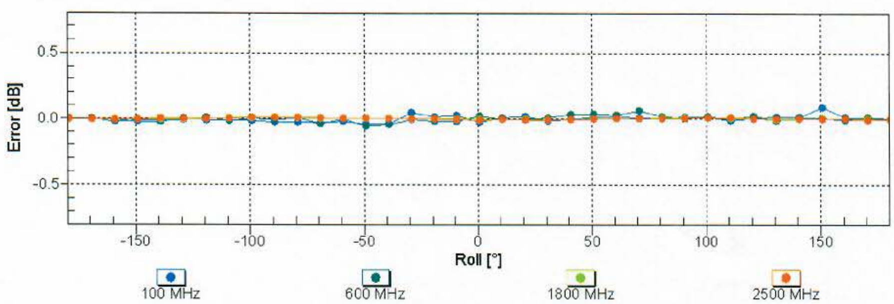
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



f=1800 MHz,R22



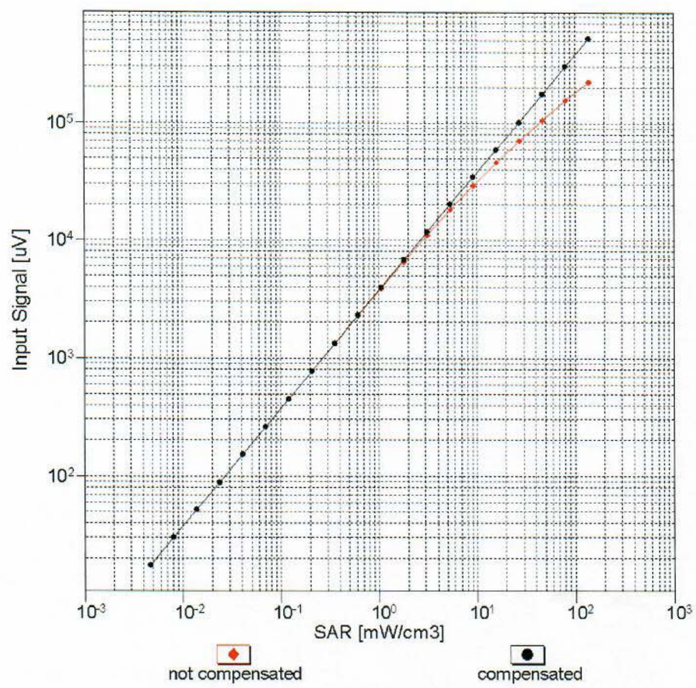


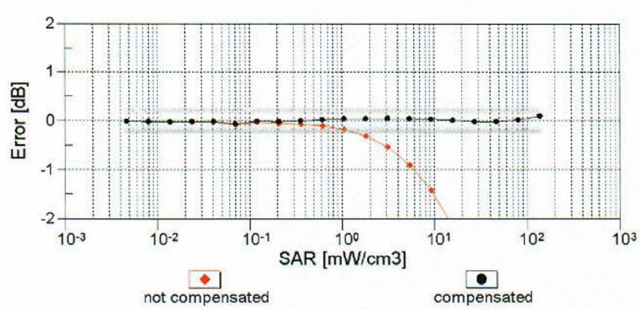
Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Certificate No: EX3-3722_Sep17 Page 8 of 11

Dynamic Range f(SAR$_{head}$)

(TEM cell , f_{eval}= 1900 MHz)



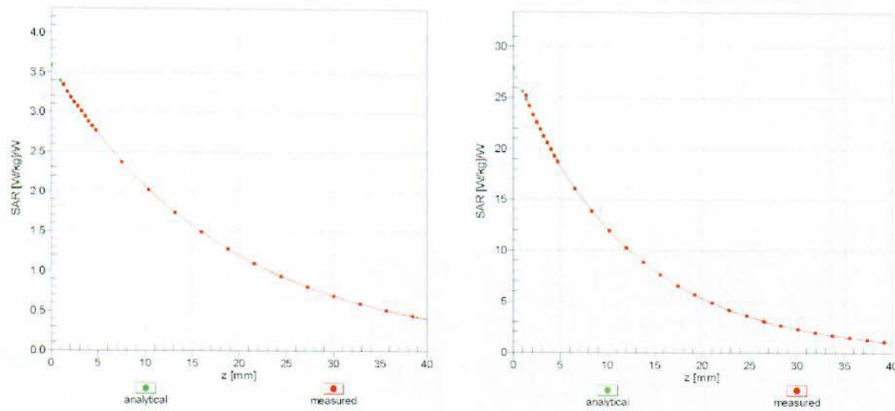


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

EX3DV4– SN:3722 September 22, 2017

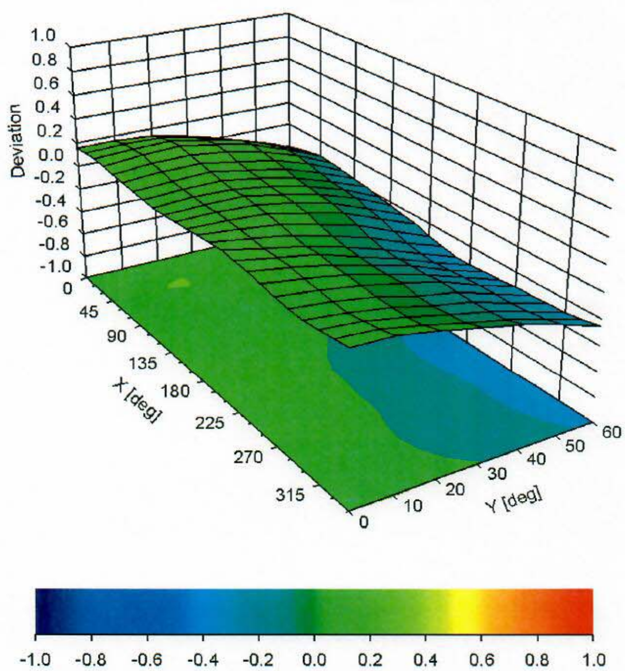
Conversion Factor Assessment

f = 900 MHz,WGLS R9 (H_convF) f = 1810 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)

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3722

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	90.8
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

ANNEX E DAE CALIBRATION CERTIFICATE

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Client **MET Laboratories**

Certificate No: DAE3-584_Sep17

CALIBRATION CERTIFICATE

Object	DAE3 - SD 000 D03 AA - SN: 584
Calibration procedure(s)	QA CAL-06.v29 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	September 18, 2017

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
Keithley Multimeter Type 2001	SN: 0810278	31-Aug-17 (No:21092)	Aug-18
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Auto DAE Calibration Unit	SE UWS 053 AA 1001	05-Jan-17 (in house check)	In house check: Jan-18
Calibrator Box V2.1	SE UMS 006 AA 1002	05-Jan-17 (in house check)	In house check: Jan-18

	Name	Function	Signature
Calibrated by:	Dominique Steffen	Laboratory Technician	
Approved by:	Sven Kühn	Deputy Manager	i.V.

Issued: September 18, 2017

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Accreditation No.: SCS 0108

Glossary

DAE	data acquisition electronics
Connector angle	information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle*: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.
  - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.
  - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage
  - *Input Offset Measurement*: Output voltage and statistical results over a large number of zero voltage measurements.
  - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
  - *Power consumption:* Typical value for information. Supply currents in various operating modes.

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100…+300 mV

Low Range: 1LSB = 61nV , full range = -1…….+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	404.476 ± 0.02% (k=2)	404.141 ± 0.02% (k=2)	404.983 ± 0.02% (k=2)
Low Range	3.95886 ± 1.50% (k=2)	3.94003 ± 1.50% (k=2)	3.99627 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	142.5 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	199997.14	1.00	0.00
Channel X	+ Input	20002.64	0.84	0.00
Channel X	- Input	-19998.40	2.61	-0.01
Channel Y	+ Input	199996.14	0.26	0.00
Channel Y	+ Input	20000.13	-1.55	-0.01
Channel Y	- Input	-20001.76	-0.62	0.00
Channel Z	+ Input	199994.33	-2.00	-0.00
Channel Z	+ Input	20001.40	-0.28	-0.00
Channel Z	- Input	-20002.87	-1.74	0.01

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2001.85	0.35	0.02
Channel X	+ Input	201.77	-0.06	-0.03
Channel X	- Input	-197.04	0.95	-0.48
Channel Y	+ Input	2001.72	0.22	0.01
Channel Y	+ Input	201.48	-0.35	-0.17
Channel Y	- Input	-198.80	-0.82	0.41
Channel Z	+ Input	2001.63	0.11	0.01
Channel Z	+ Input	200.27	-1.58	-0.78
Channel Z	- Input	-198.60	-0.48	0.24

2. Common mode sensitivity

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
Channel X	200	-3.32	-5.00
	- 200	7.23	5.54
Channel Y	200	-1.96	-1.56
	- 200	-0.62	-0.90
Channel Z	200	16.35	16.46
	- 200	-17.40	-17.56

3. Channel separation

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	-0.65	-4.02
Channel Y	200	8.39	-	1.43
Channel Z	200	10.17	4.53	-

4. AD-Converter Values with inputs shorted

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	15762	16155
Channel Y	15722	15459
Channel Z	16045	14919

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec
Input 10MΩ

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	1.91	0.57	3.49	0.58
Channel Y	-0.43	-1.89	1.14	0.57
Channel Z	0.64	-0.35	1.76	0.49

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	–0.01	-8	-9

ANNEX F 1.95 GHz MEASURED FLUID DIELECTRIC PARAMETERS

94131 ListenTech

Body 1850MHz - 2000MHz

December 11, 2017 03:02 PM

Frequency	e'	e''
1.850000000 GHz	52.3094	14.2008
1.852000000 GHz	52.3166	14.2255
1.854000000 GHz	52.3127	14.2456
1.856000000 GHz	52.2991	14.2382
1.858000000 GHz	52.2869	14.2404
1.860000000 GHz	52.2804	14.2736
1.862000000 GHz	52.2746	14.2666
1.864000000 GHz	52.2719	14.2712
1.866000000 GHz	52.2798	14.2917
1.868000000 GHz	52.2770	14.3001
1.870000000 GHz	52.2621	14.3191
1.872000000 GHz	52.2676	14.3164
1.874000000 GHz	52.2453	14.3349
1.876000000 GHz	52.2489	14.3339
1.878000000 GHz	52.2613	14.3468
1.880000000 GHz	52.2599	14.3360
1.882000000 GHz	52.2568	14.3554
1.884000000 GHz	52.2467	14.3630
1.886000000 GHz	52.2304	14.3835
1.888000000 GHz	52.2300	14.3897
1.890000000 GHz	52.2323	14.3827
1.892000000 GHz	52.2310	14.4077
1.894000000 GHz	52.2429	14.3992
1.896000000 GHz	52.2291	14.4140
1.898000000 GHz	52.2271	14.4180
1.900000000 GHz	52.2295	14.4505
1.902000000 GHz	52.2266	14.4374
1.904000000 GHz	52.2151	14.4465
1.906000000 GHz	52.2402	14.4799
1.908000000 GHz	52.2048	14.5180
1.910000000 GHz	52.1518	14.5286
1.912000000 GHz	52.1331	14.5371
1.914000000 GHz	52.1602	14.5328

1.916000000 GHz	52.1616	14.5159
1.918000000 GHz	52.1531	14.5512
1.920000000 GHz	52.1463	14.5489
1.922000000 GHz	52.1389	14.5616
1.924000000 GHz	52.1400	14.5521
1.926000000 GHz	52.1363	14.5686
1.928000000 GHz	52.1222	14.5659
1.930000000 GHz	52.0905	14.5830
1.932000000 GHz	52.0965	14.5942
1.934000000 GHz	52.0825	14.5915
1.936000000 GHz	52.0703	14.5943
1.938000000 GHz	52.0678	14.5882
1.940000000 GHz	52.0496	14.6039
1.942000000 GHz	52.0357	14.6048
1.944000000 GHz	52.0177	14.6167
1.946000000 GHz	52.0007	14.6025
1.948000000 GHz	51.9973	14.6261
1.950000000 GHz	51.9818	14.6250
1.952000000 GHz	51.9737	14.6278
1.954000000 GHz	51.9764	14.6422
1.956000000 GHz	51.9466	14.6293
1.958000000 GHz	51.9414	14.6582
1.960000000 GHz	51.9432	14.6483
1.962000000 GHz	51.9274	14.6656
1.964000000 GHz	51.9229	14.6796
1.966000000 GHz	51.9023	14.6763
1.968000000 GHz	51.8958	14.6956
1.970000000 GHz	51.8938	14.6966
1.972000000 GHz	51.8727	14.7117
1.974000000 GHz	51.8580	14.7067
1.976000000 GHz	51.8522	14.7111
1.978000000 GHz	51.8464	14.7192
1.980000000 GHz	51.8315	14.7252
1.982000000 GHz	51.8366	14.7410
1.984000000 GHz	51.8221	14.7359
1.986000000 GHz	51.8197	14.7587
1.988000000 GHz	51.8238	14.7504

ANNEX G PHANTOM CERTIFICATE OF CONFORMITY

Schmid & Partner Engineering AG

s p e a g

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

Certificate of conformity / First Article Inspection

Item	SAM Twin Phantom V4.0
Type No	QD 000 P40 C
Series No	TP-1150 and higher
Manufacturer / Origin	Untersee Composites Hauptstr. 69 CH-8559 Fruthwilen Switzerland

Tests

The series production process used allows the limitation to test of first articles.
Complete tests were made on the pre-series Type No. QD 000 P40 AA, Serial No. TP-1001 and on the series first article Type No. QD 000 P40 BA, Serial No. TP-1006. Certain parameters have been retested using further series units (called samples).

Test	Requirement	Details	Units tested
Shape	Compliance with the geometry according to the CAD model.	IT'IS CAD File (*)	First article, Samples
Material thickness	Compliant with the requirements according to the standards	2mm +/- 0.2mm in specific areas; 6mm +/- 0.2mm at ERP	First article, Samples
Material parameters	Dielectric parameters for required frequencies	200 MHz – 3 GHz Relative permittivity < 5 Loss tangent < 0.05.	Material sample TP 104-5
Material resistivity	The material has been tested to be compatible with the liquids defined in the standards if handled and cleaned according to the instructions	DEGMBE based simulating liquids	Pre-series, First article, Samples

Standards

[1] CENELEC EN 50361
[2] IEEE Std 1528-200x Draft CD 1.1 (Dec 02)
[3] IEC 62209/CD (Nov 02)
(*) The IT'IS CAD file is derived from [2] and is also within the tolerance requirements of the shapes of [1] and [3].

Conformity

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of SAR measurements specified in standard [1] and draft standards [2] and [3].

Date 7.8.2003

Signature / Stamp

s p e a g

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