

RF Exposure Lab

802 N. Twin Oaks Valley Road, Suite 105 • San Marcos, CA 92069 • U.S.A.

TEL (760) 471-2100 • FAX (760) 471-2121

<http://www.rfexposurelab.com>

CERTIFICATE OF COMPLIANCE SAR EVALUATION

Skydio, Inc.
114 Hazel Avenue
Redwood City, CA 94061

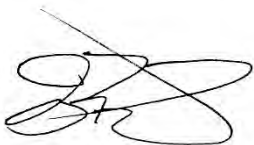
Dates of Test: September 18-25, 2023
Test Report Number: SAR.20230917
Revision C
Lab Designation Number: US1195

FCC ID:	2ATQRSMODBV3
Model(s):	SC18V1
Contains Cellular Phone:	Samsung Model S23+; FCC ID: A3LSMS916B
Test Sample:	Engineering Unit Same as Production
Serial Number:	Eng 1
Equipment Type:	Wireless Drone Remote
Classification:	Portable Transmitter Next to Body and Extremity
TX Frequency Range:	2412 – 2462 MHz; 5180 – 5250 MHz; 5250 – 5350 MHz; 5500 – 5700 MHz; 5745 – 5825 MHz
Frequency Tolerance:	± 2.5 ppm
Maximum RF Output:	2450 MHz – 27.5 dBm, UNII 1 – 24.5 dBm, UNII 2a – 19.0 dBm, UNII 2c – 20.0 dBm, UNII 3 – 26.5 dBm Conducted
Signal Modulation:	64QAM
Antenna Type:	Internal PIFA Antenna
Application Type:	Certification
FCC Rule Parts:	Part 2, 15C, 15E
KDB Test Methodology:	KDB 447498 D01 v06, KDB248227 D01 v02
Industry Canada:	RSS-102 Issue 5, Safety Code 6
Maximum SAR Value:	1.39 W/kg Reported 1 Gram Average
Simultaneous SAR Value:	0.07 Separation Ratio 10 Gram Average
Separation Distance:	10 mm For Body Measurements & 0 mm for Extremity Measurements

This wireless mobile and/or portable device has been shown to be compliant for localized specific absorption rate (SAR) for uncontrolled environment/general exposure limits specified in ANSI/IEEE Std. C95.1-1992 and had been tested in accordance with the measurement procedures specified in IEEE 1528-2013 and IEC 62209-2:2010 (See test report).

I attest to the accuracy of the data. All measurements were performed by myself or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

RF Exposure Lab, LLC certifies that no party to this application is subject to a denial of Federal benefits that includes FCC benefits pursuant to Section 5301 of the Anti-Drug Abuse Act of 1988, 21 U.S.C. 853(a).



Jay M. Moulton
Vice President



Testing Cert. # 2387.01

Table of Contents

1. Introduction	4
SAR Definition [5]	5
2. SAR Measurement Setup	6
Robotic System	6
System Hardware	6
System Electronics	6
Probe Measurement System	7
3. Probe and Dipole Calibration	14
4. Phantom & Simulating Tissue Specifications	15
Head & Body Simulating Mixture Characterization	15
5. ANSI/IEEE C95.1 – 1992 RF Exposure Limits [2]	16
Uncontrolled Environment	16
Controlled Environment	16
6. Measurement Uncertainty	17
7. System Validation	18
Tissue Verification	18
Test System Verification	18
8. SAR Test Data Summary	20
Procedures Used To Establish Test Signal	20
Device Test Condition	20
SAR Data Summary – 2450 MHz Body 802.11ax 10 MHz BW	26
SAR Data Summary – UNII 1 Body 802.11n 20 MHz BW	27
SAR Data Summary – UNII 2a Body 802.11ac 80 MHz BW	28
SAR Data Summary – UNII 2c Body 802.11ac 80 MHz BW	29
SAR Data Summary – UNII 3 Body 802.11a 20 MHz BW	30
9. Simultaneous Transmission Analysis	31
10. Test Equipment List	32
11. Conclusion	33
12. References	34
Appendix A – System Verification Plots and Data	35
Appendix B – SAR Test Data Plots	45
Appendix C – SAR Test Setup Photos	51
Appendix D – Probe Calibration Data Sheets	60
Appendix E – Dipole Calibration Data Sheets	70
Appendix F – DAE Calibration Data Sheets	85
Appendix G – Phantom Calibration Data Sheets	91
Appendix H – Validation Summary	93

Comment/Revision	Date
Original Release	October 6, 2023
Revision A – Added UNII 2A band to frequency list on page 1 which was omitted	October 12, 2023
Revision B – Show formula used for reported SAR values on pages 25-29, show the duty cycle in the formula for the reported SAR value and add the FCC ID for the Samsung S23+ to the simultaneous SAR assessment	October 25, 2023
Revision C – Change table on page 4 to maximum target, add 10 gram data and verification data and correct title on page 30 table to 10 gram	November 7, 2023

Note: The latest version supersedes all previous versions listed in the above table. The latest version shall be used.

1. Introduction

This measurement report shows compliance of the Skydio, Inc. Model SC18V1 FCC ID: 2ATQRSMODBV3 with FCC Part 2, 1093, ET Docket 93-62 Rules for mobile and portable devices. The FCC has adopted the guidelines for evaluating the environmental effects of radio frequency radiation to protect the public and workers from the potential hazards of RF emissions due to FCC regulated portable devices. [1], [6]

The test results recorded herein are based on a single type test of Skydio, Inc. Model SC18V1 and therefore apply only to the tested sample.

The test procedures, as described in ANSI C95.1 – 1999 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz [2], ANSI C95.3 – 2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields [3], IEEE Std.1528 – 2013 Recommended Practice [4], and Industry Canada Safety Code 6 Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3kHz to 300 GHz were employed.

The following table indicates all the wireless technologies operating in the SC18V1 Wireless Drone Remote. The table also shows the tolerance for the power level for each mode. The Bluetooth transmitter was not evaluated in this report due to it operating only on the internal antenna.

Band	Technology	Bandwidth	Maximum Target dBm
WLAN – 2.4 GHz	802.11g	20 MHz	26.0
WLAN – 2.4 GHz	802.11n/ac/ax	20 MHz	24.5
WLAN – 2.4 GHz	11ax	10 MHz	27.5
WLAN – 2.4 GHz	11ax	5 MHz	27.0
WLAN – 2.4 GHz	11ax	10 MHz Single RU (1 MHz)	27.0
WLAN – UNII 1	802.11a	20 MHz	21.0
WLAN – UNII 1	802.11n/ac/ax	20 MHz	24.5
WLAN – UNII 1	802.11n/ac/ax	40 MHz	24.0
WLAN – UNII 1	802.11ac/ax	80 MHz	19.0
WLAN – UNII 2a	802.11a	20 MHz	15.0
WLAN – UNII 2a	802.11n/ac/ax	20 MHz	18.0
WLAN – UNII 2a	802.11n/ac/ax	40 MHz	19.0
WLAN – UNII 2a	802.11ac/ax	80 MHz	19.0
WLAN – UNII 2c	802.11a	20 MHz	16.0
WLAN – UNII 2c	802.11n/ac/ax	20 MHz	19.0
WLAN – UNII 2c	802.11n/ac/ax	40 MHz	20.0
WLAN – UNII 2c	802.11ac/ax	80 MHz	20.0
WLAN – UNII 3	802.11a	20 MHz	26.5
WLAN – UNII 3	802.11n/ac/ax	20 MHz	26.0
WLAN – UNII 3	802.11n/ac/ax	40 MHz	26.0
WLAN – UNII 3	802.11ac/ax	80 MHz	21.5
WLAN – UNII 3	11ax	10 MHz	26.5
WLAN – UNII 3	11ax	5 MHz	26.5
WLAN – UNII 3	11ax	10 MHz Single RU (1 MHz)	26.5

Note: The power numbers listed in the Maximum Target column are per individual transmit chain only.

SAR Definition [5]

Specific Absorption Rate is defined as the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (ρ).

$$SAR = \frac{d}{dt} \left(\frac{dW}{dm} \right) = \frac{d}{dt} \left(\frac{dW}{\rho dV} \right)$$

SAR is expressed in units of watts per kilogram (W/kg). SAR can be related to the electric field at a point by

$$SAR = \frac{\sigma |E|^2}{\rho}$$

where:

σ = conductivity of the tissue (S/m)

ρ = mass density of the tissue (kg/m³)

E = rms electric field strength (V/m)

2. SAR Measurement Setup

Robotic System

These measurements are performed using the DASY52 automated dosimetric assessment system. The DASY52 is made by Schmid & Partner Engineering AG (SPEAG) in Zurich, Switzerland and consists of high precision robotics system (Staubli), robot controller, Intel Core2 computer, near-field probe, probe alignment sensor, and the generic twin phantom containing the brain equivalent material. The robot is a six-axis industrial robot performing precise movements to position the probe to the location (points) of maximum electromagnetic field (EMF) (see Fig. 2.1).

System Hardware

A cell controller system contains the power supply, robot controller teach pendant (Joystick), and a remote control used to drive the robot motors. The PC consists of the HP Intel Core2 computer with Windows XP system and SAR Measurement Software DASY52, A/D interface card, monitor, mouse, and keyboard. The Staubli Robot is connected to the cell controller to allow software manipulation of the robot. A data acquisition electronic (DAE) circuit that 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 PC plug-in card.

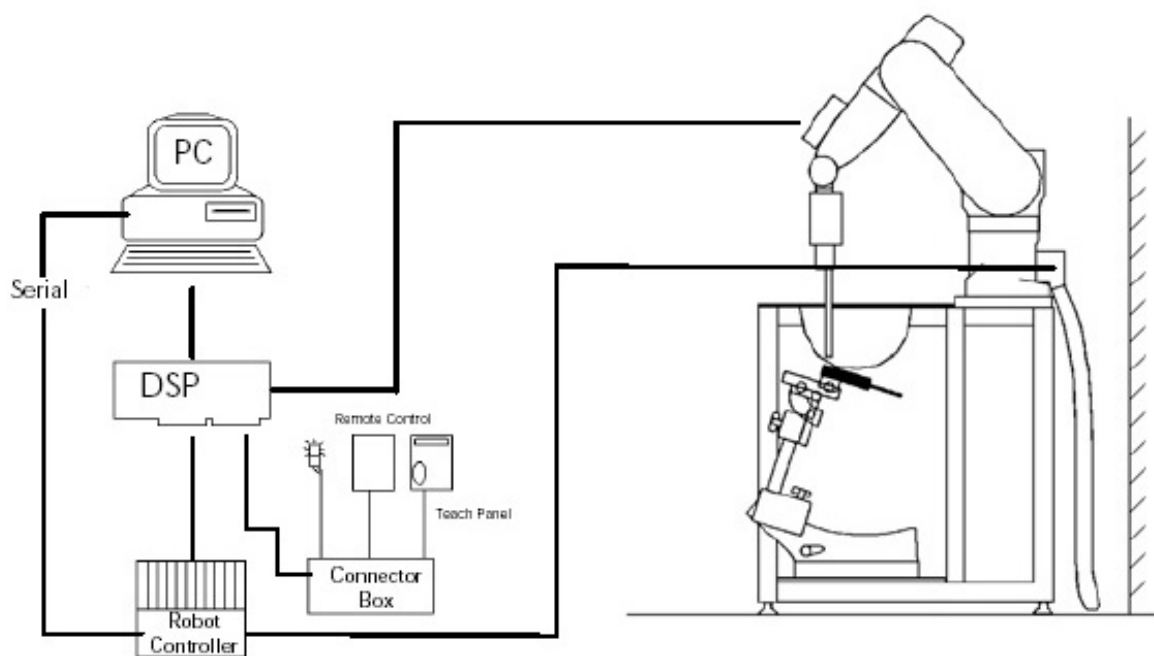


Figure 2.1 SAR Measurement System Setup

System Electronics

The DAE4 consists of 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 PC-card 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. They are also used for mechanical surface detection and probe collision detection. The robot uses its own controller with a built in VME-bus computer. The system is described in detail in.

Probe Measurement System

The SAR measurements were conducted with the dosimetric probe EX3DV4, designed in the classical triangular configuration (see Fig. 2.2) and optimized for dosimetric evaluation. The probe is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multi fiber line ending at the front of the probe tip. (see Fig. 2.3) It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY52 software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting. The approach is stopped at reaching the maximum.



DAE System

E-Field Measurement Probe

The probe is constructed using three orthogonal dipole sensors arranged on an interlocking, triangular prism core. The probe has built-in shielding against static charges and is contained within a PEEK cylindrical enclosure material at the tip.

The probe's characteristics are:

Frequency Range	30MHz – 10GHz
Length	337 mm
Probe tip external diameter	2.5 mm
Typical distance between dipoles and the probe tip	1 mm
Axial Isotropy (in human-equivalent liquids)	± 0.3 dB
Hemispherical Isotropy (in human-equivalent liquids)	± 0.5 dB
Linearity	± 0.2 dB
Maximum operating SAR	100 W/kg
Lower SAR detection threshold	0.001 W/kg



SAM Phantom

The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot.

The phantom's characteristics are:



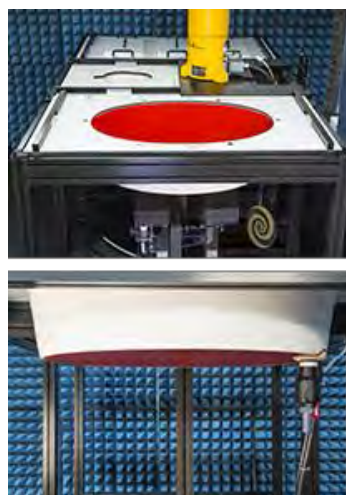
Material	Vinylester, glass fiber reinforced (VE-GF)
Shell thickness	2 mm $\pm$ 0.2 mm
Shell thickness at ERP	6 $\pm$ 0.2 mm
Filling volume	25 Liters
Dimensions	Length: 1000mm / Width: 500mm

Flat Phantom

Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.

The phantom's characteristics are:

Material	Vinylester, glass fiber reinforced (VE-GF)
Shell Thickness	2 mm $\pm$ 0.2 mm
Filling volume	30 Liters approx.
Dimensions	Major axis: 600mm / Minor axis: 400mm



Device Positioner

The SAR in the phantom is approximately inversely proportional to the square of the distance between the source and the liquid surface. For a source at 5 mm distance, a positioning uncertainty of 0.5 mm would produce a SAR uncertainty of 20%. Accurate device positioning is therefore crucial for accurate and repeatable measurements. The positions in which the devices must be measured are defined by the standards.



The DASY device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line between the ear reference points). The rotation center for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.

The DASY device holder is constructed of low-loss POM material having the following dielectric parameters: relative permittivity $\epsilon=3$ 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.



A simple but effective and easy-to-use extension for the Mounting Device; facilitates testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc.); lightweight and fits easily on the upper part of the Mounting Device in place of the phone positioner. The extension is fully compatible with the Twin SAM, ELI and other Flat Phantoms.

Probe Calibration Process

Dosimetric Assessment Procedure

Each probe is calibrated according to a dosimetric assessment procedure described in with accuracy better than +/- 10%. The spherical isotropy was evaluated with the procedure described in and found to be better than +/-0.25dB. The sensitivity parameters (Norm X, Norm Y, Norm Z), the diode compression parameter (DCP) and the conversion factor (Conv F) of the probe is tested.

Free Space Assessment

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies below 1 GHz, and in a waveguide above 1GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity at the proper orientation with the field. The probe is then rotated 360 degrees until the three channels show the maximum reading. The power density readings equates to 1 mW/cm².

Temperature Assessment *

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium, correlates to temperature rise in a dielectric medium. For temperature correlation calibration a RF transparent thermistor based temperature probe is used in conjunction with the E-field probe

$$SAR = C \frac{\Delta T}{\Delta t}$$

$$SAR = \frac{|E|^2 \cdot \sigma}{\rho}$$

where:

where:

Δt = exposure time (30 seconds),

σ = simulated tissue conductivity,

C = heat capacity of tissue (brain or muscle),

ρ = Tissue density (1.25 g/cm³ for brain tissue)

ΔT = temperature increase due to RF exposure.

SAR is proportional to $\Delta T / \Delta t$, the initial rate of tissue heating, before thermal diffusion takes place.

Now it's possible to quantify the electric field in the simulated tissue by equating the thermally derived SAR to the E- field;

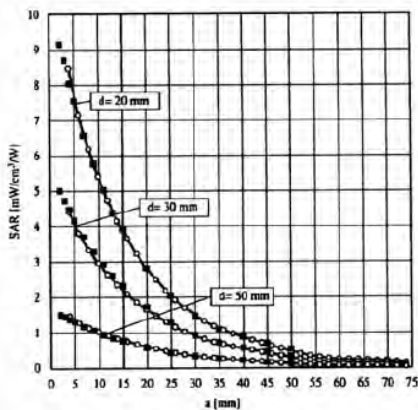


Figure 2.4 E-Field and Temperature Measurements at 900MHz

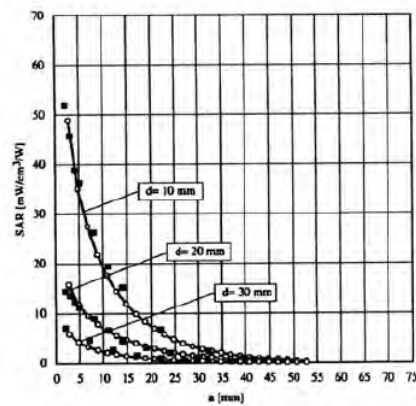


Figure 2.5 E-Field and Temperature Measurements at 1800MHz

Data Extrapolation

The DASY52 software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. 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 like below;

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

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:

E-field probes:

$$E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}$$

with V_i = compensated signal of channel i (i = x,y,z)
 $Norm_i$ = sensor sensitivity of channel i (i = x,y,z)
 $\mu V/(V/m)^2$ for E-field probes
 $ConvF$ = sensitivity of enhancement in solution
 E_i = electric field strength of channel i in V/m

The RSS value of the field components gives the total field strength (Hermetian 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.

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1000}$$

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

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

$$P_{free} = \frac{E_{tot}^2}{3770}$$

with P_{pwe} = equivalent power density of a plane wave in W/cm²
 E_{tot} = total electric field strength in V/m

Scanning procedure

- The DASY installation includes predefined files with recommended procedures for measurements and system check. They are read-only document files and destined as fully defined but unmeasured masks. All test positions (head or body-worn) are tested with the same configuration of test steps differing only in the grid definition for the different test positions.
- The „reference“ and „drift“ measurements are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure. The indicated drift is mainly the variation of the DUT's output power and should vary max. +/- 5 %.
- The highest integrated SAR value is the main concern in compliance test applications. These values can mostly be found at the inner surface of the phantom and cannot be measured directly due to the sensor offset in the probe. To extrapolate the surface values, the measurement distances to the surface must be known accurately. A distance error of 0.5mm could produce SAR errors of 6% at 1800 MHz. Using predefined locations for measurements is not accurate enough. Any shift of the phantom (e.g., slight deformations after filling it with liquid) would produce high uncertainties. For an automatic and accurate detection of the phantom surface, the DASY5 system uses the mechanical surface detection. The detection is always at touch, but the probe will move backward from the surface the indicated distance before starting the measurement.
- The „area scan“ measures the SAR above the DUT or verification dipole on a parallel plane to the surface. It is used to locate the approximate location of the peak SAR with 2D spline interpolation. The robot performs a stepped movement along one grid axis while the local electrical field strength is measured by the probe. The probe is touching the surface of the SAM during acquisition of measurement values. The scan uses different grid spacings for different frequency measurements. Standard grid spacing for head measurements in frequency ranges ≤ 2 GHz is 15 mm in x - and y- dimension. For higher frequencies a finer resolution is needed, thus for the grid spacing is reduced according the following table:

Area scan grid spacing for different frequency ranges	
Frequency range	Grid spacing
≤ 2 GHz	≤ 15 mm
2 – 4 GHz	≤ 12 mm
4 – 6 GHz	≤ 10 mm

Grid spacing and orientation have no influence on the SAR result. For special applications where the standard scan method does not find the peak SAR within the grid, e.g. mobile phones with flip cover, the grid can be adapted in orientation. Results of this coarse scan are shown in annex B.

- A „zoom scan“ measures the field in a volume around the 2D peak SAR value acquired in the previous „coarse“ scan. It uses a fine meshed grid where the robot moves the probe in steps along all the 3 axis (x,y and z-axis) starting at the bottom of the Phantom. The grid spacing for the cube measurement is varied according to the measured frequency range, the dimensions are given in the following table:

Zoom scan grid spacing and volume for different frequency ranges			
Frequency range	Grid spacing for x, y axis	Grid spacing for z axis	Minimum zoom scan volume
≤ 2 GHz	≤ 8 mm	≤ 5 mm	≥ 30 mm
2 – 3 GHz	≤ 5 mm	≤ 5 mm	≥ 28 mm
3 – 4 GHz	≤ 5 mm	≤ 4 mm	≥ 28 mm
4 – 5 GHz	≤ 4 mm	≤ 3 mm	≥ 25 mm
5 – 6 GHz	≤ 4 mm	≤ 2 mm	≥ 22 mm

DASY is also able to perform repeated zoom scans if more than 1 peak is found during area scan. In this document, the evaluated peak 1g and 10g averaged SAR values are shown in the 2D-graphics in annex B. Test results relevant for the specified standard (see section 3) are shown in table form in section 7.

Spatial Peak SAR Evaluation

The spatial peak SAR - value for 1 and 10 g is evaluated after the Cube measurements have been done. The basis of the evaluation are the SAR values measured at the points of the fine cube grid consisting of all points in the three directions x, y and z. The algorithm that finds the maximal averaged volume is separated into three different stages.

- The data between the dipole center of the probe and the surface of the phantom are extrapolated. This data cannot be measured since the center of the dipole is 1 to 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is about 1 mm (see probe calibration sheet). The extrapolated data from a cube measurement can be visualized by selecting 'Graph Evaluated'.
- The maximum interpolated value is searched with a straight-forward algorithm. Around this maximum the SAR - values averaged over the spatial volumes (1g or 10 g) are computed using the 3d-spline interpolation algorithm. If the volume cannot be evaluated (i.e., if a part of the grid was cut off by the boundary of the measurement area) the evaluation will be started on the corners of the bottom plane of the cube.
- All neighboring volumes are evaluated until no neighboring volume with a higher average value is found.

Extrapolation

The extrapolation is based on a least square algorithm [W. Gander, Computermathematik, p.168-180]. Through the points in the first 3 cm along the z-axis, polynomials of order four are calculated. These polynomials are then used to evaluate the points between the surface and the probe tip. The points, calculated from the surface, have a distance of 1 mm from each other.

Interpolation

The interpolation of the points is done with a 3d-Spline. The 3d-Spline is composed of three one-dimensional splines with the "Not a knot"-condition [W. Gander, Computermathematik, p.141-150] (x, y and z -direction) [Numerical Recipes in C, Second Edition, p.123ff].

Volume Averaging

At First the size of the cube is calculated. Then the volume is integrated with the trapezoidal algorithm. 8000 points (20x20x20) are interpolated to calculate the average.

Advanced Extrapolation

DASY uses the advanced extrapolation option which is able to compensate boundary effects on E-field probes.

3. Probe and Dipole Calibration

See Appendix D and E.

4. Phantom & Simulating Tissue Specifications

Head & Body Simulating Mixture Characterization

The head mixture consists of the material based on the table listed below. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the desired tissue.

Table 4.1 Typical Composition of Ingredients for Tissue

Ingredients		Simulating Tissue			
		2450 MHz Head	5250 MHz Head	5600 MHz Head	5750 MHz Head
Mixing Percentage					
Water		Proprietary Mixture Procured from Speag			
Sugar					
Salt					
HEC					
Bactericide					
DGBE					
Dielectric Constant	Target	39.20	35.93	35.53	35.36
Conductivity (S/m)	Target	1.80	4.71	5.07	5.22

5. ANSI/IEEE C95.1 – 1992 RF Exposure Limits [2]

Uncontrolled Environment

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

Controlled Environment

Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

Table 5.1 Human Exposure Limits

	UNCONTROLLED ENVIRONMENT General Population (W/kg) or (mW/g)	CONTROLLED ENVIROMENT Professional Population (W/kg) or (mW/g)
SPATIAL PEAK SAR ¹ Head	1.60	8.00
SPATIAL AVERAGE SAR ² Whole Body	0.08	0.40
SPATIAL PEAK SAR ³ Hands, Feet, Ankles, Wrists	4.00	20.00

¹ The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

² The Spatial Average value of the SAR averaged over the whole body.

³ The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

6. Measurement Uncertainty

Measurement uncertainty table is not required per KDB 865664 D01 v01 section 2.8.2 page 12. SAR measurement uncertainty analysis is required in the SAR report only when the highest measured SAR in a frequency band is ≥ 1.5 W/kg for 1-g SAR. The equivalent ratio (1.5/1.6) should be applied to extremity and occupational exposure conditions. The highest reported value is less than 1.5 W/kg. Therefore, the measurement uncertainty table is not required.

7. System Validation

Tissue Verification

Table 7.1 Measured Tissue Parameters

		2450 MHz Head		5250 MHz Head		5600 MHz Head	
Date(s)		Sep. 25, 2023		Sep. 19, 2023		Sep. 25, 2023	
Liquid Temperature (°C)	20.0	Target	Measured	Target	Measured	Target	Measured
Dielectric Constant: ϵ		39.20	38.17	35.93	34.77	35.53	34.35
Conductivity: σ		1.80	1.83	4.71	4.75	5.07	5.13
		5750 MHz Head		5250 MHz Head		5600 MHz Head	
Date(s)		Sep. 19, 2023		Sep. 21, 2023		Sep. 21, 2023	
Liquid Temperature (°C)	20.0	Target	Measured	Target	Measured	Target	Measured
Dielectric Constant: ϵ		35.36	34.18	35.93	34.62	35.53	34.20
Conductivity: σ		5.22	5.30	4.71	4.76	5.07	5.14
		5750 MHz Head					
Date(s)		Sep. 21, 2023					
Liquid Temperature (°C)	20.0	Target	Measured				
Dielectric Constant: ϵ		35.36	34.03				
Conductivity: σ		5.22	5.31				

See Appendix A for data printout.

Test System Verification

Prior to assessment, the system is verified to the $\pm 10\%$ of the specifications at the test frequency by using the system kit. Power is normalized to 1 watt. (Graphic Plots Attached)

Table 7.2 System Dipole Validation Target & Measured

	Test Frequency	Targeted SAR _{1g} (W/kg)	Measure SAR _{1g} (W/kg)	Tissue Used for Verification	Deviation Target and Fast SAR to SAR (%)	Plot Number
25-Sep-2023	2450 MHz	54.10	52.90	Head	+ 2.22	1
19-Sep-2023	5250 MHz	79.50	84.10	Head	+ 5.79	2
19-Sep-2023	5600 MHz	83.20	85.30	Head	+ 2.52	3
19-Sep-2023	5750 MHz	80.50	82.30	Head	+ 2.24	4
21-Sep-2023	5250 MHz	79.50	80.80	Head	+ 1.64	5
21-Sep-2023	5600 MHz	83.20	84.10	Head	+ 1.08	6
21-Sep-2023	5750 MHz	80.50	81.20	Head	+ 0.87	7

	Test Frequency	Targeted SAR _{10g} (W/kg)	Measure SAR _{10g} (W/kg)	Tissue Used for Verification	Deviation Target and Fast SAR to SAR (%)	Plot Number
25-Sep-2023	2450 MHz	25.00	24.80	Head	- 0.80	1
19-Sep-2023	5250 MHz	22.90	24.20	Head	+ 5.68	2
19-Sep-2023	5600 MHz	23.80	24.30	Head	+ 2.10	3
19-Sep-2023	5750 MHz	23.00	24.10	Head	+ 4.78	4
21-Sep-2023	5250 MHz	22.90	22.70	Head	- 0.87	5
21-Sep-2023	5600 MHz	23.80	24.30	Head	+ 2.10	6
21-Sep-2023	5750 MHz	23.00	23.50	Head	+ 2.17	7

See Appendix A for data plots.

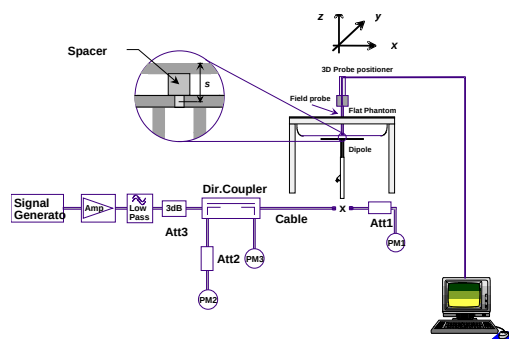


Figure 7.1 Dipole Validation Test Setup

8. SAR Test Data Summary

See Measurement Result Data Pages

See Appendix B for SAR Test Data Plots.

See Appendix C for SAR Test Setup Photos.

Procedures Used To Establish Test Signal

The device was either placed into simulated transmit mode using the manufacturer's test codes or the actual transmission is activated through a base station simulator or similar equipment. See data pages for actual procedure used in measurement.

Device Test Condition

In order to verify that the device was tested at full power, conducted output power measurements were performed before and after each SAR measurement to confirm the output power unless otherwise noted. If a conducted power deviation of more than 5% occurred, the test was repeated. The power drift of each test is measured at the start of the test and again at the end of the test. The drift percentage is calculated by the formula $((\text{end}/\text{start}) - 1) * 100$ and rounded to three decimal places. The drift percentage is calculated into the resultant SAR value on the data sheet for each test.

The EUT was tested on all sides of the device. The high transmit power of the device required all sides to be tested and none could be excluded. The device was tested at 0 mm gap for body measurements and extremity measurements. All measurements were conducted with the side of the device in direct contact with the phantom for all measurements.

The duty cycle will have a maximum of 30%. The duty cycle is hard coded in Skydio's firmware layers and the end user will not be able to modify the settings. All testing was conducted at a 100% duty cycle. The measured SAR value was then scaled to the upper end of the tolerance and then by 30% to get to the reported SAR value.

The data rates used when evaluating the WiFi transmitter were highest maximum power in the widest bandwidth at the lowest data rates for each measurement. The device was operating at its maximum output power for all measurements.

The antenna was on a minimum of 10 cm of Styrofoam during each test. The following is a pictorial drawing of the antenna location.

Band	Mode	Bandwidth (MHz)	Channel	Frequency (MHz)	Data Rate	Antenna	Avg Power (dBm)	Tune-up Pwr (dBm)	
2450 MHz	802.11g	20	1	2412	6 Mbps	Tx0	Not Required	26.00	
			6	2437				26.00	
			11	2462				26.00	
			1	2412		Tx2		26.00	
			6	2437				26.00	
			11	2462				26.00	
	802.11n/ac/ax	20	1	2412	MCS0	Tx0		24.50	
			6	2437				24.50	
			11	2462				24.50	
			1	2412		Tx2		24.50	
			6	2437				24.50	
			11	2462				24.50	
	802.11ax	10	1	2412	MCS0	Tx0	27.36	27.50	
			6	2437			27.42	27.50	
			11	2462			27.31	27.50	
			1	2412		Tx2	27.31	27.50	
			6	2437			27.40	27.50	
			11	2462			27.28	27.50	
	802.11ax	5 & 10 Single RU	3	2422	MCS0	Tx0	Not Required	27.00	
			6	2437				27.00	
			9	2452				27.00	
			3	2422		Tx2		27.00	
			6	2437				27.00	
			9	2452				27.00	
UNII 1	802.11a	20	36	5180	6 Mbps	Tx0		Not Required	21.00
			40	5200					21.00
			44	5220					21.00
			48	5240					21.00
			36	5180		Tx2			21.00
			40	5200					21.00
			44	5220			21.00		
			48	5240			21.00		
	802.11n/ac/ax	20	36	5180	MCS0	Tx0	24.21	24.50	
			40	5200			24.29	24.50	
			44	5220			24.32	24.50	
			48	5240			24.26	24.50	
			36	5180		Tx2	24.22	24.50	
			40	5200			24.24	24.50	
			44	5220			24.28	24.50	
			48	5240			24.20	24.50	
	802.11n/ac/ax	40	38	5190	MCS0	Tx0	Not Required	24.00	
			46	5230				24.00	
			38	5190		Tx2		24.00	
			46	5230				24.00	
	802.11ac/ax	80	42	5210	MCS0	Tx0		19.00	
						Tx2		19.00	

Band	Mode	Bandwidth (MHz)	Channel	Frequency (MHz)	Data Rate	Antenna	Avg Power (dBm)	Tune-up Pwr (dBm)	
UNII 2a	802.11a	20	52	5260	6 Mbps	Tx0	Not Required	15.00	
			56	5280				15.00	
			60	5300				15.00	
			64	5320				15.00	
			52	5260		Tx2		15.00	
			56	5280				15.00	
			60	5300				15.00	
			64	5320				15.00	
	802.11n/ac/ax	20	52	5260	MCS0	Tx0		18.00	
			56	5280				18.00	
			60	5300				18.00	
			64	5320				18.00	
			52	5260		Tx2		18.00	
			56	5280				18.00	
			60	5300				18.00	
			64	5320				18.00	
	802.11n/ac/ax	40	54	5270	MCS0	Tx0		19.00	
			62	5310		19.00			
			54	5270		Tx2		19.00	
			62	5310		19.00			
	802.11ac/ax	80	58	5290	MCS0	Tx0		18.69	19.00
						Tx2		18.64	19.00

Band	Mode	Bandwidth (MHz)	Channel	Frequency (MHz)	Data Rate	Antenna	Avg Power (dBm)	Tune-up Pwr (dBm)
UNII 2c	802.11a	20	100	5500	6 Mbps	Tx0	Not Required	16.00
			104	5520				16.00
			108	5540				16.00
			112	5560				16.00
			116	5580				16.00
			120	5600				16.00
			124	5620				16.00
			128	5640				16.00
			132	5660				16.00
			136	5680				16.00
			140	5700				16.00
			100	5500		Tx1		16.00
			104	5520				16.00
			108	5540				16.00
			112	5560				16.00
			116	5580				16.00
			120	5600				16.00
			124	5620				16.00
			128	5640				16.00
			132	5660				16.00
			136	5680				16.00
			140	5700				16.00
	802.11n/ac/ax	20	100	5500	MCS0	Tx0		19.00
			104	5520				19.00
			108	5540				19.00
			112	5560				19.00
			116	5580				19.00
			120	5600				19.00
			124	5620				19.00
			128	5640				19.00
			132	5660				19.00
			136	5680				19.00
			140	5700				19.00
			100	5500		Tx1		19.00
			104	5520				19.00
			108	5540				19.00
			112	5560				19.00
			116	5580				19.00
			120	5600				19.00
			124	5620				19.00
			128	5640				19.00
			132	5660				19.00
			136	5680				19.00
			140	5700				19.00
	802.11n/ac/ax	40	102	5510	MCS0	Tx0		20.00
			110	5550				20.00
			118	5590				20.00
			126	5630				20.00
			134	5670				20.00
			102	5510		Tx1		20.00
110			5550	20.00				
118			5590	20.00				
126			5630	20.00				
134			5670	20.00				
802.11ac/ax	80	106	5530	MCS0	Tx0	19.59	20.00	
		122	5610			19.62	20.00	
		138	5690			19.57	20.00	
		106	5530		Tx1	19.63	20.00	
		122	5610			19.68	20.00	
		138	5690			19.65	20.00	

Band	Mode	Bandwidth (MHz)	Channel	Frequency (MHz)	Data Rate	Antenna	Avg Power (dBm)	Tune-up Pwr (dBm)
UNII 3	802.11a	20	149	5745	6 Mbps	Tx0	26.44	26.50
			153	5765			26.46	26.50
			157	5785			26.49	26.50
			161	5805			26.47	26.50
			165	5825			26.44	26.50
			149	5745		Tx2	26.44	26.50
			153	5765			26.48	26.50
			157	5785			26.48	26.50
			161	5805			26.45	26.50
			165	5825			26.43	26.50
	802.11n/ac/ax	20	149	5745	MCS0	Tx0	Not Required	26.00
			153	5765				26.00
			157	5785				26.00
			161	5805				26.00
			165	5825				26.00
			149	5745		Tx2		26.00
			153	5765				26.00
			157	5785				26.00
			161	5805				26.00
			165	5825				26.00
	802.11n/ac/ax	40	151	5755	MCS0	Tx0		26.00
			159	5795		Tx2		26.00
			151	5755				26.00
			159	5795				26.00
	802.11ac/ax	80	155	5775	MCS0	Tx0		21.50
						Tx2		21.50
	802.11ax	5 & 10 & 10 Single RU	149	5745	MCS0	Tx0		26.50
			153	5765				26.50
			157	5785				26.50
			161	5805				26.50
			165	5825				26.50
			149	5745		Tx2		26.50
			153	5765				26.50
			157	5785				26.50
			161	5805				26.50
			165	5825				26.50

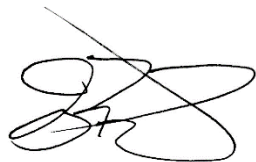
SAR Data Summary – 2450 MHz Body 802.11ax 10 MHz BW

MEASUREMENT RESULTS

Gap	Plot	Position	Frequency		Modulation	Antenna	End Power (dBm)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)	Measured 10g SAR (W/kg)	Reported 10g SAR (W/kg)
			MHz	Ch.							
0 mm	-----	Back	2412	1	OFDM	Tx0	27.36	1.51	0.47	0.798	0.25
	-----		2437	6	OFDM		27.42	1.57	0.48	0.830	0.25
	-----	Front	2412	1	OFDM		27.36	1.82	0.56	0.962	0.30
	-----		2437	6	OFDM		27.42	2.01	0.61	1.06	0.32
	-----	Left	2437	6	OFDM		27.42	0.611	0.19	0.323	0.10
	-----	Right	2437	6	OFDM		27.42	0.136	0.04	0.072	0.02
	-----	Top	2437	6	OFDM		27.42	0.798	0.24	0.422	0.13
	-----	Bottom	2437	6	OFDM		27.42	0.118	0.04	0.062	0.02
	-----	Back	2412	1	OFDM	Tx2	27.31	1.41	0.44	0.745	0.23
	-----		2437	6	OFDM		27.40	1.6	0.49	0.845	0.26
	-----	Front	2412	1	OFDM		27.31	2.73	0.86	1.44	0.45
	1		2437	6	OFDM		27.40	3.35	1.03	1.77	0.54
	-----	Left	2437	6	OFDM		27.40	0.198	0.06	0.105	0.03
	-----	Right	2437	6	OFDM		27.40	0.623	0.19	0.329	0.10
	-----	Top	2437	6	OFDM		27.40	0.753	0.23	0.398	0.12
	-----	Bottom	2437	6	OFDM		27.40	0.178	0.05	0.094	0.03
	-----	Repeat	2437	6	OFDM		27.40	3.33	1.02	1.76	0.54

Body
1.6 W/kg (mW/g)
 averaged over 1 gram
4.0 W/kg (mW/g)
 averaged over 10 gram

- SAR Measurement
 Phantom Configuration ☐ Left Head ☒ Eli4 ☐ Right Head
 SAR Configuration ☐ Head ☒ Body
 Test Signal Call Mode ☒ Test Code ☐ Base Station Simulator
 Test Configuration ☐ With Belt Clip ☐ Without Belt Clip ☒ N/A
 Tissue Depth is at least 15.0 cm



Jay M. Moulton
 Vice President

The measured SAR value is at 100% duty cycle. Therefore, the formula used for calculation of the reported SAR value is the measured SAR Value in the above table scaled to the upper end of the tune tolerance (27.5 dBm) than multiplied by 30% for the maximum duty cycle of the transmitter.

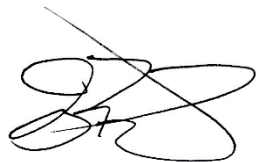
SAR Data Summary – UNII 1 Body 802.11n 20 MHz BW

MEASUREMENT RESULTS

Gap	Plot	Position	Frequency		Modulation	Antenna	End Power (dBm)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)	Measured 10g SAR (W/kg)	Reported 10g SAR (W/kg)
			MHz	Ch.							
0 mm	-----	Back	5200	40	OFDM	Tx0	24.29	2.51	0.79	0.939	0.30
	-----		5220	44	OFDM		24.32	2.26	0.71	0.845	0.26
	-----	Front	5200	40	OFDM		24.29	2.00	0.63	0.748	0.24
	-----		5220	44	OFDM		24.32	1.69	0.53	0.632	0.20
	-----	Left	5220	44	OFDM		24.32	0.128	0.04	0.048	0.02
	-----	Right	5220	44	OFDM		24.32	0.0687	0.02	0.026	0.01
	-----	Top	5220	44	OFDM		24.32	0.264	0.08	0.099	0.03
	-----	Bottom	5220	44	OFDM		24.32	0.103	0.03	0.039	0.01
	-----	Back	5200	40	OFDM	Tx2	24.24	2.03	0.65	0.759	0.24
	-----		5220	44	OFDM		24.28	2.70	0.85	1.01	0.32
	-----	Front	5200	40	OFDM		24.24	1.47	0.47	0.550	0.17
	-----		5220	44	OFDM		24.28	1.49	0.47	0.557	0.18
	-----	Left	5220	44	OFDM		24.28	0.0856	0.03	0.032	0.01
	-----	Right	5220	44	OFDM		24.28	0.109	0.03	0.041	0.01
	-----	Top	5220	44	OFDM		24.28	0.370	0.12	0.138	0.05
	-----	Bottom	5220	44	OFDM		24.28	0.0632	0.02	0.024	0.01
	-----	Repeat	5220	44	OFDM		24.28	2.67	0.84	0.999	0.32

Body
1.6 W/kg (mW/g)
 averaged over 1 gram
4.0 W/kg (mW/g)
 averaged over 10 gram

- SAR Measurement
 Phantom Configuration ☐ Left Head ☒ Eli4 ☐ Right Head
 SAR Configuration ☐ Head ☒ Body
- Test Signal Call Mode ☒ Test Code ☐ Base Station Simulator
- Test Configuration ☐ With Belt Clip ☐ Without Belt Clip ☒ N/A
- Tissue Depth is at least 15.0 cm



Jay M. Moulton
Vice President

The measured SAR value is at 100% duty cycle. Therefore, the formula used for calculation of the reported SAR value is the measured SAR Value in the above table scaled to the upper end of the tune tolerance (24.5 dBm) than multiplied by 30% for the maximum duty cycle of the transmitter.

SAR Data Summary – UNII 2a Body 802.11ac 80 MHz BW

MEASUREMENT RESULTS

Gap	Plot	Position	Frequency		Modulation	Antenna	End Power (dBm)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)	Measured 10g SAR (W/kg)	Reported 10g SAR (W/kg)
			MHz	Ch.							
0 mm	3	Back	5290	58	OFDM	Tx0	18.69	1.78	0.57	0.591	0.19
	-----	Front	5290	58	OFDM		18.69	0.388	0.13	0.129	0.04
	-----	Left	5290	58	OFDM		18.69	0.0421	0.01	0.014	0.00
	-----	Right	5290	58	OFDM		18.69	0.0106	0.00	0.004	0.00
	-----	Top	5290	58	OFDM		18.69	0.0522	0.02	0.017	0.01
	-----	Bottom	5290	58	OFDM		18.69	0.00973	0.00	0.003	0.00
	-----	Back	5290	58	OFDM	Tx2	18.64	1.60	0.52	0.531	0.17
	-----	Front	5290	58	OFDM		18.64	0.539	0.18	0.179	0.06
	-----	Left	5290	58	OFDM		18.64	0.00987	0.00	0.003	0.00
	-----	Right	5290	58	OFDM		18.64	0.101	0.03	0.034	0.01
	-----	Top	5290	58	OFDM		18.64	0.109	0.04	0.036	0.01
	-----	Bottom	5290	58	OFDM		18.64	0.0129	0.00	0.004	0.00
	-----	Repeat	5290	58	OFDM		18.69	1.75	0.56	0.581	0.19

Body

1.6 W/kg (mW/g)

averaged over 1 gram

4.0 W/kg (mW/g)

averaged over 10 gram

1. SAR Measurement

Phantom Configuration

☐ Left Head

☒ Eli4

☐ Right Head

SAR Configuration

☐ Head

☒ Body

2. Test Signal Call Mode

☒ Test Code

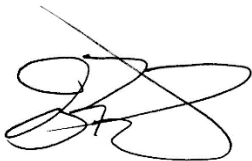
☐ Base Station Simulator

3. Test Configuration

☐ With Belt Clip

☐ Without Belt Clip ☒ N/A

4. Tissue Depth is at least 15.0 cm



Jay M. Moulton
Vice President

The measured SAR value is at 100% duty cycle. Therefore, the formula used for calculation of the reported SAR value is the measured SAR Value in the above table scaled to the upper end of the tune tolerance (19.0 dBm) than multiplied by 30% for the maximum duty cycle of the transmitter.

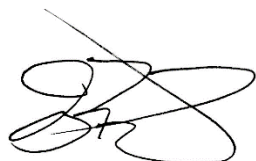
SAR Data Summary – UNII 2c Body 802.11ac 80 MHz BW

MEASUREMENT RESULTS

Gap	Plot	Position	Frequency		Modulation	Antenna	End Power (dBm)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)	Measured 10g SAR (W/kg)	Reported 10g SAR (W/kg)
			MHz	Ch.							
0 mm	4	Back	5610	122	OFDM	Tx0	19.62	2.43	0.80	0.789	0.26
	-----		5690	138	OFDM		19.57	2.32	0.77	0.753	0.25
	-----	Front	5610	122	OFDM		19.62	0.539	0.18	0.175	0.06
	-----		5610	122	OFDM		19.57	0.211	0.07	0.069	0.02
	-----	Right	5610	122	OFDM		19.57	0.0987	0.03	0.032	0.01
	-----		5610	122	OFDM		19.57	0.296	0.10	0.096	0.03
	-----	Top	5610	122	OFDM		19.57	0.0957	0.03	0.031	0.01
	-----		5610	122	OFDM		19.68	2.04	0.66	0.662	0.21
	-----	Bottom	5610	122	OFDM	Tx2	19.65	1.97	0.64	0.640	0.21
	-----		5690	138	OFDM		19.68	0.649	0.21	0.211	0.07
	-----	Back	5610	122	OFDM		19.65	0.0856	0.03	0.028	0.01
	-----		5610	122	OFDM		19.65	0.239	0.08	0.078	0.02
	-----	Front	5610	122	OFDM		19.65	0.304	0.10	0.099	0.03
	-----		5610	122	OFDM		19.65	0.0967	0.03	0.031	0.01
	-----	Left	5610	122	OFDM		19.57	2.40	0.79	0.779	0.26
	-----		5610	122	OFDM						
	-----	Right	5610	122	OFDM						
	-----		5610	122	OFDM						
	-----	Top	5610	122	OFDM						
	-----		5610	122	OFDM						
	-----	Bottom	5610	122	OFDM						
	-----		5610	122	OFDM						
	-----	Repeat	5610	122	OFDM						

Body
1.6 W/kg (mW/g)
averaged over 1 gram
4.0 W/kg (mW/g)
averaged over 10 gram

- SAR Measurement
Phantom Configuration ☐ Left Head ☒ Eli4 ☐ Right Head
SAR Configuration ☐ Head ☒ Body
- Test Signal Call Mode ☒ Test Code ☐ Base Station Simulator
- Test Configuration ☐ With Belt Clip ☐ Without Belt Clip ☒ N/A
- Tissue Depth is at least 15.0 cm



Jay M. Moulton
Vice President

The measured SAR value is at 100% duty cycle. Therefore, the formula used for calculation of the reported SAR value is the measured SAR Value in the above table scaled to the upper end of the tune tolerance (20.0 dBm) than multiplied by 30% for the maximum duty cycle of the transmitter.

SAR Data Summary – UNII 3 Body 802.11a 20 MHz BW

MEASUREMENT RESULTS

Gap	Plot	Position	Frequency		Modulation	Antenna	End Power (dBm)	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)	Measured 10g SAR (W/kg)	Reported 10g SAR (W/kg)
			MHz	Ch.							
0 mm	-----	Back	5745	149	OFDM	Tx0	26.44	3.69	1.12	1.26	0.38
	5		5785	157	OFDM		26.49	4.61	1.39	1.57	0.47
	-----		5825	165	OFDM		26.44	4.49	1.37	1.53	0.47
	-----	Front	5785	157	OFDM		26.49	1.37	0.41	0.467	0.14
	-----		5825	165	OFDM		26.44	1.46	0.44	0.497	0.15
	-----		5785	157	OFDM		26.49	0.231	0.07	0.079	0.02
	-----	Left	5785	157	OFDM		26.49	0.102	0.03	0.035	0.01
	-----	Right	5785	157	OFDM		26.49	0.274	0.08	0.093	0.03
	-----	Top	5785	157	OFDM		26.49	0.0975	0.03	0.033	0.01
	-----	Bottom	5785	157	OFDM		26.44	3.72	1.13	1.27	0.39
	-----	Back	5745	149	OFDM	Tx2	26.48	4.13	1.25	1.41	0.43
	-----		5785	157	OFDM		26.43	4.43	1.35	1.51	0.46
	-----		5825	165	OFDM		26.48	1.56	0.47	0.531	0.16
	-----	Front	5785	157	OFDM		26.43	1.52	0.46	0.518	0.16
	-----		5825	165	OFDM		26.48	0.0967	0.03	0.033	0.01
	-----		5785	157	OFDM		26.48	0.197	0.06	0.067	0.02
	-----	Left	5785	157	OFDM		26.48	0.263	0.08	0.090	0.03
	-----	Right	5785	157	OFDM		26.48	0.0928	0.03	0.032	0.01
	-----	Top	5785	157	OFDM		26.49	4.57	1.37	1.56	0.47
	-----	Bottom	5785	157	OFDM						
	-----	Repeat	5785	157	OFDM						

Body

1.6 W/kg (mW/g)

averaged over 1 gram

4.0 W/kg (mW/g)

averaged over 10 gram

1. SAR Measurement

Phantom Configuration

☐ Left Head

☒ Eli4

☐ Right Head

SAR Configuration

☐ Head

☒ Body

2. Test Signal Call Mode

☒ Test Code

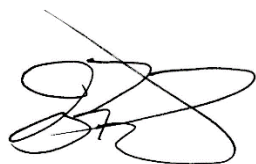
☐ Base Station Simulator

3. Test Configuration

☐ With Belt Clip

☐ Without Belt Clip ☒ N/A

4. Tissue Depth is at least 15.0 cm



Jay M. Moulton
Vice President

The measured SAR value is at 100% duty cycle. Therefore, the formula used for calculation of the reported SAR value is the measured SAR Value in the above table scaled to the upper end of the tune tolerance (26.5 dBm) than multiplied by 30% for the maximum duty cycle of the transmitter.

9. Simultaneous Transmission Analysis

The Samsung S23+ data (FCC ID: A3LSMS916B) was extracted from the original filing on the FCC site. The 10 gram average was used for the simultaneous evaluation with the cellular phone. The phone position would only allow it to be next to the extremity. The data listed in the tables below was extracted from the reports filed with this report.

Sim-Tx configuration

No.	Simultaneous Transmission Configuration	Exposure Positions
		Body
1	2.4 GHz in C18 + 5 GHz Phone + Cellular Phone	Yes
2	5 GHz in C18 + 2.4 GHz Phone + Cellular Phone	Yes

General Note:

1. The worst case WLAN reported SAR for each configuration was used for SAR summation, regardless of whether the WLAN channel has Hotspot capability. Therefore, the following summations represent the absolute worst cases for simultaneous transmission with WLAN.
2. The Scaled SAR summation is calculated based on the same configuration and test position.

Body Exposure Conditions

C18	Exposure Position	1	2	3	4	5	1+3+5 Summed 10g SAR (W/kg)	2+3+4 Summed 10g SAR (W/kg)
		C18 2.4 GHz	C18 5 GHz	S23+ WWAN	S23+ 2.4 GHz	S23+ 5 GHz		
		10g SAR (W/kg)	10g SAR (W/kg)	10g SAR (W/kg)	10g SAR (W/kg)	10g SAR (W/kg)		
2.4 GHz	Worst Case	0.54		2.81		2.83	6.18	
5 GHz	Worst Case		0.47	2.81	1.06			4.34

The sum of all three transmitters is not less than the extremity limit of 4.0 W/kg. Therefore, the separation ratio was used to verify the simultaneous was excluded. The S23+ WWAN to S23+ WiFi was not evaluated in this report as it was covered in the original filing.

The formula is $(SAR_1 + SAR_2)^{1.5} / R_i \leq 0.10$

For the 2.4 GHz simultaneous line,

$SAR_1 = 0.54 \text{ W/kg}$
 $SAR_2 = 2.81 \text{ W/kg}$
 $R_i = 85 \text{ mm}$

$SAR_1 = 0.54 \text{ W/kg}$
 $SAR_2 = 2.83 \text{ W/kg}$
 $R_i = 85 \text{ mm}$

$(0.54+2.81)^{1.5} / 85 = 0.07$, which is excluded

$(0.54+2.83)^{1.5} / 85 = 0.07$, which is excluded

For the 5 GHz simultaneous line,

$SAR_1 = 0.47 \text{ W/kg}$
 $SAR_2 = 2.81 \text{ W/kg}$
 $R_i = 85 \text{ mm}$

$SAR_1 = 0.47 \text{ W/kg}$
 $SAR_2 = 1.06 \text{ W/kg}$
 $R_i = 85 \text{ mm}$

$(0.47+2.81)^{1.5} / 85 = 0.07$, which is excluded

$(0.47+1.06)^{1.5} / 85 = 0.02$, which is excluded

10. Test Equipment List

Table 10.1 Equipment Specifications

Type	Calibration Due Date	Calibration Done Date	Serial Number
Staubli Robot TX60L	N/A	N/A	F07/55M6A1/A/01
Measurement Controller CS8c	N/A	N/A	1012
ELI4 Flat Phantom	N/A	N/A	1065
Device Holder	N/A	N/A	N/A
Data Acquisition Electronics 4	01/17/2024	01/17/2023	1321
SPEAG E-Field Probe EX3DV4	02/10/2024	02/10/2023	3662
Speag Validation Dipole D2450V2	06/03/2024	06/03/2021	881
Speag Validation Dipole D5GHzV2	06/08/2024	06/08/2021	1119
Agilent N1911A Power Meter	03/14/2024	03/14/2023	GB45100254
Agilent N1922A Power Sensor	03/13/2024	03/13/2023	MY45240464
Agilent (HP) 8596E Spectrum Analyzer	03/13/2024	03/13/2023	3826A01468
Agilent (HP) 83752A Synthesized Sweeper	03/14/2024	03/14/2023	3610A01048
Agilent (HP) 8753C Vector Network Analyzer	03/14/2024	03/14/2023	3135A01724
Agilent (HP) 85047A S-Parameter Test Set	03/14/2024	03/14/2023	2904A00595
Copper Mountain R140 Vector Reflectometer	03/13/2024	03/13/2023	21390004
Agilent 778D Dual Directional Coupler	N/A	N/A	MY48220184
MiniCircuits BW-N20W5+ Fixed 20 dB Attenuator	N/A	N/A	N/A
MiniCircuits SPL-10.7+ Low Pass Filter	N/A	N/A	R8979513746
Apriel Dielectric Probe Assembly	N/A	N/A	0011
Head Equivalent Matter (2450 MHz)	N/A	N/A	N/A
Head Equivalent Matter (3-6 GHz)	N/A	N/A	N/A

11. Conclusion

The SAR measurement indicates that the EUT complies with the RF radiation exposure limits of the FCC. These measurements are taken to simulate the RF effects exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The tested device complies with the requirements in respect to all parameters subject to the test. The test results and statements relate only to the item(s) tested.

Please note that the absorption and distribution of electromagnetic energy in the body is a very complex phenomena that depends on the mass, shape, and size of the body; the orientation of the body with respect to the field vectors; and, the electrical properties of both the body and the environment. Other variables that may play a substantial role in possible biological effects are those that characterize the environment (e.g. ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g. age, gender, activity level, debilitation, or disease). Because innumerable factors may interact to determine the specific biological outcome of an exposure to electromagnetic fields, any protection guide shall consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables.

12. References

- [1] Federal Communications Commission, ET Docket 93-62, Guidelines for Evaluating the Environmental Effects of Radio Frequency Radiation, August 1996
- [2] ANSI/IEEE C95.1 – 1992, American National Standard Safety Levels with respect to Human Exposure to Radio Frequency Electromagnetic Fields, 300kHz to 100GHz, New York: IEEE, 1992.
- [3] ANSI/IEEE C95.3 – 1992, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave, New York: IEEE, 1992.
- [4] International Electrotechnical Commission, IEC 62209-2 (Edition 1.0), Human Exposure to radio frequency fields from hand-held and body mounted wireless communication devices – Human models, instrumentation, and procedures – Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz), March 2010.
- [5] IEEE Standard 1528 – 2013, IEEE Recommended Practice for Determining the Peak-Spatial Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communication Devices: Measurement Techniques, June 2013.
- [6] Industry Canada, RSS – 102 Issue 5, Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands), March 2015.
- [7] Health Canada, Safety Code 6, Limits of Human Exposure to Radiofrequency Electromagnetic Fields in the Frequency Range from 3kHz to 300 GHz, 2009.

Appendix A – System Verification Plots and Data

Test Result for UIM Dielectric Parameter

Mon 25/Sep/2023

Freq Frequency(GHz)

FCC_eH Limits for Head Epsilon

FCC_sH Limits for Head Sigma

Test_e Epsilon of UIM

Test_s Sigma of UIM

Freq	FCC_eH	FCC_sH	Test_e	Test_s
2.4100	39.26	1.76	38.27	1.78
2.4120	39.258	1.762	38.266	1.782*
2.4200	39.25	1.77	38.25	1.79
2.4300	39.24	1.78	38.23	1.80
2.4370	39.226	1.787	38.223	1.814*
2.4400	39.22	1.79	38.22	1.82
2.4500	39.20	1.80	38.17	1.83
2.4600	39.19	1.81	38.17	1.84
2.4620	39.186	1.812	38.166	1.842*
2.4700	39.17	1.82	38.15	1.85
2.4800	39.16	1.83	38.13	1.88

* value interpolated

Test Result for UIM Dielectric Parameter

Tue 19/Sep/2023

Freq Frequency(GHz)

FCC_eH Limits for Head Epsilon

FCC_sH Limits for Head Sigma

Test_e Epsilon of UIM

Test_s Sigma of UIM

Freq	FCC_eH	FCC_sH	Test_e	Test_s
5.1000	36.10	4.55	34.94	4.58
5.1200	36.08	4.57	34.92	4.60
5.1400	36.05	4.59	34.89	4.62
5.1600	36.03	4.61	34.87	4.65
5.1800	36.01	4.63	34.85	4.67
5.2000	35.99	4.65	34.82	4.69
5.2200	35.96	4.68	34.80	4.71
5.2400	35.94	4.70	34.78	4.73
5.2500	35.93	4.71	34.765	4.745
5.2600	35.92	4.72	34.75	4.76
5.2800	35.89	4.74	34.72	4.78
5.2900	35.88	4.75	34.705	4.79*
5.3000	35.87	4.76	34.69	4.80
5.3200	35.85	4.78	34.67	4.82
5.3400	35.83	4.80	34.65	4.85
5.3600	35.80	4.82	34.63	4.87
5.3800	35.78	4.84	34.60	4.89
5.4000	35.76	4.86	34.58	4.91
5.4200	35.73	4.88	34.56	4.94
5.4400	35.71	4.90	34.55	4.96
5.4600	35.69	4.92	34.52	4.98
5.4800	35.67	4.94	34.49	5.00
5.5000	35.64	4.96	34.46	5.02
5.5200	35.62	4.98	34.44	5.04
5.5300	35.61	4.99	34.43	5.05*
5.5400	35.60	5.00	34.42	5.06
5.5600	35.57	5.02	34.40	5.09
5.5800	35.55	5.04	34.37	5.11
5.6000	35.53	5.07	34.35	5.13
5.6100	35.52	5.08	34.335	5.14*
5.6200	35.51	5.09	34.32	5.15
5.6400	35.48	5.11	34.30	5.18
5.6600	35.46	5.13	34.28	5.20
5.6800	35.44	5.15	34.26	5.22
5.6900	35.425	5.16	34.245	5.23*
5.7000	35.41	5.17	34.23	5.24
5.7200	35.39	5.19	34.21	5.27
5.7400	35.37	5.21	34.19	5.29
5.7450	35.365	5.215	34.185	5.295*
5.7500	35.36	5.22	34.18	5.30*
5.7600	35.35	5.23	34.17	5.31
5.7800	35.32	5.25	34.15	5.33
5.7850	35.315	5.255	34.14	5.335*
5.8000	35.30	5.27	34.11	5.35
5.8200	35.28	5.29	34.09	5.38
5.8250	35.273	5.295	34.085	5.385*
5.8400	35.25	5.31	34.07	5.40
5.8600	35.23	5.33	34.05	5.42

* value interpolated

Test Result for UIM Dielectric Parameter

Thu 21/Sep/2023

Freq Frequency(GHz)

FCC_eH Limits for Head Epsilon

FCC_sH Limits for Head Sigma

Test_e Epsilon of UIM

Test_s Sigma of UIM

Freq	FCC_eH	FCC_sH	Test_e	Test_s
5.1000	36.10	4.55	34.79	4.59
5.1200	36.08	4.57	34.77	4.61
5.1400	36.05	4.59	34.74	4.63
5.1600	36.03	4.61	34.72	4.66
5.1800	36.01	4.63	34.70	4.68
5.2000	35.99	4.65	34.67	4.70
5.2200	35.96	4.68	34.65	4.72
5.2400	35.94	4.70	34.63	4.74
5.2500	35.93	4.71	34.615	4.755
5.2600	35.92	4.72	34.60	4.77
5.2800	35.89	4.74	34.57	4.79
5.2900	35.88	4.75	34.555	4.80*
5.3000	35.87	4.76	34.54	4.81
5.3200	35.85	4.78	34.52	4.83
5.3400	35.83	4.80	34.50	4.86
5.3600	35.80	4.82	34.48	4.88
5.3800	35.78	4.84	34.45	4.90
5.4000	35.76	4.86	34.43	4.92
5.4200	35.73	4.88	34.41	4.95
5.4400	35.71	4.90	34.40	4.97
5.4600	35.69	4.92	34.37	4.99
5.4800	35.67	4.94	34.34	5.01
5.5000	35.64	4.96	34.31	5.03
5.5200	35.62	4.98	34.29	5.05
5.5300	35.61	4.99	34.28	5.06*
5.5400	35.60	5.00	34.27	5.07
5.5600	35.57	5.02	34.25	5.10
5.5800	35.55	5.04	34.22	5.12
5.6000	35.53	5.07	34.20	5.14
5.6100	35.52	5.08	34.185	5.15*
5.6200	35.51	5.09	34.17	5.16
5.6400	35.48	5.11	34.15	5.19
5.6600	35.46	5.13	34.13	5.21
5.6800	35.44	5.15	34.11	5.23
5.6900	35.425	5.16	34.095	5.24*
5.7000	35.41	5.17	34.08	5.25
5.7200	35.39	5.19	34.06	5.28
5.7400	35.37	5.21	34.04	5.30
5.7450	35.365	5.215	34.035	5.305*
5.7500	35.36	5.22	34.03	5.31
5.7600	35.35	5.23	34.02	5.32
5.7800	35.32	5.25	34.00	5.34
5.7850	35.315	5.255	33.99	5.345*
5.8000	35.30	5.27	33.96	5.36
5.8200	35.28	5.29	33.94	5.39
5.8250	35.273	5.295	33.935	5.395*
5.8400	35.25	5.31	33.92	5.41
5.8600	35.23	5.33	33.90	5.43

* value interpolated

RF Exposure Lab

Plot 1

DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2 - SN:881

Communication System: CW; Frequency: 2450 MHz; Duty Cycle: 1:1

Medium: HSL2450; Medium parameters used: $f = 2450$ MHz; $\sigma = 1.83$ S/m; $\epsilon_r = 38.17$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Test Date: Date: 9/25/2023; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 – SN3662; ConvF(7.26, 7.26, 7.26); Calibrated: 2/10/2023;

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1321; Calibrated: 1/17/2023

Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1065

Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

2450 MHz Head/Verification/Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 7.93 W/kg

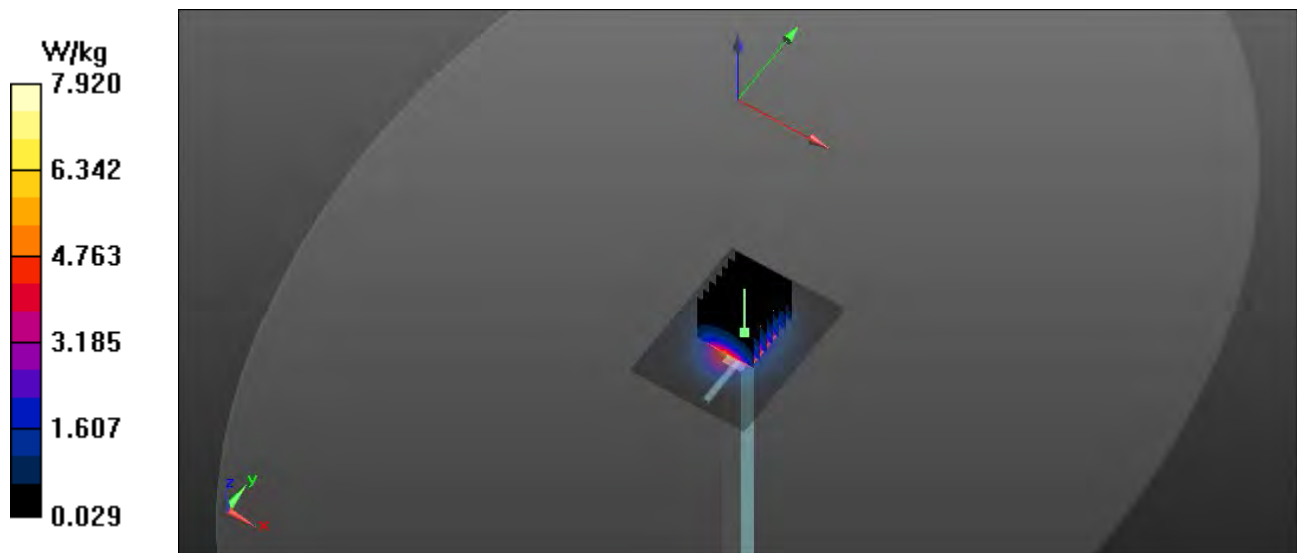
2450 MHz Head/Verification/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 58.792 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 11.15 W/kg

SAR(1 g) = 5.29 W/kg; SAR(10 g) = 2.48 W/kg

Maximum value of SAR (measured) = 8.39 W/kg



RF Exposure Lab

Plot 2

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1119

Communication System: CW; Frequency: 5250 MHz; Duty Cycle: 1:1

Medium: HSL3-6GHz; Medium parameters used (interpolated): $f = 5250$ MHz; $\sigma = 4.745$ S/m; $\epsilon_r = 34.765$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Test Date: Date: 9/19/2023; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 – SN3662; ConvF(5, 5, 5); Calibrated: 2/10/2023;

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1321; Calibrated: 1/17/2023

Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1065

Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

5250 MHz Head/Verification/Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 1.5 W/kg

5250 MHz Head/Verification/Zoom Scan (8x8x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

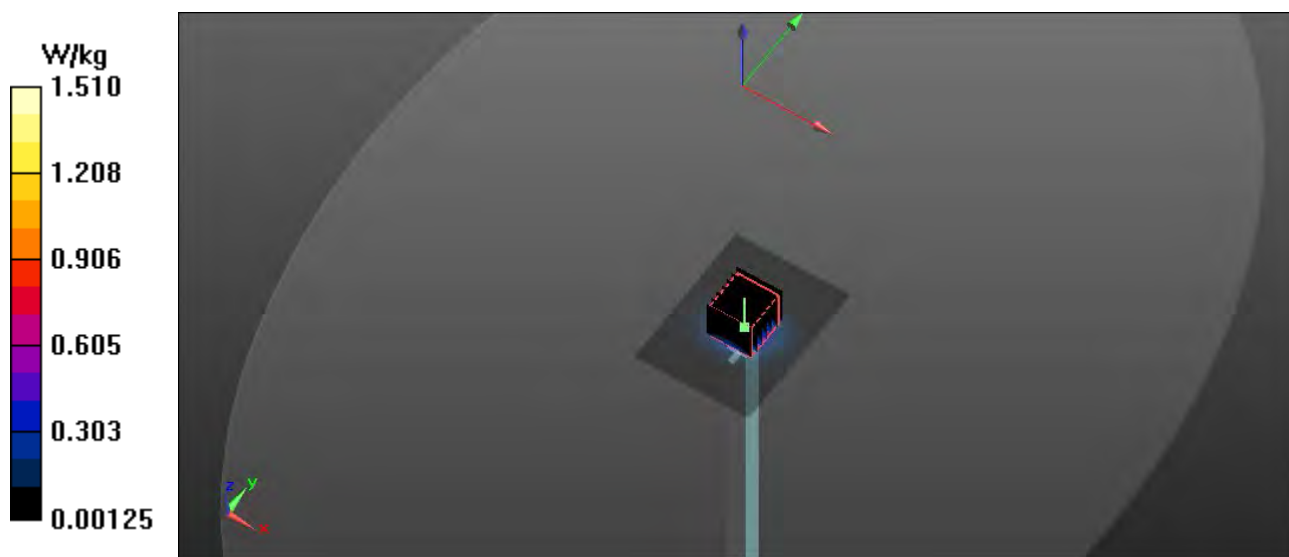
Reference Value = 58.697 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 3.06 W/kg

SAR(1 g) = 0.841 W/kg; SAR(10 g) = 0.242 W/kg

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 1.96 W/kg



RF Exposure Lab

Plot 3

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1119

Communication System: CW; Frequency: 5600 MHz; Duty Cycle: 1:1

Medium: HSL3-6GHz; Medium parameters used: $f = 5600$ MHz; $\sigma = 5.13$ S/m; $\epsilon_r = 34.35$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Test Date: Date: 9/19/2023; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 – SN3662; ConvF(4.7, 4.7, 4.7); Calibrated: 2/10/2023;

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1321; Calibrated: 1/17/2023

Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1065

Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

5600 MHz Head/Verification/Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 1.75 W/kg

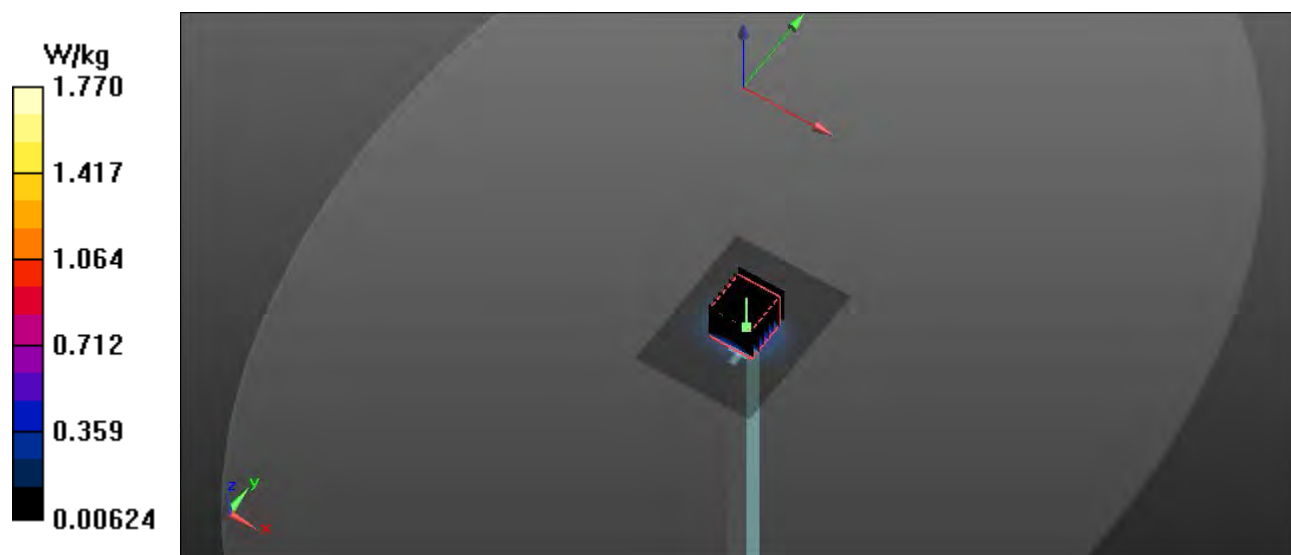
5600 MHz Head/Verification/Zoom Scan (8x8x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 13.798 V/m; Power Drift = -0.01 dB

Peak SAR (extrapolated) = 3.79 W/kg

SAR(1 g) = 0.853 W/kg; SAR(10 g) = 0.243 W/kg

Maximum value of SAR (measured) = 2.03 W/kg



RF Exposure Lab

Plot 4

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1119

Communication System: CW; Frequency: 5750 MHz; Duty Cycle: 1:1

Medium: HSL3-6GHz; Medium parameters used (interpolated): $f = 5750$ MHz; $\sigma = 5.3$ S/m; $\epsilon_r = 34.18$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Test Date: Date: 9/19/2023; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 – SN3662; ConvF(4.85, 4.85, 4.85); Calibrated: 2/10/2023;

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1321; Calibrated: 1/17/2023

Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1065

Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

5750 MHz Head/Verification/Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 1.67 W/kg

5750 MHz Head/Verification/Zoom Scan (8x8x15)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

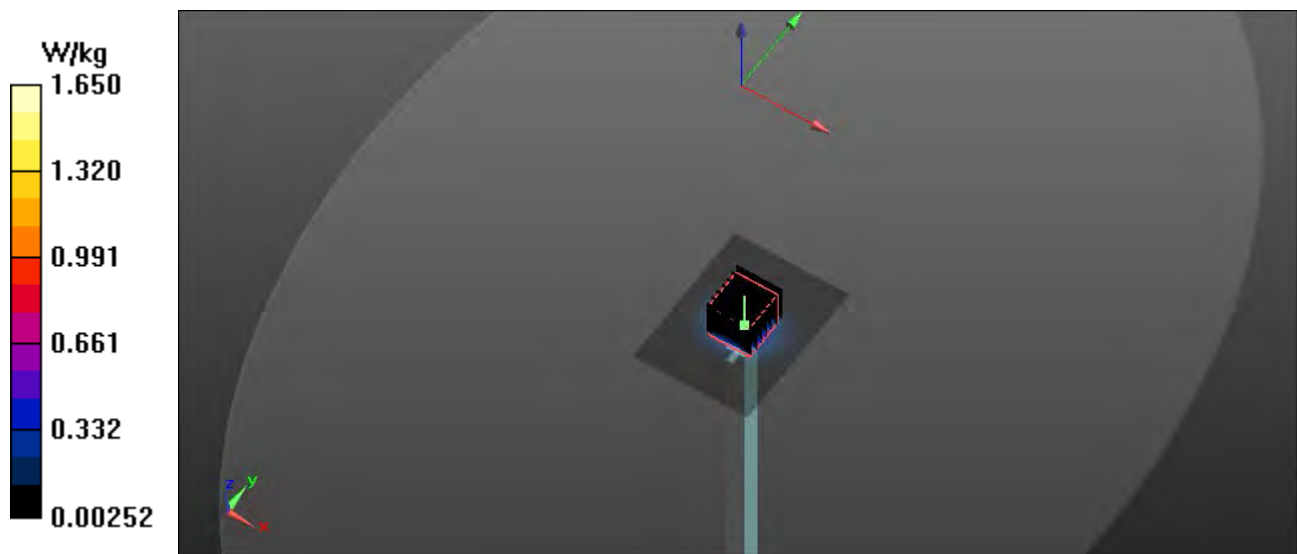
Reference Value = 12.942 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 3.59 W/kg

SAR(1 g) = 0.823 W/kg; SAR(10 g) = 0.241 W/kg

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 1.86 W/kg



RF Exposure Lab

Plot 5

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1119

Communication System: CW; Frequency: 5250 MHz; Duty Cycle: 1:1

Medium: HSL5GHz; Medium parameters used (interpolated): $f = 5250$ MHz; $\sigma = 4.755$ S/m; $\epsilon_r = 34.615$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Test Date: Date: 9/21/2023; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 – SN3662; ConvF(5, 5, 5); Calibrated: 2/10/2023;

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1321; Calibrated: 1/17/2023

Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1065

Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

5250 MHz Head/Verification/Area Scan (61x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (interpolated) = 1.47 W/kg

5250 MHz Head/Verification/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 15.267 V/m; Power Drift = -0.02 dB

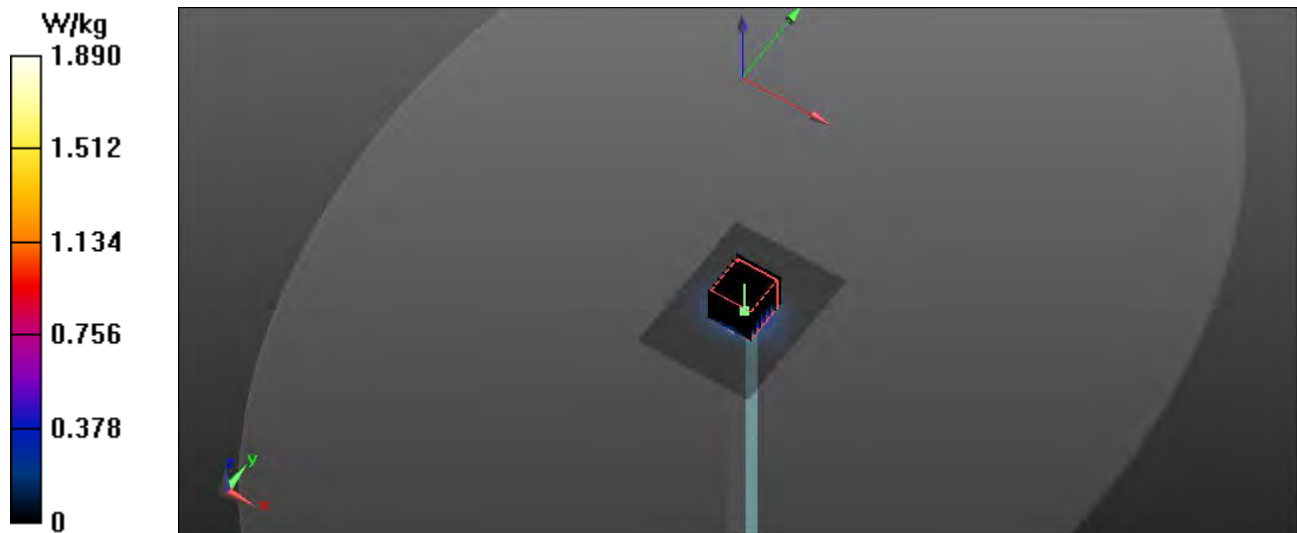
Peak SAR (extrapolated) = 3.22 W/kg

Pin=10 mW

SAR(1 g) = 0.808 W/kg; SAR(10 g) = 0.227 W/kg

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 1.88 W/kg



RF Exposure Lab

Plot 6

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1119

Communication System: CW; Frequency: 5600 MHz; Duty Cycle: 1:1

Medium: HSL5GHz; Medium parameters used: $f = 5600$ MHz; $\sigma = 5.14$ S/m; $\epsilon_r = 34.2$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Test Date: Date: 9/21/2023; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 – SN3662; ConvF(4.7, 4.7, 4.7); Calibrated: 2/10/2023;

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1321; Calibrated: 1/17/2023

Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1065

Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

Head Verification/5600 MHz/Area Scan (61x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

Maximum value of SAR (interpolated) = 1.72 W/kg

Head Verification/5600 MHz/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

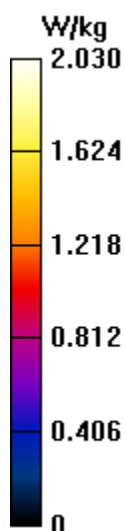
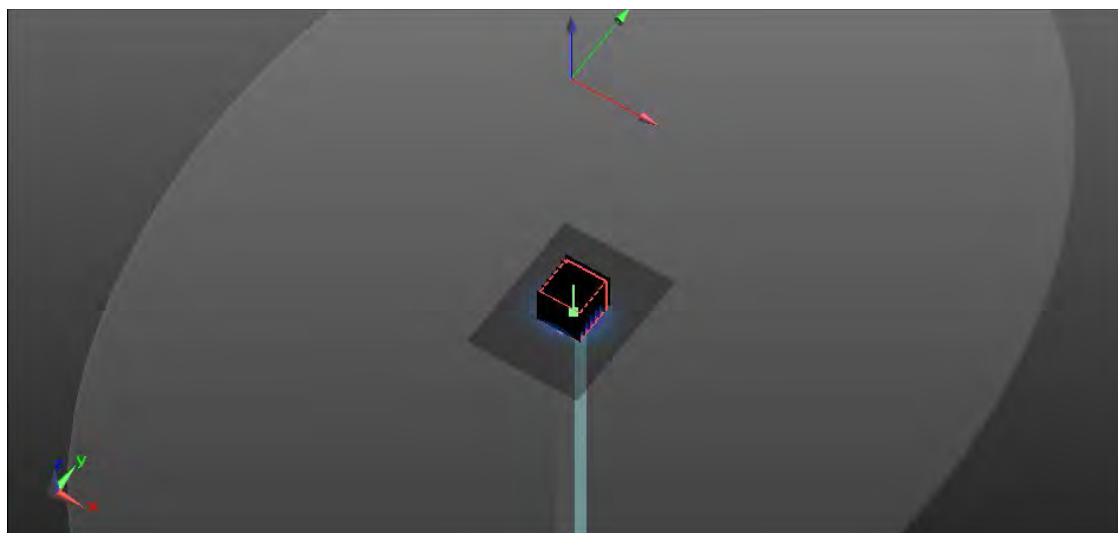
Reference Value = 15.398 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 3.59 W/kg

Pin=10 mW

SAR(1 g) = 0.841 W/kg; SAR(10 g) = 0.243 W/kg

Maximum value of SAR (measured) = 2.01 W/kg



RF Exposure Lab

Plot 7

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN: 1119

Communication System: CW; Frequency: 5750 MHz; Duty Cycle: 1:1

Medium: HSL5GHz; Medium parameters used (interpolated): $f = 5750$ MHz; $\sigma = 5.31$ S/m; $\epsilon_r = 34.03$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Test Date: Date: 9/21/2023; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 – SN3662; ConvF(4.85, 4.85, 4.85); Calibrated: 2/10/2023;

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1321; Calibrated: 1/17/2023

Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1065

Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

5750 MHz Head/Verification/Area Scan (61x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (interpolated) = 1.61 W/kg

5750 MHz Head/Verification/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 14.521 V/m; Power Drift = -0.02 dB

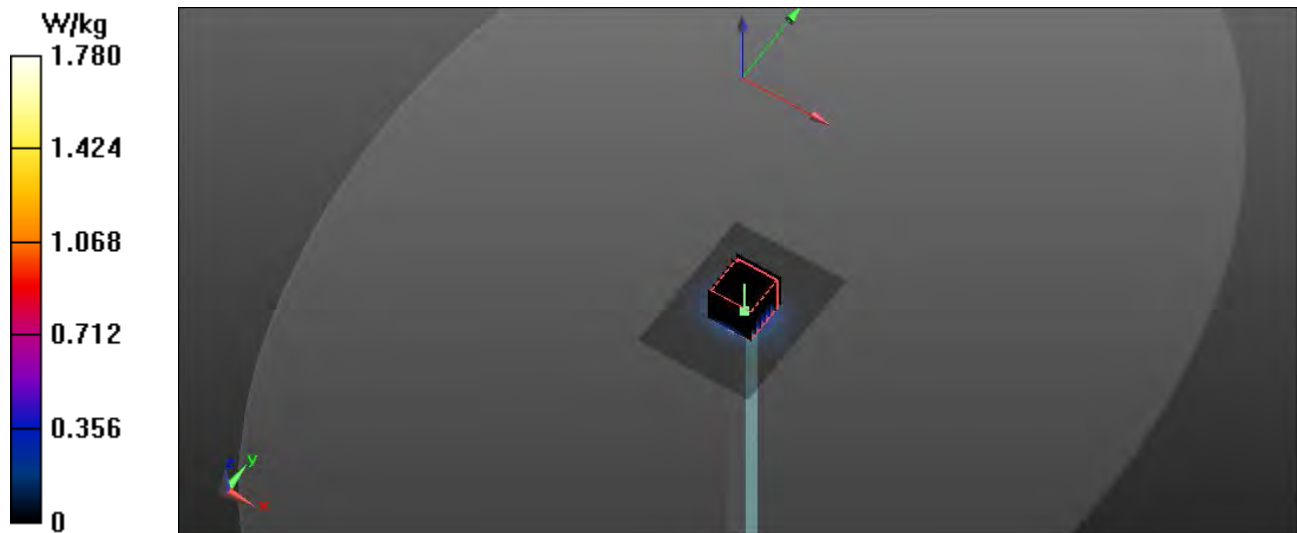
Peak SAR (extrapolated) = 2.34 W/kg

Pin=10 mW

SAR(1 g) = 0.812 W/kg; SAR(10 g) = 0.235 W/kg

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 1.78 W/kg



Appendix B – SAR Test Data Plots

RF Exposure Lab

Plot 1

DUT: SC18V1; Type: Drone Remote; Serial: Eng 1

Communication System: WiFi 802.11ax (OFDM, 10 MHz MCS0); Frequency: 2437 MHz; Duty Cycle: 1:1
Medium: HSL2450; Medium parameters used (interpolated): $f = 2437$ MHz; $\sigma = 1.814$ S/m; $\epsilon_r = 38.223$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

Test Date: Date: 9/25/2023; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 - SN3662; ConvF(7.26, 7.26, 7.26); Calibrated: 2/10/2023
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1321; Calibrated: 1/17/2023
Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1065
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

2450 MHz 0 mm/Front Tx2 6/Area Scan (9x7x1): Measurement grid: dx=10mm, dy=10mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 4.61 W/kg

2450 MHz 0 mm/Front Tx2 6/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

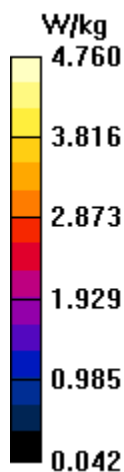
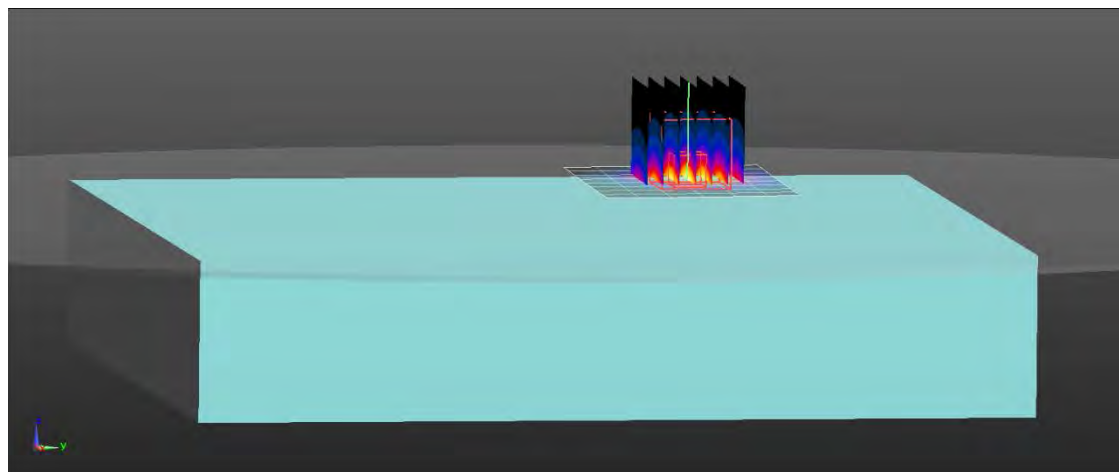
Reference Value = 3.439 V/m; Power Drift = 0.02 dB

Peak SAR (extrapolated) = 6.08 W/kg

SAR(1 g) = 3.35 W/kg; SAR(10 g) = 1.77 W/kg

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 4.76 W/kg



RF Exposure Lab

Plot 2

DUT: SC18V1; Type: Drone Remote; Serial: Eng 1

Communication System: WiFi 802.11n (OFDM, 20 MHz MCS0); Frequency: 5220 MHz; Duty Cycle: 1:1
Medium: HSL 3-6 GHz; Medium parameters used: $f = 5220$ MHz; $\sigma = 4.72$ S/m; $\epsilon_r = 34.65$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

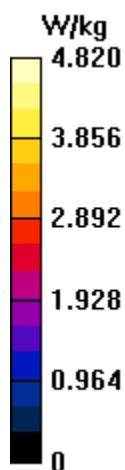
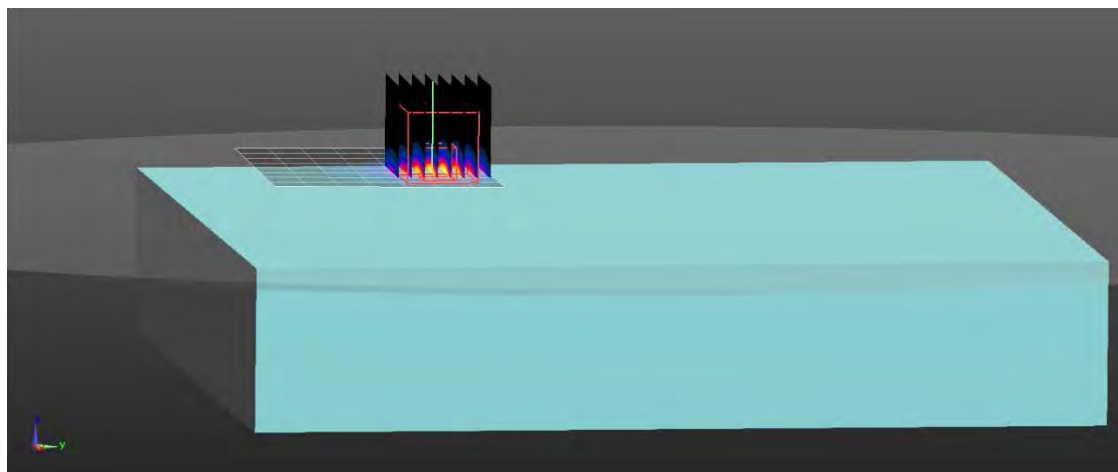
Test Date: Date: 9/22/2023; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 - SN3662; ConvF(5, 5, 5); Calibrated: 2/10/2023
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1321; Calibrated: 1/17/2023
Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1065
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

UNII 1 0 mm 3/Back Tx2 44/Area Scan (9x8x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 4.42 W/kg

UNII 1 0 mm 3/Back Tx2 44/Zoom Scan (8x8x16)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 3.032 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 8.69 W/kg
SAR(1 g) = 2.7 W/kg; SAR(10 g) = 1.01 W/kg
Maximum value of SAR (measured) = 4.82 W/kg



RF Exposure Lab

Plot 3

DUT: SC18V1; Type: Drone Remote; Serial: Eng 1

Communication System: WiFi 802.11ac (OFDM, 80 MHz MCS0); Frequency: 5290 MHz; Duty Cycle: 1:1
Medium: HSL 3-6 GHz; Medium parameters used (interpolated): $f = 5290$ MHz; $\sigma = 4.8$ S/m; $\epsilon_r = 34.555$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

Test Date: Date: 9/21/2023; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 - SN3662; ConvF(5, 5, 5); Calibrated: 2/10/2023
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1321; Calibrated: 1/17/2023
Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1065
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

UNII 2a 0 mm 2/Back Tx0 58/Area Scan (9x8x1): Measurement grid: dx=10mm, dy=10mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 2.73 W/kg

UNII 2a 0 mm 2/Back Tx0 58/Zoom Scan (8x8x16)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

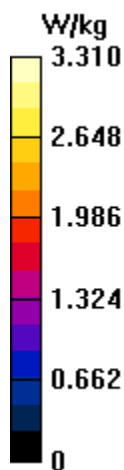
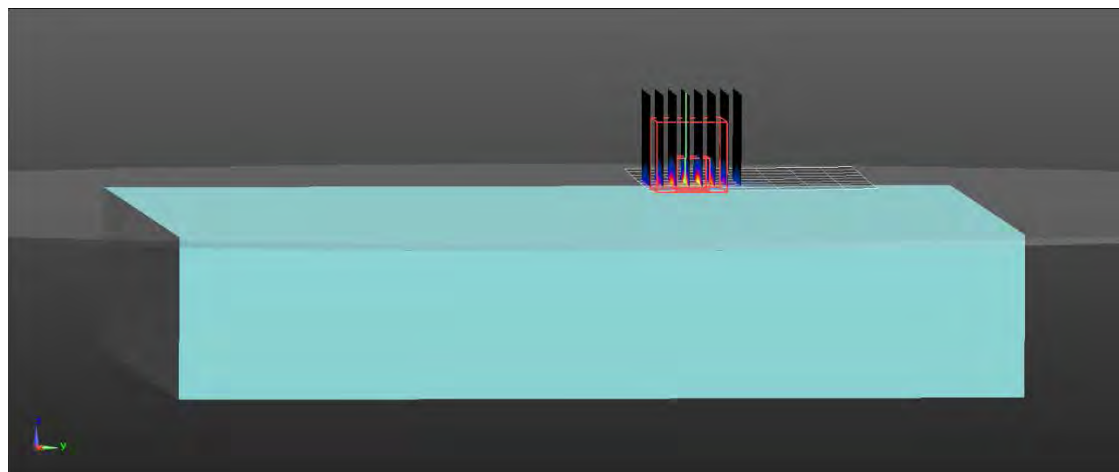
Reference Value = 0.3400 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 6.21 W/kg

SAR(1 g) = 1.78 W/kg; SAR(10 g) = 0.591 W/kg

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 3.31 W/kg



RF Exposure Lab

Plot 4

DUT: SC18V1; Type: Drone Remote; Serial: Eng 1

Communication System: WiFi 802.11ac (OFDM, 80 MHz MCS0); Frequency: 5610 MHz; Duty Cycle: 1:1
Medium: HSL 3-6 GHz; Medium parameters used (interpolated): $f = 5610$ MHz; $\sigma = 5.14$ S/m; $\epsilon_r = 34.335$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

Test Date: Date: 9/20/2023; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 - SN3662; ConvF(4.7, 4.7, 4.7); Calibrated: 2/10/2023
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1321; Calibrated: 1/17/2023
Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1065
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

UNII 2c 0 mm/Back Tx0 122/Area Scan (9x8x1): Measurement grid: dx=10mm, dy=10mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 4.51 W/kg

UNII 2c 0 mm/Back Tx0 122/Zoom Scan (8x8x16)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

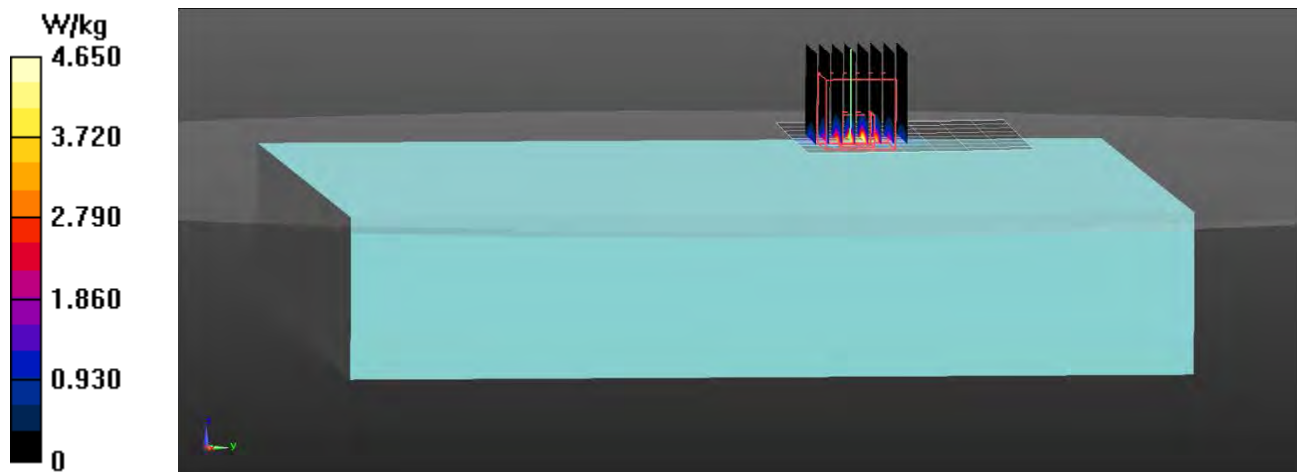
Reference Value = 0.2760 V/m; Power Drift = -0.06 dB

Peak SAR (extrapolated) = 9.38 W/kg

SAR(1 g) = 2.43 W/kg; SAR(10 g) = 0.789 W/kg

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 4.65 W/kg



RF Exposure Lab

Plot 5

DUT: SC18V1; Type: Drone Remote; Serial: Eng 1

Communication System: WiFi 802.11a (OFDM, 6 Mbps); Frequency: 5785 MHz; Duty Cycle: 1:1
Medium: HSL 3-6 GHz; Medium parameters used (interpolated): $f = 5785$ MHz; $\sigma = 5.335$ S/m; $\epsilon_r = 34.14$; $\rho = 1000$ kg/m³
Phantom section: Flat Section

Test Date: Date: 9/19/2023; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 - SN3662; ConvF(4.85, 4.85, 4.85); Calibrated: 2/10/2023
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn1321; Calibrated: 1/17/2023
Phantom: ELI v4.0; Type: QDOVA001BB; Serial: 1065
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

UNII 3 0 mm 2/Back Tx0 157/Area Scan (9x7x1): Measurement grid: dx=10mm, dy=10mm

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 8.05 W/kg

UNII 3 0 mm 2/Back Tx0 157/Zoom Scan (9x9x16)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

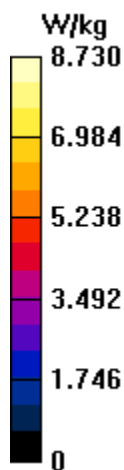
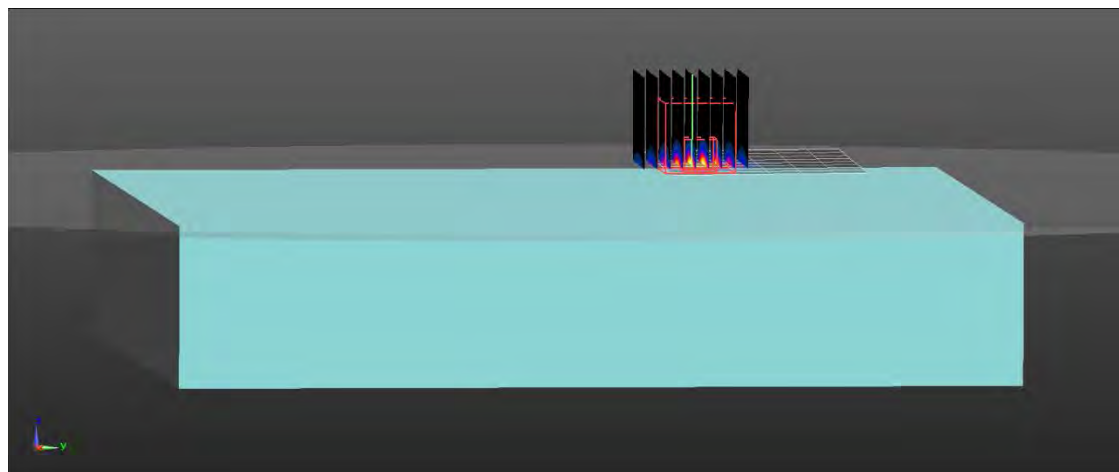
Reference Value = 1.478 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 17.8 W/kg

SAR(1 g) = 4.61 W/kg; SAR(10 g) = 1.57 W/kg

[Info: Interpolated medium parameters used for SAR evaluation.](#)

Maximum value of SAR (measured) = 8.73 W/kg



Appendix C – SAR Test Setup Photos

Photo Removed

Test Position Back 0 mm Gap

Note: The cable is removed for testing.

Photo Removed

Test Position Back (Front View) 0 mm Gap

Photo Removed

Test Position Front 0 mm Gap

Note: The cable is removed for testing.

Photo Removed

Test Position Left 0 mm Gap

Note: The cable is removed for testing.

Photo Removed

Test Position Right 0 mm Gap

Note: The cable is removed for testing.

Photo Removed

Test Position Top 47 mm Gap

Note: The cable is removed for testing.

Photo Removed

Test Position Bottom 0 mm Gap

Photo Removed

Front of Device

Photo Removed

Back of Device

Appendix D – Probe Calibration Data Sheets



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

RF Exposure Lab

Certificate No

EX-3662_Feb23

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:3662**

Calibration procedure(s) **QA CAL-01.v10, QA CAL-12.v10, QA CAL-14.v7, QA CAL-23.v6,
QA CAL-25.v8
Calibration procedure for dosimetric E-field probes**

Calibration date **February 10, 2023**

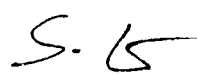
This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	04-Apr-22 (No. 217-03525/03524)	Apr-23
Power sensor NRP-Z91	SN: 103244	04-Apr-22 (No. 217-03524)	Apr-23
OCP DAK-3.5 (weighted)	SN: 1249	20-Oct-22 (OCP-DAK3.5-1249_Oct22)	Oct-23
OCP DAK-12	SN: 1016	20-Oct-22 (OCP-DAK12-1016_Oct22)	Oct-23
Reference 20 dB Attenuator	SN: CC2552 (20x)	04-Apr-22 (No. 217-03527)	Apr-23
DAE4	SN: 660	10-Oct-22 (No. DAE4-660_Oct22)	Oct-23
Reference Probe ES3DV2	SN: 3013	06-Jan-23 (No. ES3-3013_Jan23)	Jan-24

Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-22)	In house check: Jun-24
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-22)	In house check: Jun-24
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-22)	In house check: Jun-24
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-22)	In house check: Jun-24
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-22)	In house check: Oct-24

	Name	Function	Signature
Calibrated by	Michael Weber	Laboratory Technician	
Approved by	Sven Kühn	Technical Manager	

Issued: February 10, 2023

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



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
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,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., $\vartheta = 0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

- IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices – Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}**: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E^2 -field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z}** = NORM_{x,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.
- DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal. DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,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 $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,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 NORM_x (no uncertainty required).

Parameters of Probe: EX3DV4 - SN:3662

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k = 2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.41	0.49	0.48	$\pm 10.1\%$
DCP (mV) ^B	101.0	102.5	98.0	$\pm 4.7\%$

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B $\text{dB}\sqrt{\mu\text{V}}$	C	D dB	VR mV	Max dev.	Max Unc ^E k = 2
0	CW	X	0.00	0.00	1.00	0.00	150.8	$\pm 3.0\%$	$\pm 4.7\%$
		Y	0.00	0.00	1.00		161.2		
		Z	0.00	0.00	1.00		147.6		

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 Page 5).

^B Linearization parameter uncertainty for maximum specified field strength.

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

Parameters of Probe: EX3DV4 - SN:3662**Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle	-96.9°
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

Note: Measurement distance from surface can be increased to 3–4 mm for an *Area Scan* job.

Parameters of Probe: EX3DV4 - SN:3662**Calibration Parameter Determined in Head Tissue Simulating Media**

f (MHz)^C	Relative Permittivity^F	Conductivity^F (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha^G	Depth^G (mm)	Unc (k = 2)
150	52.3	0.76	11.68	11.68	11.68	0.00	1.00	±13.3%
220	49.0	0.81	11.50	11.50	11.50	0.00	1.00	±13.3%
300	45.3	0.87	11.22	11.22	11.22	0.09	1.00	±13.3%
450	43.5	0.87	10.79	10.79	10.79	0.16	1.30	±13.3%
600	42.7	0.88	10.35	10.35	10.35	0.10	1.25	±13.3%
750	41.9	0.89	9.28	9.28	9.28	0.53	0.80	±12.0%
900	41.5	0.97	8.80	8.80	8.80	0.51	0.80	±12.0%
1450	40.5	1.20	8.26	8.26	8.26	0.33	0.80	±12.0%
1640	40.2	1.31	8.10	8.10	8.10	0.37	0.86	±12.0%
1750	40.1	1.37	7.91	7.91	7.91	0.31	0.86	±12.0%
1900	40.0	1.40	7.67	7.67	7.67	0.34	0.86	±12.0%
2300	39.5	1.67	7.60	7.60	7.60	0.33	0.90	±12.0%
2450	39.2	1.80	7.26	7.26	7.26	0.44	0.90	±12.0%
2600	39.0	1.96	7.11	7.11	7.11	0.45	0.90	±12.0%
5250	35.9	4.71	5.00	5.00	5.00	0.40	1.80	±14.0%
5600	35.5	5.07	4.70	4.70	4.70	0.40	1.80	±14.0%
5750	35.4	5.22	4.85	4.85	4.85	0.40	1.80	±14.0%

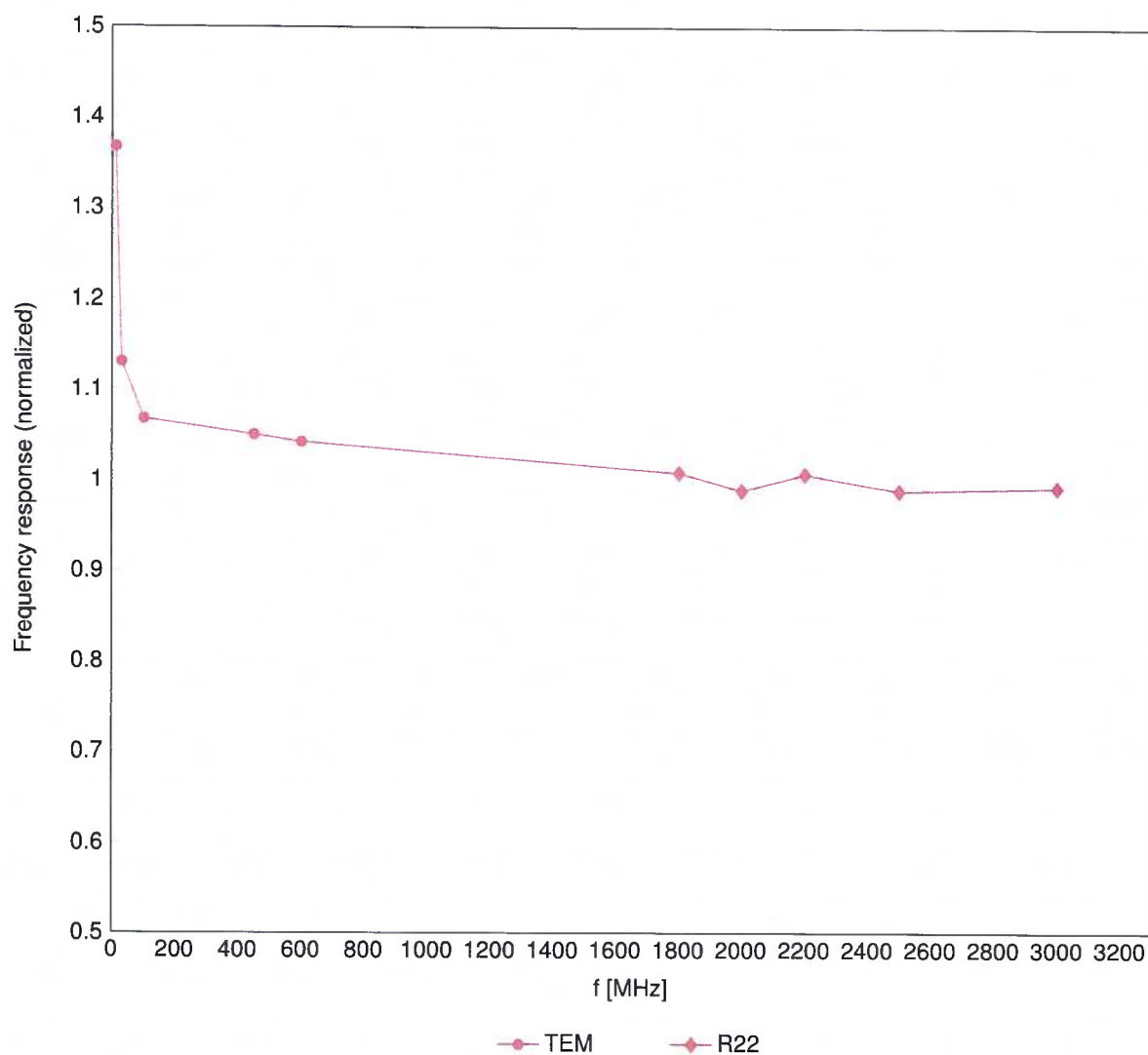
^C Frequency validity above 300 MHz of ±100 MHz only applies for DASy v4.4 and higher (see Page 2), else it is restricted to ±50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ±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 The probes are calibrated using tissue simulating liquids (TSL) that deviate for ϵ and σ by less than ±5% from the target values (typically better than ±3%) and are valid for TSL with deviations of up to ±10%. If TSL with deviations from the target of less than ±5% are used, the calibration uncertainties are 11.1% for 0.7 - 3 GHz and 13.1% for 3 - 6 GHz.

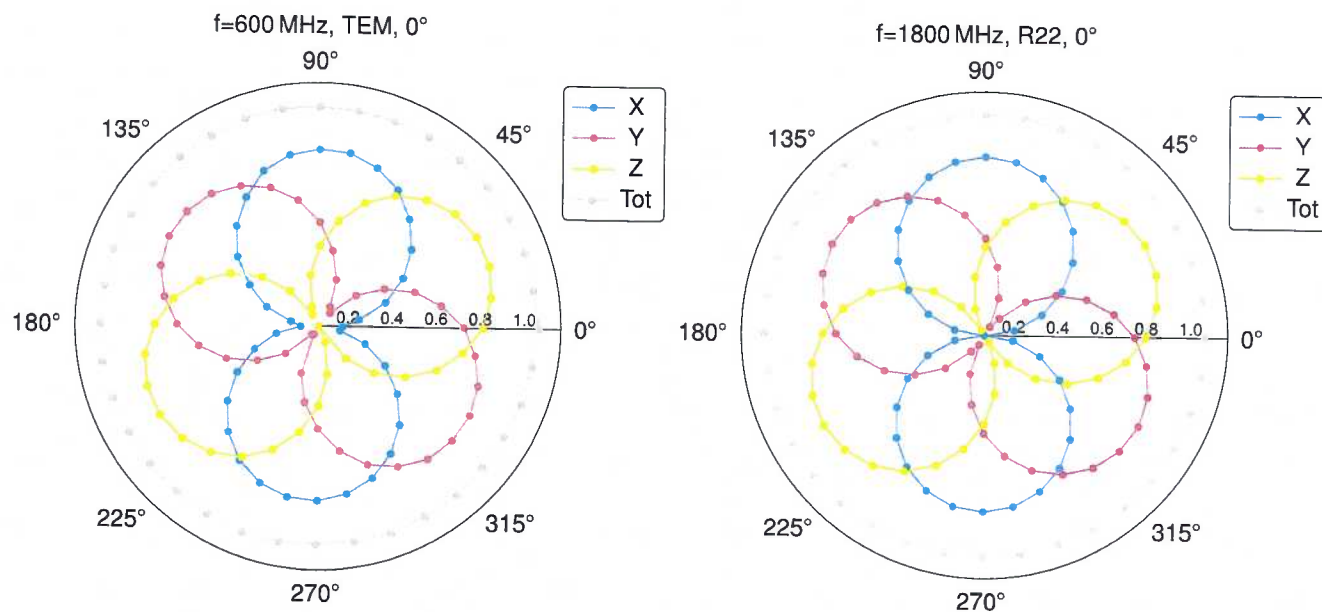
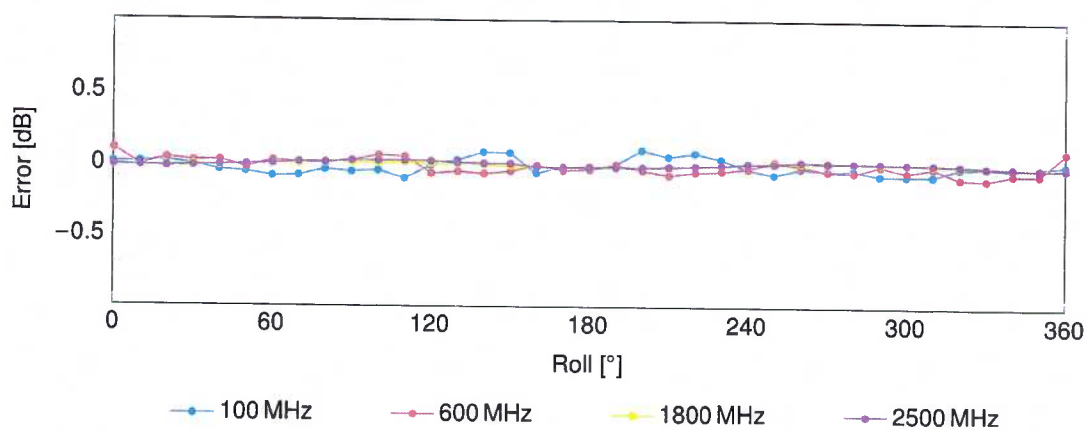
^G Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ±1% for frequencies below 3 GHz and below ±2% for frequencies between 3–6 GHz at any distance larger than half the probe tip diameter from the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

Frequency Response of E-Field

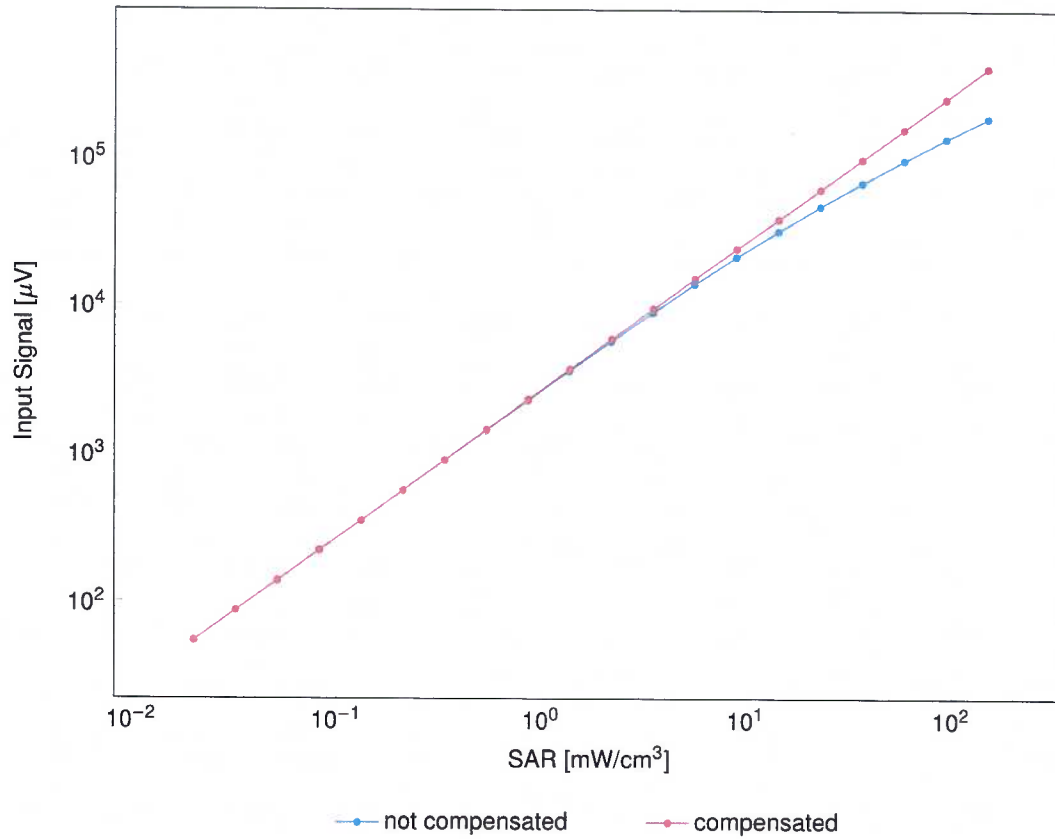
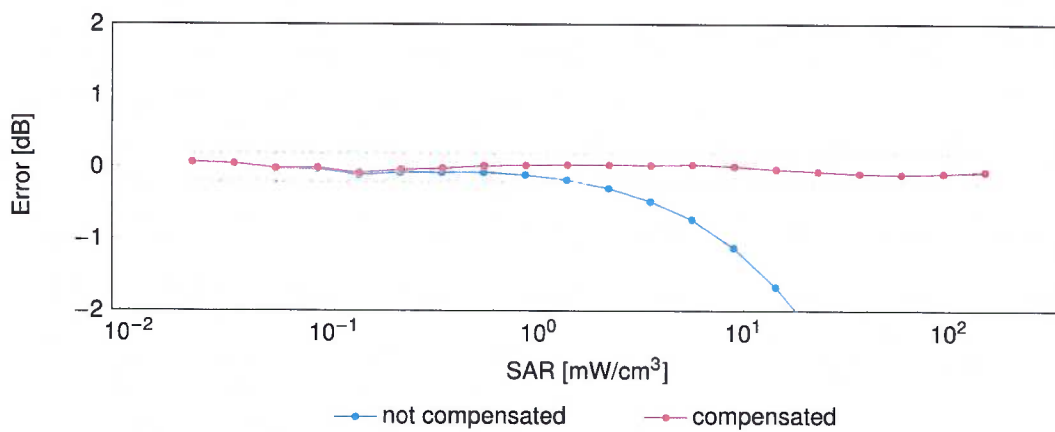
(TEM-Cell:ifi110 EXX, Waveguide:R22)



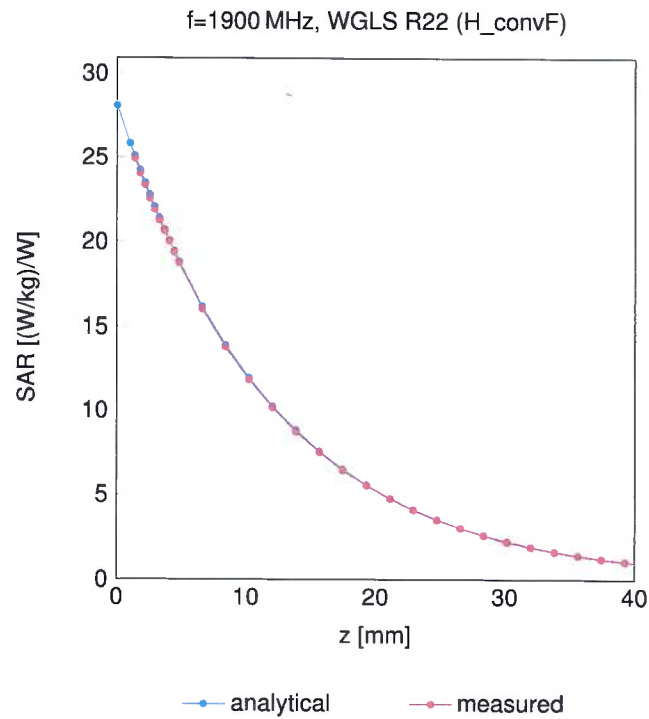
Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

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

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

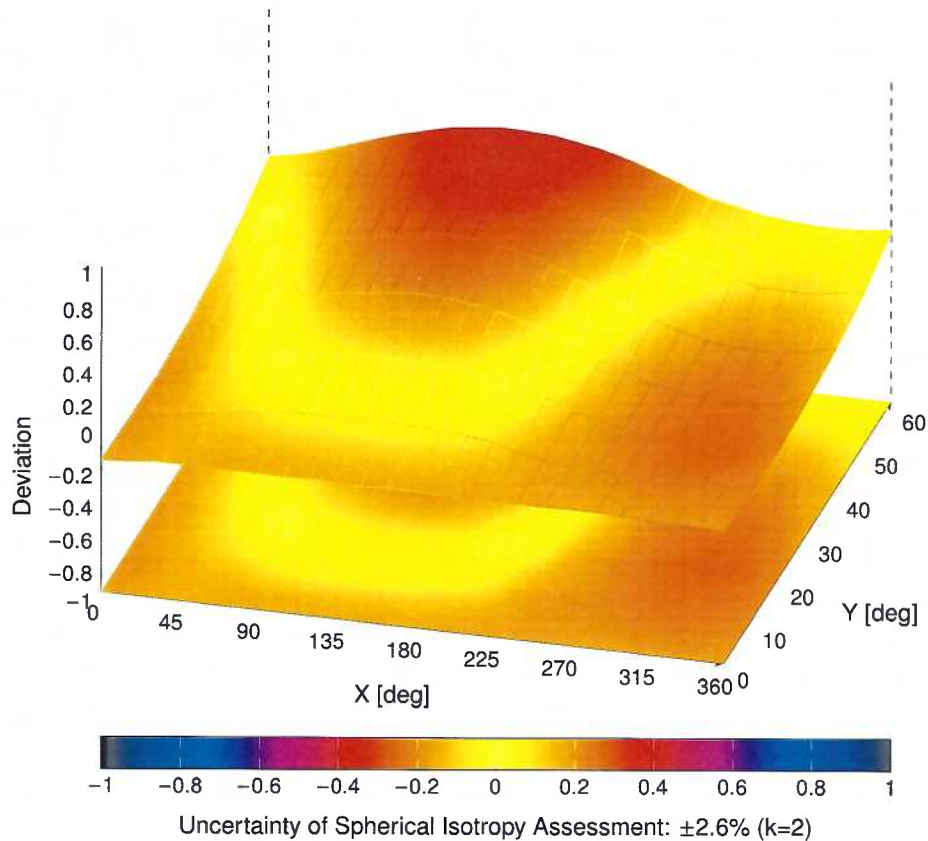
Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell, $f_{\text{eval}} = 1900 \text{ MHz}$)Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, θ), $f = 900\text{ MHz}$



Appendix E – Dipole Calibration Data Sheets

gm

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



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

Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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

Client **RF Exposure Lab**

Certificate No: **D2450V2-881_Jun21**

CALIBRATION CERTIFICATE

Object **D2450V2 - SN:881**

Calibration procedure(s) **QA CAL-05 v11**
Calibration Procedure for SAR Validation Sources between 0.7-3 GHz

Calibration date: **June 03, 2021**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	09-Apr-21 (No. 217-03291/03292)	Apr-22
Power sensor NRP-Z91	SN: 103244	09-Apr-21 (No. 217-03291)	Apr-22
Power sensor NRP-Z91	SN: 103245	09-Apr-21 (No. 217-03292)	Apr-22
Reference 20 dB Attenuator	SN: BH9394 (20k)	09-Apr-21 (No. 217-03343)	Apr-22
Type-N mismatch combination	SN: 310982 / 06327	09-Apr-21 (No. 217-03344)	Apr-22
Reference Probe EX3DV4	SN: 7349	28-Dec-20 (No. EX3-7349_Dec20)	Dec-21
DAE4	SN: 601	02-Nov-20 (No. DAE4-601_Nov20)	Nov-21
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-20)	In house check: Oct-22
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-21

	Name	Function	Signature
Calibrated by:	Jeffrey Katzman	Laboratory Technician	<i>[Signature]</i>
Approved by:	Katja Pokovic	Technical Manager	<i>[Signature]</i>

Issued: June 8, 2021

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



Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions:** Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:** The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss:** These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay:** One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured:** SAR measured at the stated antenna input power.
- SAR normalized:** SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:** The measured TSL parameters are used to calculate the nominal SAR result.

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

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz $\pm$ 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	37.7 $\pm$ 6 %	1.87 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	13.9 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	54.1 W/kg $\pm$ 17.0 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.34 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	25.0 W/kg $\pm$ 16.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	54.3 Ω + 4.3 j Ω
Return Loss	- 24.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.156 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
-----------------	-------

Extended Calibration

Usage of SAR dipoles calibrated less than 3 years ago but more than 1 year ago were confirmed in maintaining return loss (<-20 dB, within 20% of prior calibration) and impedance (within 5 ohm from prior calibration) requirements per extended calibrations in KDB Publication 865664 D01 v01r04.

D2450V2 SN: 829 - Head						
Date of Measurement	Return Loss (dB)	$\Delta\%$	Impedance Real (Ω)	$\Delta\Omega$	Impedance Imaginary (j Ω)	$\Delta\Omega$
6/3/2021	-24.7		54.3		4.3	
6/3/2022	-25.3	2.4	55.2	0.9	4.1	-0.2
6/6/2023	-26.2	6.1	53.1	-1.2	4.2	-0.1

DASY5 Validation Report for Head TSL

Date: 03.06.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:881

Communication System: UID 0 - CW; Frequency: 2450 MHz

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.87$ S/m; $\epsilon_r = 37.7$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(7.96, 7.96, 7.96) @ 2450 MHz; Calibrated: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

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 = 119.0 V/m; Power Drift = 0.05 dB

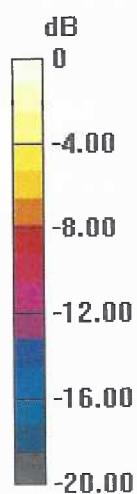
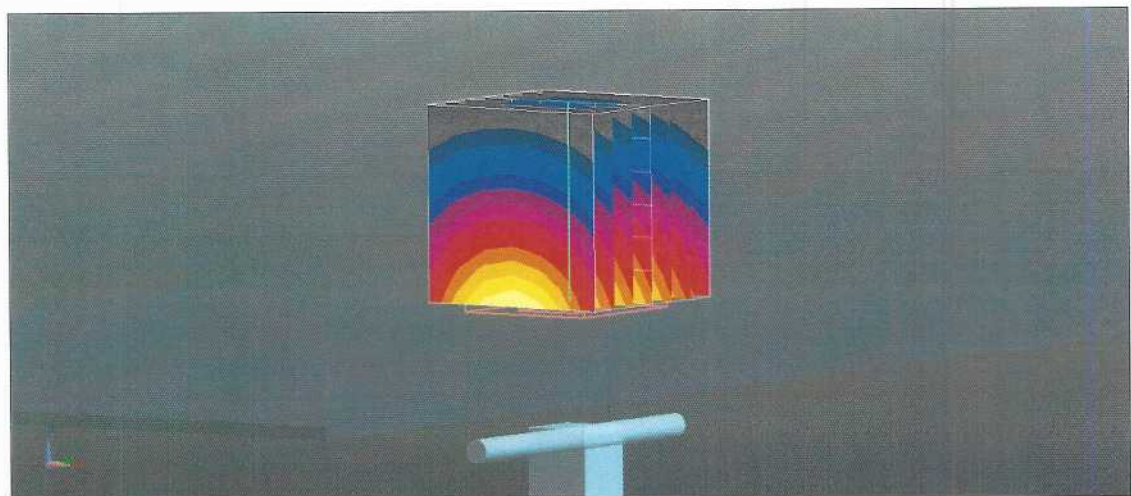
Peak SAR (extrapolated) = 28.0 W/kg

SAR(1 g) = 13.9 W/kg; SAR(10 g) = 6.34 W/kg

Smallest distance from peaks to all points 3 dB below = 9 mm

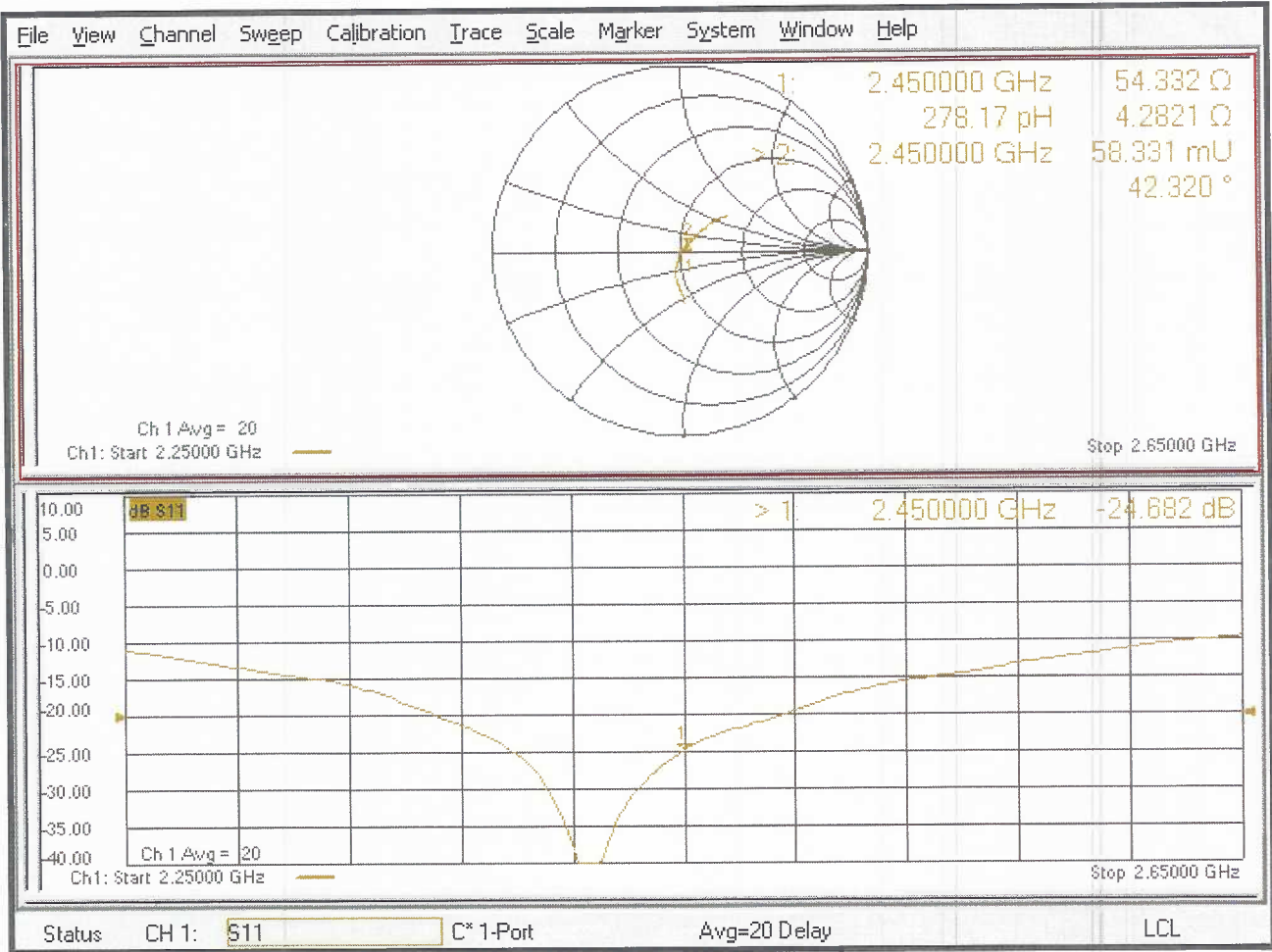
Ratio of SAR at M2 to SAR at M1 = 49.5%

Maximum value of SAR (measured) = 23.1 W/kg



0 dB = 23.1 W/kg = 13.64 dBW/kg

Impedance Measurement Plot for Head TSL





Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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

Client **RF Exposure Lab**

Certificate No: **D5GHzV2-1119_Jun21**

CALIBRATION CERTIFICATE

Object **D5GHzV2 - SN:1119**

Calibration procedure(s) **QA CAL-22.v6**
Calibration Procedure for SAR Validation Sources between 3-10 GHz

Calibration date: **June 08, 2021**

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	09-Apr-21 (No. 217-03291/03292)	Apr-22
Power sensor NRP-Z91	SN: 103244	09-Apr-21 (No. 217-03291)	Apr-22
Power sensor NRP-Z91	SN: 103245	09-Apr-21 (No. 217-03292)	Apr-22
Reference 20 dB Attenuator	SN: BH9394 (20k)	09-Apr-21 (No. 217-03343)	Apr-22
Type-N mismatch combination	SN: 310982 / 06327	09-Apr-21 (No. 217-03344)	Apr-22
Reference Probe EX3DV4	SN: 3503	30-Dec-20 (No. EX3-3503_Dec20)	Dec-21
DAE4	SN: 601	02-Nov-20 (No. DAE4-601_Nov20)	Nov-21
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-20)	In house check: Oct-22
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-21

Calibrated by: **Michael Weber** **Laboratory Technician**

Signature

Approved by: **Katja Pokovic** **Technical Manager**

Issued: June 8, 2021

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



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:

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

Additional Documentation:

- DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- Measurement Conditions:** Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- Antenna Parameters with TSL:** The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- Feed Point Impedance and Return Loss:** These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- Electrical Delay:** One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- SAR measured:** SAR measured at the stated antenna input power.
- SAR normalized:** SAR as measured, normalized to an input power of 1 W at the antenna connector.
- SAR for nominal TSL parameters:** The measured TSL parameters are used to calculate the nominal SAR result.

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

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom V5.0	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4.0 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	5250 MHz $\pm$ 1 MHz 5600 MHz $\pm$ 1 MHz 5750 MHz $\pm$ 1 MHz	

Head TSL parameters at 5250 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.9	4.71 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	34.6 $\pm$ 6 %	4.59 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	---	---

SAR result with Head TSL at 5250 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.02 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	79.5 W/kg $\pm$ 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.32 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	22.9 W/kg $\pm$ 19.5 % (k=2)

Head TSL parameters at 5600 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.5	5.07 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	34.1 $\pm$ 6 %	4.95 mho/m $\pm$ 6 %
Head TSL temperature change during test	< 0.5 °C	---	---

SAR result with Head TSL at 5600 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.40 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	83.2 W/kg $\pm$ 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.41 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.8 W/kg $\pm$ 19.5 % (k=2)

Head TSL parameters at 5750 MHz

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	35.4	5.22 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	33.9 ± 6 %	5.10 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL at 5750 MHz

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	8.13 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	80.5 W/kg ± 19.9 % (k=2)

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.33 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	23.0 W/kg ± 19.5 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL at 5250 MHz

Impedance, transformed to feed point	51.9 Ω - 7.3 j Ω
Return Loss	- 22.6 dB

Antenna Parameters with Head TSL at 5600 MHz

Impedance, transformed to feed point	56.8 Ω - 1.3 j Ω
Return Loss	- 23.8 dB

Antenna Parameters with Head TSL at 5750 MHz

Impedance, transformed to feed point	56.9 Ω - 1.8 j Ω
Return Loss	- 23.5 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.206 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
-----------------	-------

Extended Calibration

Usage of SAR dipoles calibrated less than 3 years ago but more than 1 year ago were confirmed in maintaining return loss (<-20 dB, within 20% of prior calibration) and impedance (within 5 ohm from prior calibration) requirements per extended calibrations in KDB Publication 865664 D01 v01r04.

D5GHzV2 SN: 1085 - Head							
Date of Measurement	Frequency	Return Loss (dB)	$\Delta\%$	Impedance Real (Ω)	$\Delta\Omega$	Impedance Imaginary (j Ω)	$\Delta\Omega$
6/8/2021	5250 MHz	-22.6		51.9		-7.3	
6/5/2022		-22.9	1.3	52.6	0.7	-7.7	-0.4
6/8/2023		-22.7	0.4	52.9	1.0	-7.5	-0.2
6/8/2021	5600 MHz	-23.8		56.8		-1.3	
6/5/2022		-24.6	3.4	55.2	-1.6	-1.6	-0.3
6/8/2023		-24.2	1.7	56.9	0.1	-1.5	-0.2
6/8/2021	5750 MHz	-23.5		56.9		-1.8	
6/5/2022		-24.8	5.5	56.2	-0.7	-2.5	-0.7
6/8/2023		-22.8	-3.0	57.3	0.4	-2.2	-0.4

DASY5 Validation Report for Head TSL

Date: 08.06.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole D5GHzV2; Type: D5GHzV2; Serial: D5GHzV2 - SN:1119

Communication System: UID 0 - CW; Frequency: 5250 MHz, Frequency: 5600 MHz, Frequency: 5750 MHz

Medium parameters used: $f = 5250$ MHz; $\sigma = 4.59$ S/m; $\epsilon_r = 34.6$; $\rho = 1000$ kg/m³,

Medium parameters used: $f = 5600$ MHz; $\sigma = 4.95$ S/m; $\epsilon_r = 34.1$; $\rho = 1000$ kg/m³,

Medium parameters used: $f = 5750$ MHz; $\sigma = 5.1$ S/m; $\epsilon_r = 33.9$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

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

DASY52 Configuration:

- Probe: EX3DV4 - SN3503; ConvF(5.5, 5.5, 5.5) @ 5250 MHz, ConvF(5.1, 5.1, 5.1) @ 5600 MHz, ConvF(5.08, 5.08, 5.08) @ 5750 MHz; Calibrated: 30.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5250 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 76.83 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 27.1 W/kg

SAR(1 g) = 8.02 W/kg; SAR(10 g) = 2.32 W/kg

Smallest distance from peaks to all points 3 dB below = 7.2 mm

Ratio of SAR at M2 to SAR at M1 = 70.7%

Maximum value of SAR (measured) = 17.7 W/kg

Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5600 MHz/Zoom Scan, dist=1.4mm (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 76.09 V/m; Power Drift = 0.05 dB

Peak SAR (extrapolated) = 30.6 W/kg

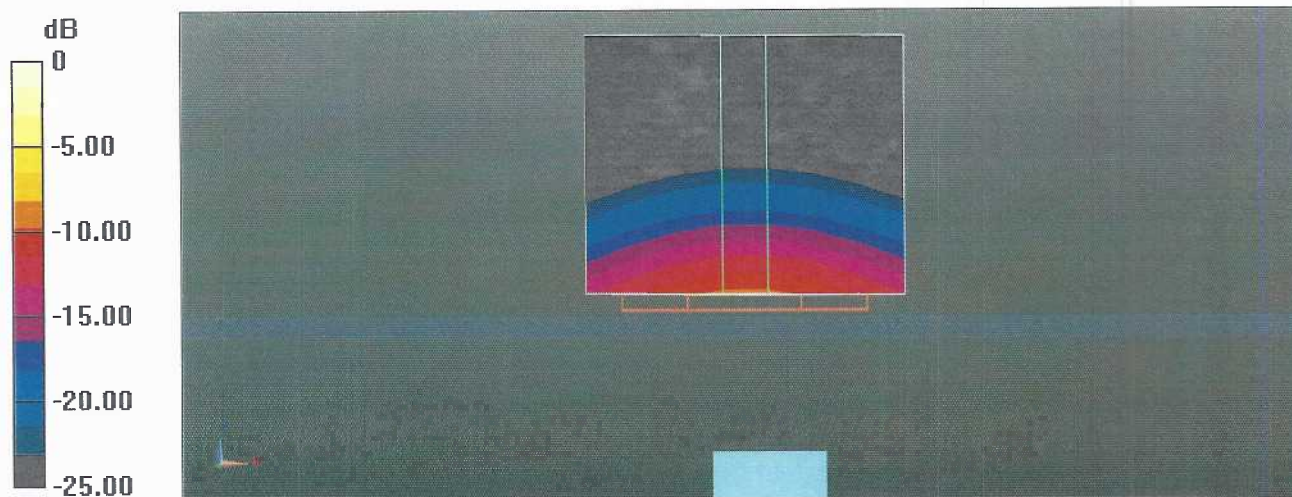
SAR(1 g) = 8.4 W/kg; SAR(10 g) = 2.41 W/kg

Smallest distance from peaks to all points 3 dB below = 7.5 mm

Ratio of SAR at M2 to SAR at M1 = 68.4%

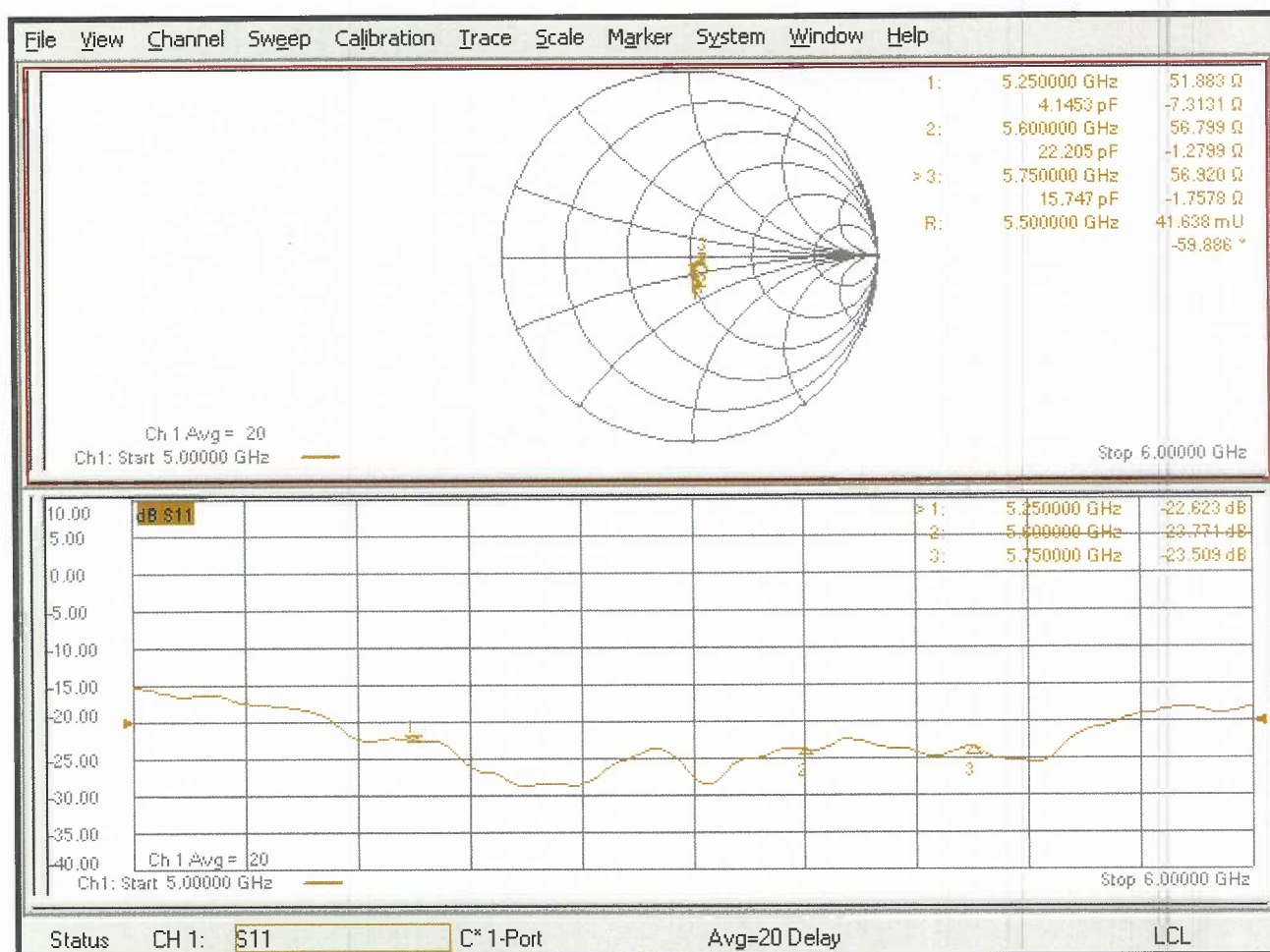
Maximum value of SAR (measured) = 19.1 W/kg

**Dipole Calibration for Head Tissue/Pin=100mW, dist=10mm, f=5750 MHz/Zoom Scan,
dist=1.4mm (8x8x7)/Cube 0:** Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 75.64 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 31.8 W/kg
SAR(1 g) = 8.13 W/kg; SAR(10 g) = 2.33 W/kg
Smallest distance from peaks to all points 3 dB below = 7.4 mm
Ratio of SAR at M2 to SAR at M1 = 65.4%
Maximum value of SAR (measured) = 19.3 W/kg



0 dB = 19.3 W/kg = 12.86 dBW/kg

Impedance Measurement Plot for Head TSL



Appendix F – DAE Calibration Data Sheets



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 **RF Exposure Lab**

Certificate No: **DAE4-1321_Jan23**

CALIBRATION CERTIFICATE

Object **DAE4 - SD 000 D04 BM - SN: 1321**

Calibration procedure(s) **QA CAL-06.v30**
Calibration procedure for the data acquisition electronics (DAE)

Calibration date: **January 17, 2023**

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	29-Aug-22 (No:34389)	Aug-23
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	24-Jan-22 (in house check)	In house check: Jan-23
Calibrator Box V2.1	SE UMS 006 AA 1002	24-Jan-22 (in house check)	In house check: Jan-23

Calibrated by: **Dominique Steffen** **Laboratory Technician**

Signature

Approved by: **Sven Kühn** **Technical Manager**

Issued: January 17, 2023

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



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

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 = 6.1 μ V, 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	405.044 $\pm$ 0.02% (k=2)	404.871 $\pm$ 0.02% (k=2)	405.277 $\pm$ 0.02% (k=2)
Low Range	3.96891 $\pm$ 1.50% (k=2)	3.99639 $\pm$ 1.50% (k=2)	4.00664 $\pm$ 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	0.0 ° $\pm$ 1 °
---	-----------------

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range	Reading (μV)	Difference (μV)	Error (%)
Channel X + Input	199998.20	2.09	0.00
Channel X + Input	20005.06	2.37	0.01
Channel X - Input	-19997.24	4.02	-0.02
Channel Y + Input	199998.08	2.12	0.00
Channel Y + Input	20002.44	-0.24	-0.00
Channel Y - Input	-20003.80	-2.58	0.01
Channel Z + Input	199999.04	3.10	0.00
Channel Z + Input	20000.12	-2.47	-0.01
Channel Z - Input	-20002.86	-1.60	0.01

Low Range	Reading (μV)	Difference (μV)	Error (%)
Channel X + Input	2003.05	1.18	0.06
Channel X + Input	202.06	-0.02	-0.01
Channel X - Input	-197.92	-0.24	0.12
Channel Y + Input	2003.23	1.47	0.07
Channel Y + Input	202.30	0.42	0.21
Channel Y - Input	-197.83	0.02	-0.01
Channel Z + Input	2003.37	1.85	0.09
Channel Z + Input	201.58	-0.19	-0.09
Channel Z - Input	-199.71	-1.79	0.90

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	16.84	15.39
	- 200	-13.92	-15.69
Channel Y	200	1.94	1.75
	- 200	-3.21	-3.08
Channel Z	200	-13.89	-13.91
	- 200	12.19	12.24

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	-	1.54	-4.23
Channel Y	200	8.66	-	2.50
Channel Z	200	10.29	6.58	-

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	15476	15505
Channel Y	15581	15764
Channel Z	16351	15451

5. Input Offset Measurement

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

Input 10M Ω

	Average (μ V)	min. Offset (μ V)	max. Offset (μ V)	Std. Deviation (μ V)
Channel X	0.87	-0.22	2.33	0.50
Channel Y	-0.35	-1.87	1.65	0.61
Channel Z	-0.83	-2.49	0.72	0.58

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

Appendix G – Phantom Calibration Data Sheets

Certificate of Conformity / First Article Inspection

Item	Oval Flat Phantom ELI 4.0
Type No	QD OVA 001 B
Series No	1003 and higher
Manufacturer	Untersee Composites Knebelstrasse 8 CH-8268 Mannenbach, Switzerland

Tests

Complete tests were made on the prototype units QD OVA 001 AA 1001, QD OVA 001 AB 1002, pre-series units QD OVA 001 BA 1003-1005 as well as on the series units QD OVA 001 BB, 1006 ff.

Test	Requirement	Details	Units tested
Material thickness	Compliant with the standard requirements	Bottom plate: 2.0mm +/- 0.2mm	all
Material parameters	Dielectric parameters for required frequencies	< 6 GHz: Rel. permittivity = 4 +/-1, Loss tangent ≤ 0.05	Material sample
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.	DGBE based simulating liquids. Observe Technical Note for material compatibility.	Equivalent phantoms, Material sample
Shape	Thickness of bottom material, Internal dimensions, Sagging compatible with standards from minimum frequency	Bottom elliptical 600 x 400 mm Depth 190 mm, Shape is within tolerance for filling height up to 155 mm, Eventual sagging is reduced or eliminated by support via DUT	Prototypes, Sample testing

Standards

- [1] CENELEC EN 50361-2001, « Basic standard for the measurement of the Specific Absorption Rate related to human exposure to electromagnetic fields from mobile phones (300 MHz – 3 GHz) », July 2001
- [2] IEEE 1528-2003, "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques, December 2003
- [3] IEC 62209 – 1, "Specific Absorption Rate (SAR) in the frequency range of 300 MHz to 3 GHz – Measurement Procedure, Part 1: Hand-held mobile wireless communication devices", February 2005
- [4] IEC 62209 – 2, Draft, "Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices – Human models, Instrumentation and Procedures – Part 2: Procedure to determine the Specific Absorption Rate (SAR) in the head and body for 30 MHz to 6 GHz Handheld and Body-Mounted Devices used in close proximity to the Body.", February 2005
- [5] OET Bulletin 65, Supplement C, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", Edition January 2001

Based on the tests above, we certify that this item is in compliance with the standards [1] to [5] if operated according to the specific requirements and considering the thickness. The dimensions are fully compliant with [4] from 30 MHz to 6 GHz. For the other standards, the minimum lower frequency limit is limited due to the dimensional requirements ([1]: 450 MHz, [2]: 300 MHz, [3]: 800 MHz, [5]: 375 MHz) and possibly further by the dimensions of the DUT.

s p e a g

Date 28.4.2008

Signature / Stamp

Schmid & Partner Engineering AG
 Zeughausstrasse 43, 8004 Zurich, Switzerland
 Phone +41 44 245 9700, Fax +41 44 245 9779
 info@speag.com; http://www.speag.com

Appendix H – Validation Summary

Per FCC KDB 865664 D02v01, SAR system validation status should be documented to confirm measurement accuracy. The SAR systems (including SAR probes, system components and software versions) used for this device were validated against its performance specifications prior to the SAR measurements. Reference dipoles were used with the required tissue equivalent media for system validation according to the procedures outlined in FCC KDB 865664 D01 v01 and IEEE 1528-2013. Since SAR probe calibrations are frequency dependent, each probe calibration point was validated at a frequency within the valid frequency range of the probe calibration point using the system that normally operates with the probe for routine SAR measurements and according to the required tissue equivalent media.

A tabulated summary of the system validation status including the validation date(s), measurement frequencies, SAR probes and tissue dielectric parameters has been included.

Table H-1
SAR System Validation Summary

SAR System #	Freq. (MHz)	Date	Probe S/N	Probe Type	Probe Cal. Point		Cond. (σ)	Perm. (ε _r)	CW Validation			Modulation Validation		
									Sens-itivity	Probe Linearity	Probe Isotropy	Modulation Type	Duty Factor	PAR
2	2450	02/21/2023	3662	EX3DV4	2450	Head	1.83	38.56	Pass	Pass	Pass	DSSS	Pass	Pass
2	5250	02/21/2023	3662	EX3DV4	5250	Head	4.75	34.62	Pass	Pass	Pass	OFDM	Pass	Pass
2	5600	02/22/2023	3662	EX3DV4	5600	Head	5.10	34.29	Pass	Pass	Pass	OFDM	Pass	Pass
2	5750	02/22/2023	3662	EX3DV4	5750	Head	5.24	34.01	Pass	Pass	Pass	OFDM	Pass	Pass