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

Inseego	Dates of Test:	June 10-11, 2022
9645 Scranton Road, Suite 205	Test Report Number:	SAR.20220614
San Diego, CA 92121		Revision D

FCC ID:	PKRISGM3100
HVIN/Model(s):	M3100
Product Market Number (PMN):	M3100
Test Sample:	Engineering Unit Same as Production
Serial Number:	BB110122F00067
Equipment Type:	Portable Router (Hotspot)
Classification:	Portable Transmitter Next to Body
TX Frequency Range:	824 – 849 MHz, 1710 – 1780 MHz, 1850 – 1910 MHz, 3300 – 4200 MHz, 3550 – 3700 MHz
Frequency Tolerance:	± 2.5 ppm
Maximum RF Output:	850 MHz (FR1) – 24.0 dBm, 1750 MHz (FR1) – 24.5 dBm, 1900 MHz (FR1) – 24.5 dBm, 3600 MHz (FR1) – 26.0 dBm Conducted
Signal Modulation:	DFT-s-OFDM/CP-OFDM, Pi2 BPSK
Antenna Type:	Internal
Application Type:	Certification
FCC Rule Parts:	Part 2, 22, 24, 27, 90
KDB Test Methodology:	KDB 447498 D01 v07, KDB 248227 v02r02, KDB 941225 D01 v03r01, D02 v02r01, D05 v02r05 & D06 v02r01
Industry Canada:	RSS-102 Issue 5, Safety Code 6
Max. Stand Alone SAR Value:	0.90 W/kg Reported
Max. Simultaneous SAR Value:	1.36 W/kg Reported
Max. Simultaneous Value:	0.79 Ratio
Separation Distance:	10 mm

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 62209-1528:2020 (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

ACCREDITED
Testing Cert. # 2387.01

Table of Contents

Comment/Revision	Date
Original Release	June 17, 2022
Revision A – Correct all simultaneous combination tables with the correct power level for n48, add the proximity sensor information, correct the tables of SAR/ratio values and add the test setup photos for 20 mm testing	June 28, 2022
Revision B – Add proximity sensor data	July 7, 2022
Revision C & D – Add TDD evaluation mode	July 21, 2022

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 Inseego Model M3100 FCC ID: PKRISGM3100 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 in ET Docket 93-62 on August 6, 1996 to protect the public and workers from the potential hazards of RF emissions due to FCC regulated portable devices. [1], [6]

The testing of this device utilized data re-use per KDB 484596. The original unit was filed under Model M3000A FCC ID: PKRISGM3000A. The data is being referenced in the SAR report filed number SAR.20220611. All data in this report was taken on the M3100 referencing the original model's data.

The test results recorded herein are based on a single type test of Inseego Model M3100 and therefore apply only to the tested sample.

The test procedures and limits, 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 M3100 Portable Router (Hotspot). The table also shows the tolerance for the power level for each mode.

Band	Technology	Power	3GPP Nominal Power dBm	Calibrated Nominal Power dBm	Tolerance dBm	Lower Tolerance dBm	Upper Tolerance dBm
Band n5 – 835 MHz	FR1	Full	23.0	23.0	+1.0/-1.3	21.7	24.0
Band n66 – 1750 MHz	FR1	Full	23.0	23.0	+1.5/-1.3	21.7	24.5
Band n66 – 1750 MHz	FR1	Backoff	18.0	18.0	+1.5/-1.3	16.7	19.5
Band n2 – 1900 MHz	FR1	Full	23.0	23.0	+1.5/-1.3	21.7	24.5
Band n2 – 1900 MHz	FR1	Backoff	16.0	16.0	+1.5/-1.3	14.7	17.5
Band n48 – 3600 MHz	FR1	Full	20.5	20.5	+1.0/-1.3	19.2	21.5
Band n77 – 3700 MHz PC3	FR1	Full	23.0	23.0	+1.5/-1.3	21.7	24.5
Band n77 – 3700 MHz PC3	FR1	Backoff	20.0	20.0	+1.5/-1.3	18.9	21.5
Band n77 – 3700 MHz PC2	FR1	Full	25.0	25.0	+1.0/-3.0	22.0	26.0
Band n77 – 3700 MHz PC2	FR1	Backoff	20.0	20.0	+1.5/-1.3	18.9	21.5

LTE UL CA Combinations (Aggregate Power)

Band UL 2CA Combination	Technology	Class	Nominal dBm	Tolerance dBm	Lower Tolerance dBm	Upper Tolerance dBm
2A-4A	LTE	3	23.0	+1.0/-1.3	21.7	24.0
2A-5A	LTE	3	23.0	+1.0/-1.3	21.7	24.0
2A-13A	LTE	3	23.0	+1.0/-1.3	21.7	24.0
2A-66A	LTE	3	23.0	+1.0/-1.3	21.7	24.0
4A-5A	LTE	3	23.0	+1.0/-1.3	21.7	24.0
4A-13A	LTE	3	23.0	+1.0/-1.3	21.7	24.0
5A-66A	LTE	3	23.0	+1.0/-1.3	21.7	24.0
5B	LTE	3	23.0	+1.0/-1.3	21.7	24.0
13A-66A	LTE	3	23.0	+1.0/-1.3	21.7	24.0
48C	LTE	3	16.0	+1.0/-1.3	14.7	17.0
66B	LTE	3	23.0	+1.0/-1.3	21.7	24.0
66C	LTE	3	23.0	+1.0/-1.3	21.7	24.0

FR1 NSA UL ENDC Combinations (Aggregate Power)

Band UL ENDC Combination	Technology	Class	Nominal dBm	Tolerance dBm	Lower Tolerance dBm	Upper Tolerance dBm
5A-n2A	LTE+FR1	3	23.0	+1.5/-1.3	21.7	24.5
13A-n2A	LTE+FR1	3	23.0	+1.5/-1.3	21.7	24.5
66A-n2A	LTE+FR1	3	23.0	+1.5/-1.3	21.7	24.5
2A-n5A	LTE+FR1	3	23.0	+1.5/-1.3	21.7	24.5
48A-n5A	LTE+FR1	3	20.0	+1.5/-1.3	17.0	21.5
66A-n5A	LTE+FR1	3	23.0	+1.5/-1.3	21.7	24.5
2A-n66A	LTE+FR1	3	23.0	+1.5/-1.3	21.7	24.5
5A-n66A	LTE+FR1	3	23.0	+1.5/-1.3	21.7	24.5
7A-n66A	LTE+FR1	3	23.0	+1.5/-1.3	21.7	24.5
13A-n66A	LTE+FR1	3	23.0	+1.5/-1.3	21.7	24.5
48A-n66A	LTE+FR1	3	20.0	+1.5/-1.3	17.0	21.5
2A-n77A	LTE+FR1	3	23.0	+1.5/-1.3	21.7	24.5
5A-n77A	LTE+FR1	3	23.0	+1.0/-1.3	21.7	24.0
7A-n77A	LTE+FR1	3	23.0	+1.0/-1.3	21.7	24.0
13A-n77A	LTE+FR1	3	23.0	+1.0/-1.3	21.7	24.0
66A-n77A	LTE+FR1	3	23.0	+1.5/-1.3	21.7	24.5

FR2 UL ENDC LTE Combinations

Band UL ENDC Combination		Technology
1CC	2A-n260A	LTE+FR2
	5A-n260A	LTE+FR2
	13A-n260A	LTE+FR2
	48A-n260A	LTE+FR2
	66A-n260A	LTE+FR2
2CC	2A-n260G	LTE+FR2
	5A-n260G	LTE+FR2
	13A-n260G	LTE+FR2
	48A-n260G	LTE+FR2
	66A-n260G	LTE+FR2
1CC	2A-n261A	LTE+FR2
	5A-n261A	LTE+FR2
	13A-n261A	LTE+FR2
	48A-n261A	LTE+FR2
	66A-n261A	LTE+FR2
2CC	2A-n261G	LTE+FR2
	5A-n261G	LTE+FR2
	13A-n261G	LTE+FR2
	48A-n261G	LTE+FR2
	66A-n261G	LTE+FR2

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/m^3)

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.

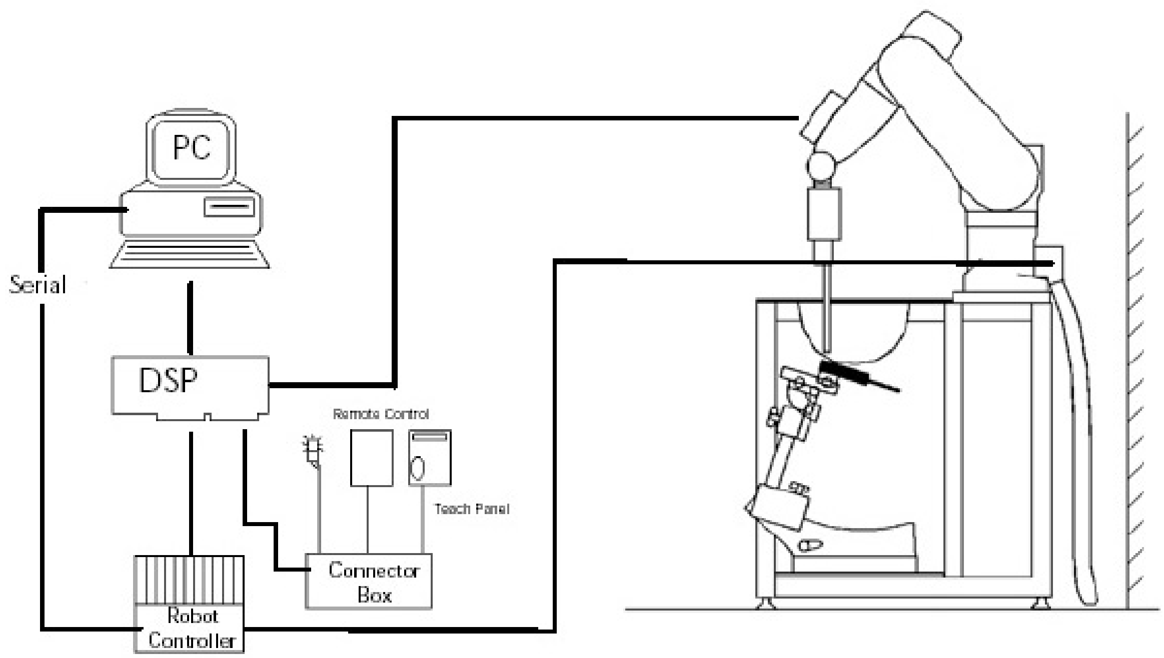


Figure 2.1 SAR Measurement System Setup

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

Probe Specifications

Calibration: In air from 10 MHz to 6.0 GHz
In brain and muscle simulating tissue at Frequencies of 450 MHz, 835 MHz, 1750 MHz, 1900 MHz, 2450 MHz, 2600 MHz, 3500 MHz, 5200 MHz, 5300 MHz, 5600 MHz, 5800 MHz

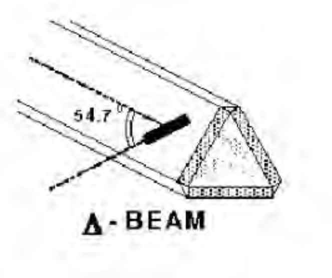


Figure 2.2 Triangular Probe Configurations

Frequency: 10 MHz to 6 GHz

Linearity: ±0.2dB (30 MHz to 6 GHz)

Dynamic: 10 mW/kg to 100 W/kg

Range: Linearity: ±0.2dB

Dimensions: Overall length: 330 mm

Tip length: 20 mm

Body diameter: 12 mm

Tip diameter: 2.5 mm

Distance from probe tip to sensor center: 1 mm

Application: SAR Dosimetry Testing
Compliance tests of wireless device

Figure 2.3 Probe Thick-Film Technique

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/cm^2.

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

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

where:

Δt = exposure time (30 seconds),

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

ΔT = temperature increase due to RF exposure.

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

where:

σ = simulated tissue conductivity,

ρ = Tissue density (1.25 g/cm^3 for brain tissue)

SAR is proportional to ΔT / Δt , 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;

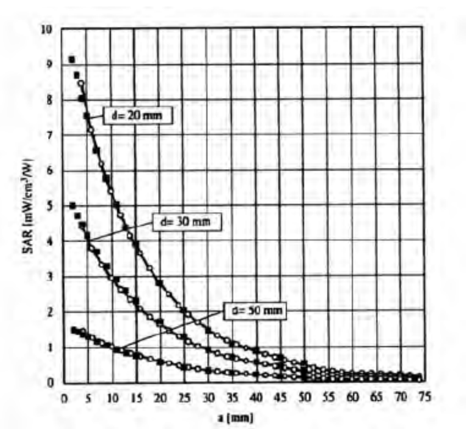


Figure 2.4 E-Field and Temperature Measurements at 900MHz

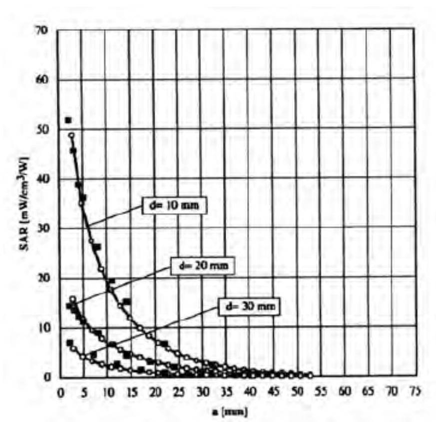


Figure 2.5 E-Field and Temperature Measurements at 1800MHz

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/cm^3

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

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

with
P_{pwe} = equivalent power density of a plane wave in W/cm^2
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 ≤ 2GHz 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 neighbouring volumes are evaluated until no neighbouring 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.

SAM PHANTOM

The SAM Twin Phantom V4.0 is constructed of a fiberglass shell integrated in a wooden table. The shape of the shell is based on data from an anatomical study designed to determine the maximum exposure in at least 90% of all users. 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 the evaporation of the liquid. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot. (see Fig. 2.6)

Phantom Specification

Phantom: SAM Twin Phantom (V4.0)
Shell Material: Vivac Composite
Thickness: 2.0 ± 0.2 mm

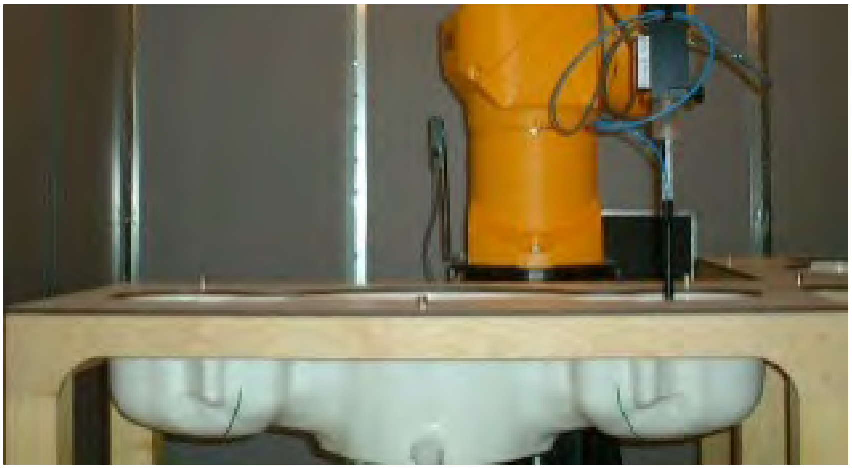


Figure 2.6 SAM Twin Phantom

Device Holder for Transmitters

In combination with the SAM Twin Phantom V4.0 the Mounting Device (see Fig. 2.7), enables the rotation of the mounted transmitter in spherical coordinates whereby the rotation point is the ear opening. The devices can be easily, accurately, and repeat ably be positioned according to the FCC, CENELEC, IEC and IEEE specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).

Figure 2.7 Mounting Device

Note: A simulating human hand is not used due to the complex anatomical and geometrical structure of the hand that may produce infinite number of configurations. To produce the worst-case condition (the hand absorbs antenna output power), the hand is omitted during the tests.

3. Probe and Dipole Calibration

See Appendix D and E.

4. Phantom & Simulating Tissue Specifications

Head & Body Simulating Mixture Characterization

The head and body mixtures consist 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. Body tissue parameters that have not been specified in IEEE1528 – 2013 are derived from the issue dielectric parameters computed from the 4-Cole-Cole equations.

Table 4.1 Typical Composition of Ingredients for Tissue

Ingredients		Simulating Tissue				
		900 MHz Head	1750 MHz Head	1900 MHz Head	3500 MHz Head	3700 MHz Head
Mixing Percentage						
Water		Proprietary Purchased From Speag				
Sugar						
Salt						
HEC						
Bactericide						
DGBE						
Dielectric Constant	Target	41.50	40.08	40.00	37.93	37.70
Conductivity (S/m)	Target	0.97	1.37	1.40	2.91	3.12

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

		900 MHz Head		1750 MHz Head		1900 MHz Head	
Date(s)		Jun. 10, 2022		Jun. 11, 2022		Jun. 10, 2022	
Liquid Temperature (˚C)	20.0	Target	Measured	Target	Measured	Target	Measured
Dielectric Constant: ε		41.50	41.07	40.08	39.35	40.00	39.70
Conductivity: σ		0.97	1.00	1.37	1.41	1.40	1.44

		3500 MHz Head		3700 MHz Head	
Date(s)		Jun. 11, 2022		Jun. 11, 2022	
Liquid Temperature (˚C)	20.0	Target	Measured	Target	Measured
Dielectric Constant: ε		37.93	37.10	37.70	36.87
Conductivity: σ		2.91	2.92	3.12	3.13

See Appendix A for data printout.

Test System Verification

Prior to assessment, the system is verified to the ±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 (%)	Plot Number
10-Jun-2022	900 MHz	11.20	11.80	Head	+ 5.36	1
11-Jun-2022	1750 MHz	37.70	38.30	Head	+ 1.59	2
10-Jun-2022	1900 MHz	40.40	41.50	Head	+ 2.72	3
11-Jun-2022	3500 MHz	67.00	67.90	Head	+ 1.34	4
11-Jun-2022	3700 MHz	68.30	69.50	Head	+ 1.76	5

See Appendix A for data plots.

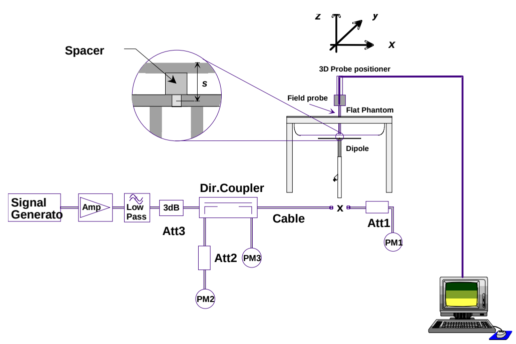


Figure 7.1 Dipole Validation Test Setup

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 ((end/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.

Required Test Positions						
Antenna	Side A	Side B	Side C	Side D	Side E	Side F
Ant 0	Yes	Yes	Yes	Yes	No	Yes
Ant 1	Yes	Yes	Yes	Yes	Yes	No
Ant 4	Yes	Yes	Yes	No	No	Yes
Ant 6	Yes	No	Yes	Yes	Yes	No
Ant 8	Yes	No	Yes	Yes	No	No

This device supports SRS capability in bands n48, n77 and n78. The SRS maximum uplink duty cycle is 1.43%. Per 47 CFR 1.1307, the average power for the maximum upper end of the tolerance for the bands are all excluded from SAR testing. The following table shows the peak transmit power, average transmit power and exclusion limit for each of the bands.

Band	Peak Transmit Power (dBm)	Duty Cycle	Average Power (mW)	Exclusion Limit
n48	21.5	1.43%	2	8
n77	26.0	1.43%	6	7
n78	26.0	1.43%	6	7

This device uses a power reduction mechanism to reduce output powers in certain use conditions when the device is used close the user's body.

When the device's antenna is within a certain distance of the user, the sensor activates and reduces the maximum allowed output power. However, the sensor is not active when the device is moved beyond the sensor triggering distance and the maximum output power is no longer limited. Therefore, additional evaluation is needed in the vicinity of the triggering distance to ensure SAR is compliant when the device is allowed to operate at a non-reduced output power level. FCC KDB Publication 616217 D04v01r02 Section 6 was used as a guideline for selecting SAR test distances for this device at these additional test positions. Sensor triggering distance summary data is included below.

The sensor is designed to support sufficient detection range and sensitivity to cover regions of the sensors in all applicable directions since the sensor entirely covers the antennas. The device form factor will not allow the device to be sitting at an angle. Therefore, tilt measurements were not conducted on this device.

Per the May 2017 TCBC Workshop Notes, demonstration of proper functioning of the power reduction mechanisms is required to support the corresponding SAR configurations. The verification process was divided into two parts: (1) evaluation of the output power levels for individual or multiple triggering mechanisms and (2) evaluation of the triggering distances for proximity-based sensors.

9.1 Power Verification Procedure

The power verification was performed according to the following procedure.

- A base station simulator was used to establish a conducted RF connection and the output power was monitored. The power measurements were confirmed to be within the expected tolerances for all states before and after a power reduction mechanism was triggered.
- Step 1 was repeated for all relevant modes and frequency bands for the mechanism being investigated.
- Steps 1 and 2 were repeated for all individual power reduction mechanisms and combinations thereof. For the combination cases, one mechanism was switched to a "triggered" state at a time; powers were confirmed to be within the tolerances after each additional mechanism was activated.

9.2 Distance Verification Procedure

The distance verification procedure was performed according to the following procedure.

- A base station simulator was used to establish an RF connection and to monitor the power levels. The device being tested was placed below the relevant section of the phantom with the relevant side or edge of the device facing toward the phantom.
- The device was moved toward and away from the phantom to determine the distance at which the mechanism triggers and the output power is reduced, per KDB Publication 616217 D04v01r02 and FCC Guidance. Each applicable test position was evaluated. The distances were confirmed to be the same or larger (more conservative) than the minimum distances provided by the manufacturer.
- Steps 1 and 2 were repeated for low, mid and high bands, as appropriate.
- Steps 1 through 3 were repeated for all distance-based power reduction mechanisms.

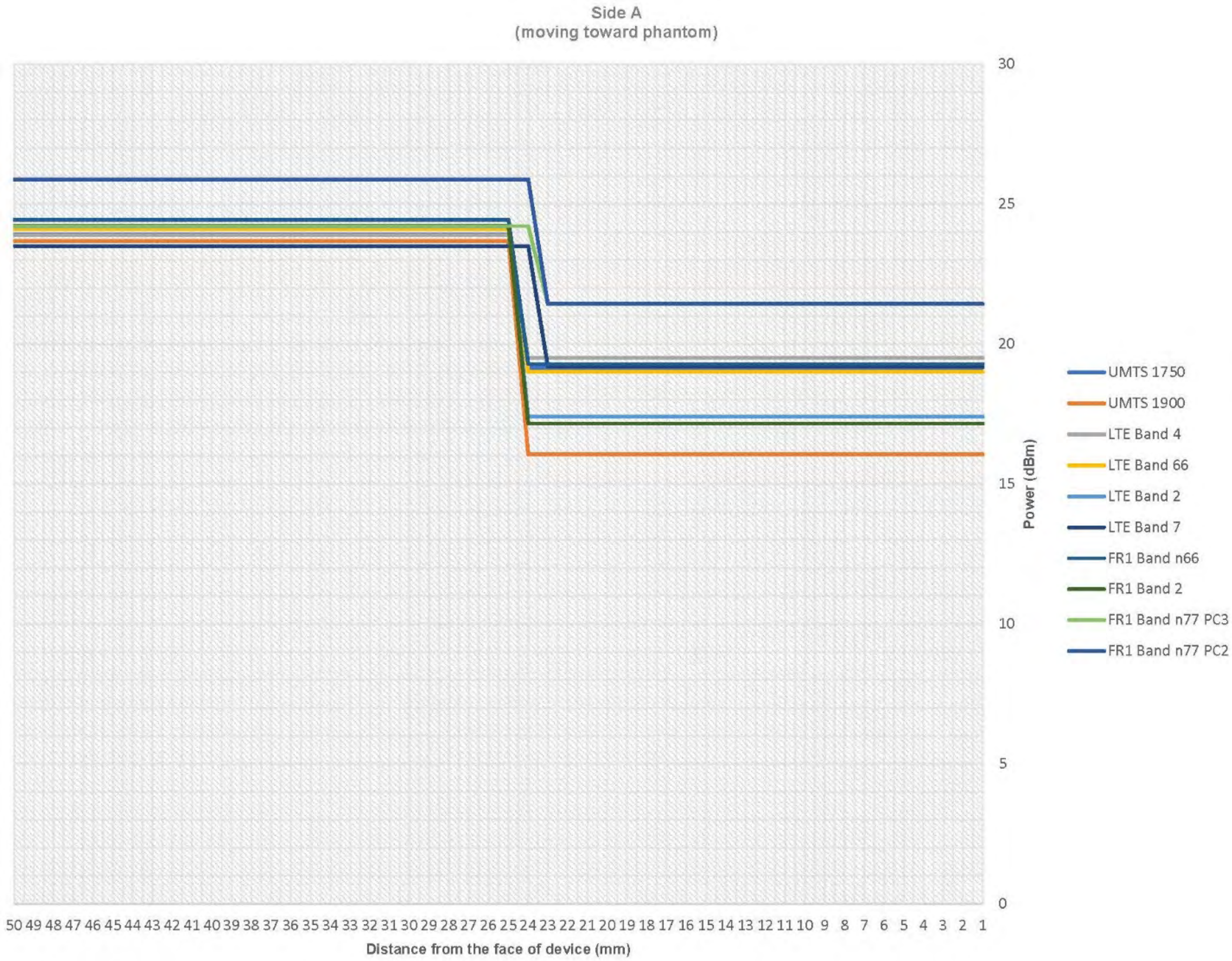
9.3 WWAN Antenna Verification Summary

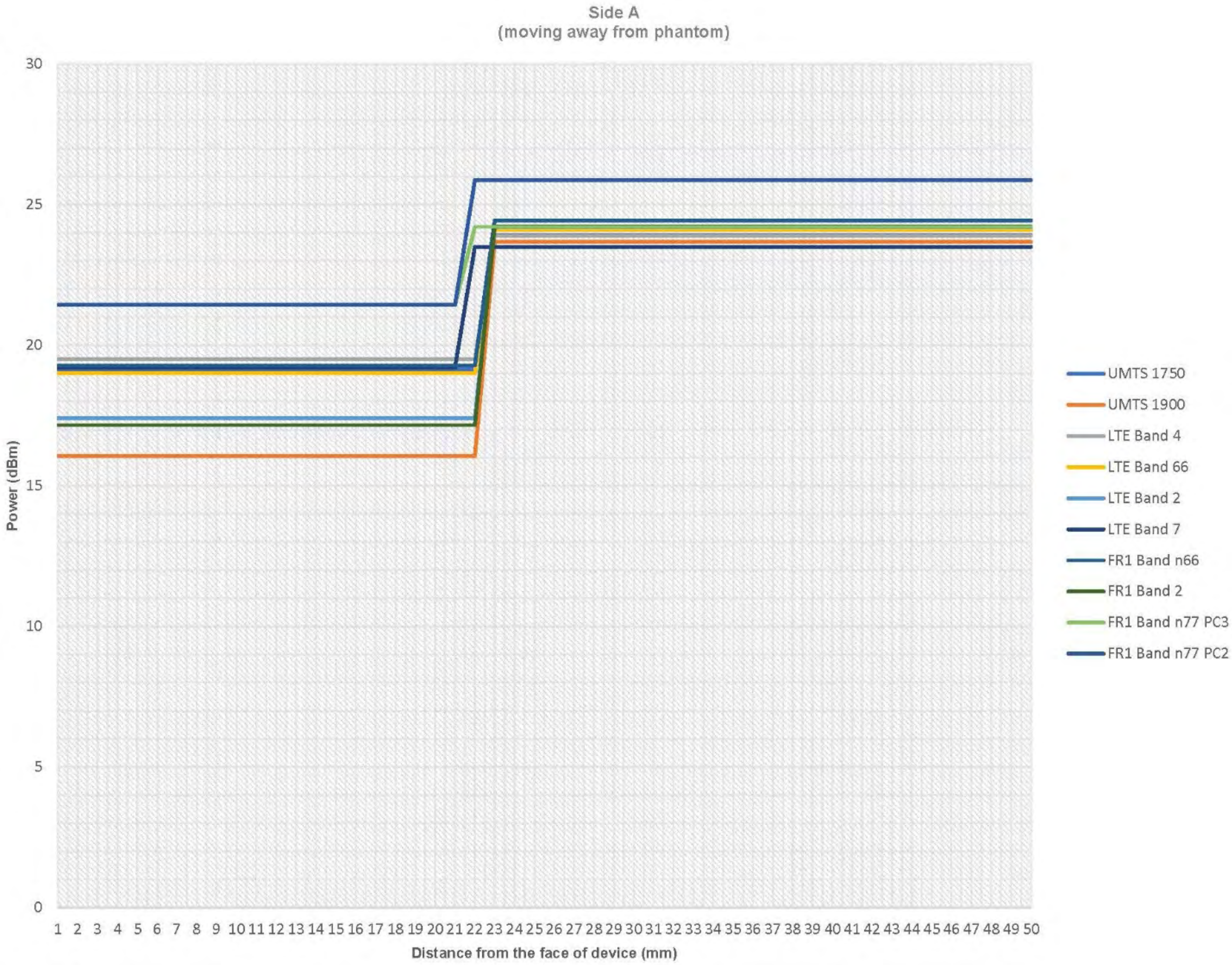
Table 9.1
Power Measurement Verification for WWAN Antenna

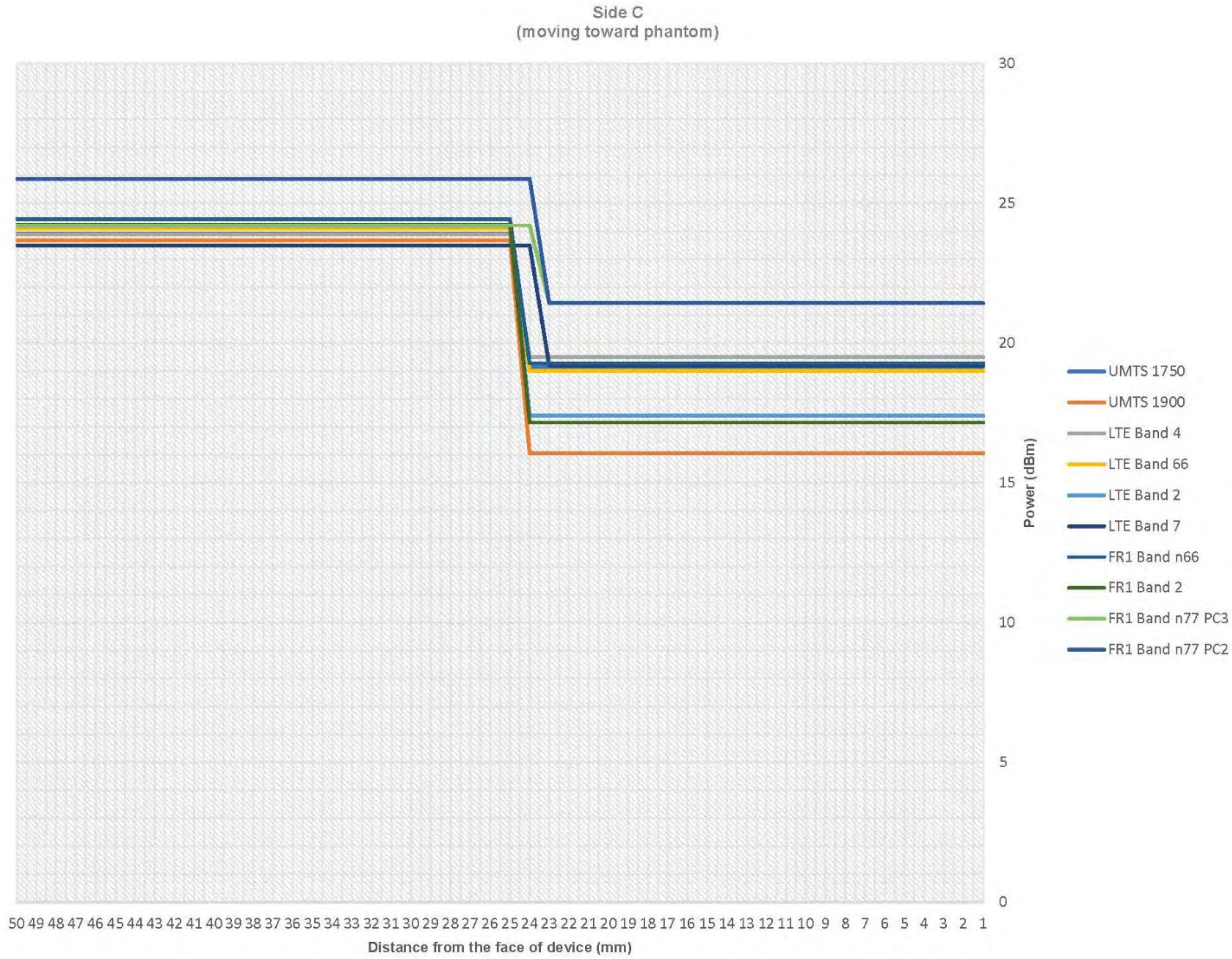
Mechanism	Mode/Band	Conducted Power (dBm)	
1st		Un-triggered (Max)	Mechanism #1 (Reduced)
Capacitive	UMTS 1750	23.91	19.16
	UMTS 1900	23.67	16.06
	LTE FDD Band 4	23.90	19.50
	LTE FDD Band 66	24.10	19.00
	LTE FDD Band 2	24.20	17.40
	LTE FDD Band 7	23.50	19.20
	FR1 FDD Band n66	24.44	19.28
	FR1 FDD Band n2	24.22	17.16
	FR1 TDD Band n77 (PC3)	24.21	21.43
	FR1 TDD Band n77 (PC2)	25.87	21.43

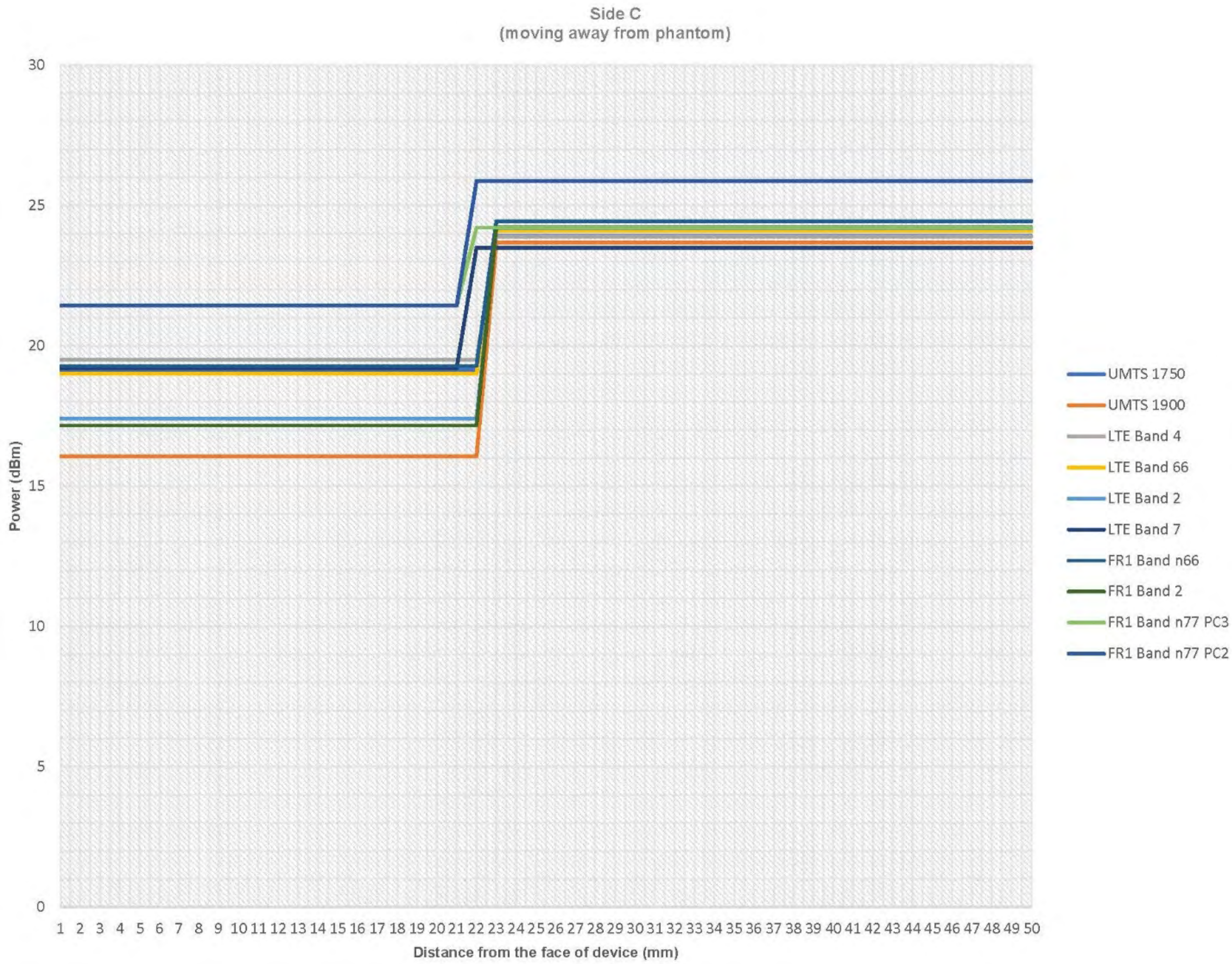
Table 9.2
Distance Measurement Verification for WWAN Antenna

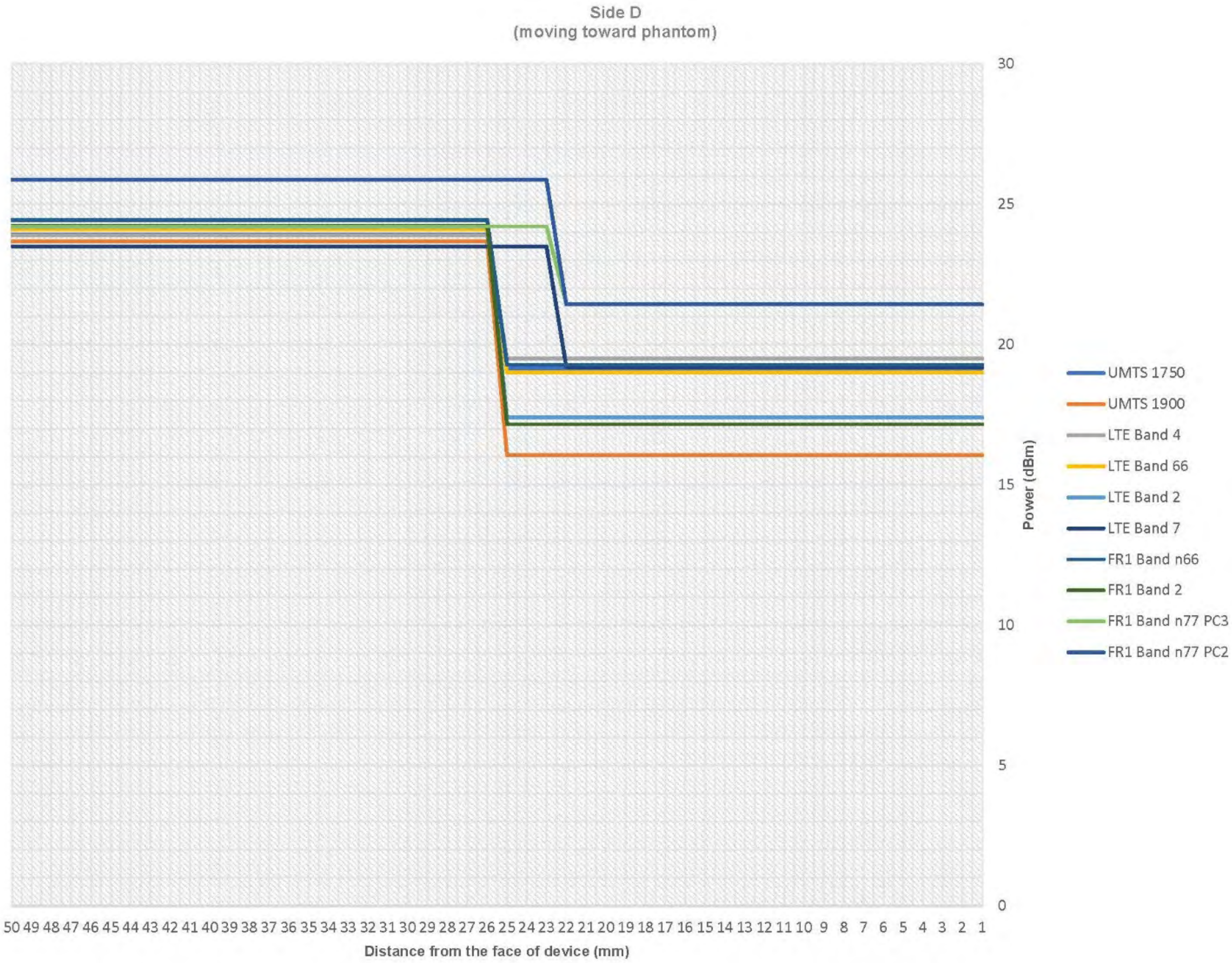
Mechanism	Test Condition	Band	Distance Measurements (mm)		Minimum Distance per Manufacturer (mm)
			Moving Toward	Moving Away	
Capacitive	Side A	Mid	24	23	20
	Side C	Mid	24	23	20
	Side D	Mid	25	24	20
	Side F	Mid	23	22	20
	Side A	High	23	22	20
	Side C	High	23	22	20
	Side D	High	22	21	20
	Side F	High	24	23	20

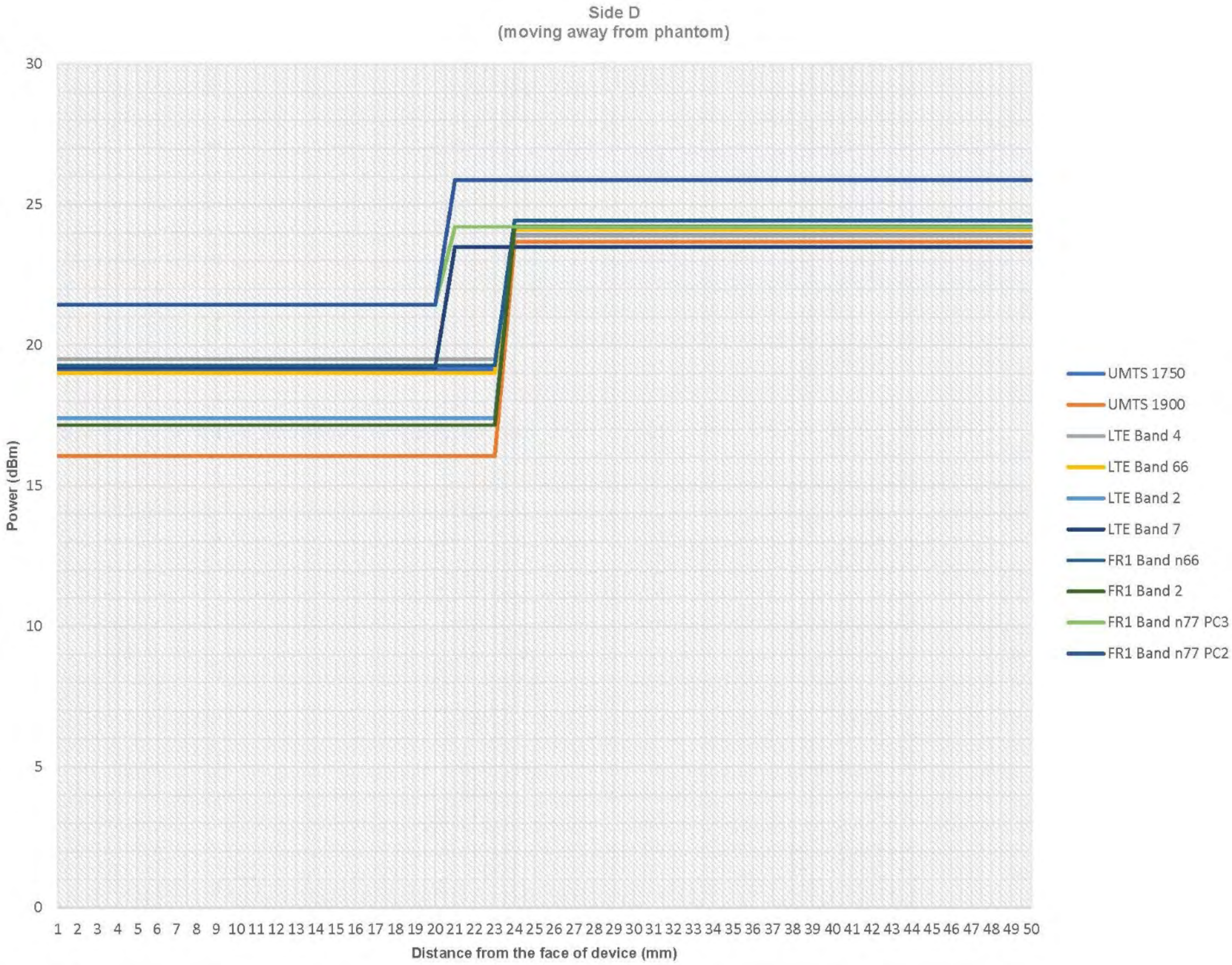

Side A
(moving toward phantom)
30
25
20
15
10
5
0
Power (dBm)
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
Distance from the face of device (mm)
UMTS 1750
UMTS 1900
LTE Band 4
LTE Band 66
LTE Band 2
LTE Band 7
FR1 Band n66
FR1 Band 2
FR1 Band n77 PC3
FR1 Band n77 PC2

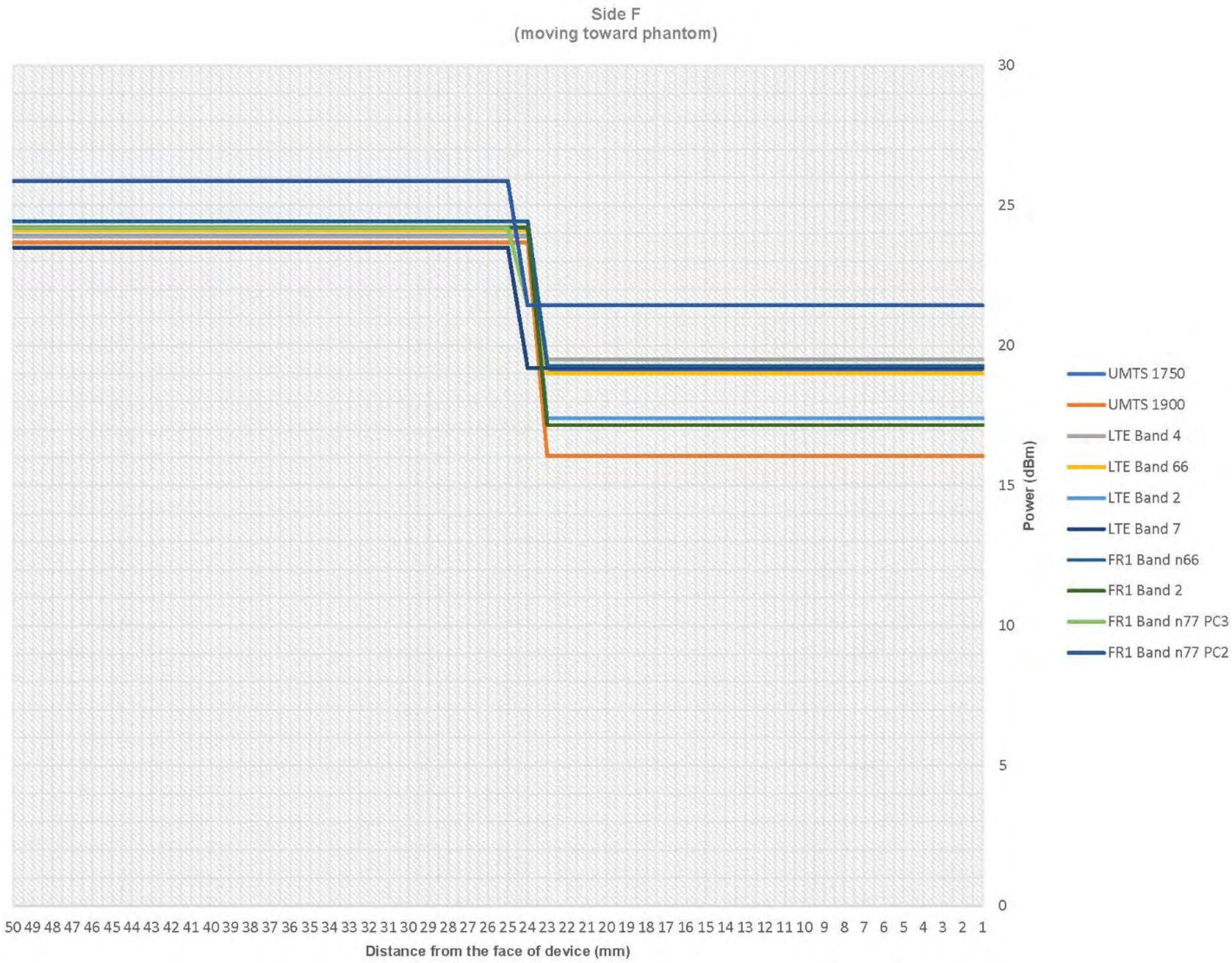

Side A
(moving away from phantom)
Power (dBm)
30
25
20
15
10
5
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
Distance from the face of device (mm)
UMTS 1750
UMTS 1900
LTE Band 4
LTE Band 66
LTE Band 2
LTE Band 7
FR1 Band n66
FR1 Band 2
FR1 Band n77 PC3
FR1 Band n77 PC2

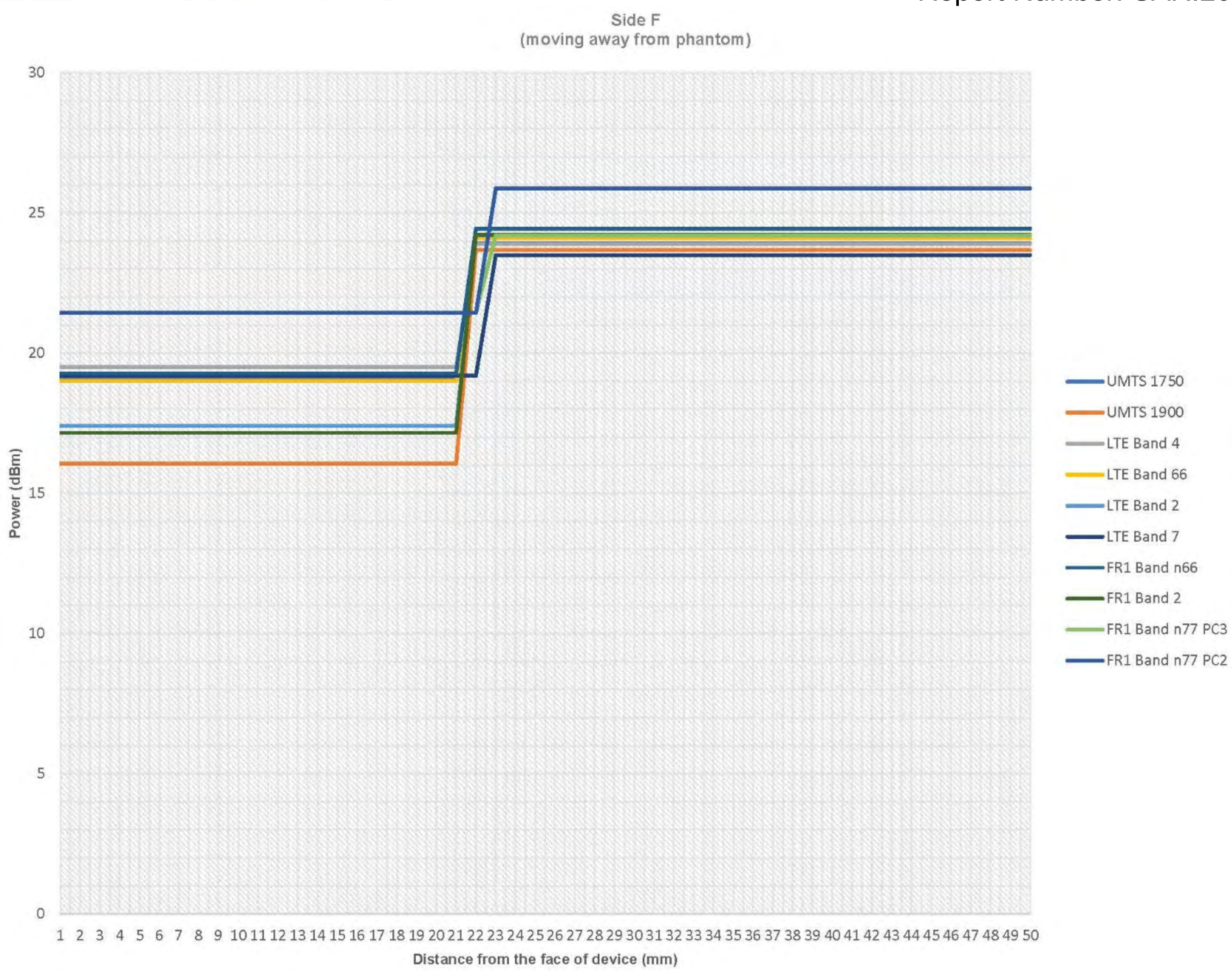

Side C
(moving toward phantom)
30
25
20
15
10
5
0
Power (dBm)
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
Distance from the face of device (mm)
UMTS 1750
UMTS 1900
LTE Band 4
LTE Band 66
LTE Band 2
LTE Band 7
FR1 Band n66
FR1 Band 2
FR1 Band n77 PC3
FR1 Band n77 PC2


Side C
(moving away from phantom)
Power (dBm)
30
25
20
15
10
5
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
Distance from the face of device (mm)
UMTS 1750
UMTS 1900
LTE Band 4
LTE Band 66
LTE Band 2
LTE Band 7
FR1 Band n66
FR1 Band 2
FR1 Band n77 PC3
FR1 Band n77 PC2


Side D
(moving toward phantom)
30
25
20
15
10
5
0
Power (dBm)
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
Distance from the face of device (mm)
UMTS 1750
UMTS 1900
LTE Band 4
LTE Band 66
LTE Band 2
LTE Band 7
FR1 Band n66
FR1 Band 2
FR1 Band n77 PC3
FR1 Band n77 PC2


Side D
(moving away from phantom)
Power (dBm)
Distance from the face of device (mm)
UMTS 1750
UMTS 1900
LTE Band 4
LTE Band 66
LTE Band 2
LTE Band 7
FR1 Band n66
FR1 Band 2
FR1 Band n77 PC3
FR1 Band n77 PC2


Side F
(moving toward phantom)
30
25
20
15
10
5
0
Power (dBm)
50 49 48 47 46 45 44 43 42 41 40 39 38 37 36 35 34 33 32 31 30 29 28 27 26 25 24 23 22 21 20 19 18 17 16 15 14 13 12 11 10 9 8 7 6 5 4 3 2 1
Distance from the face of device (mm)
UMTS 1750
UMTS 1900
LTE Band 4
LTE Band 66
LTE Band 2
LTE Band 7
FR1 Band n66
FR1 Band 2
FR1 Band n77 PC3
FR1 Band n77 PC2


Side F
(moving away from phantom)
30
25
20
15
10
5
0
Power (dBm)
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46 47 48 49 50
Distance from the face of device (mm)
UMTS 1750
UMTS 1900
LTE Band 4
LTE Band 66
LTE Band 2
LTE Band 7
FR1 Band n66
FR1 Band 2
FR1 Band n77 PC3
FR1 Band n77 PC2

FR1 Conducted Power

GENERAL NOTE:

1. NR implementation of n2, n5, n12, n25, n41, n66 and n71 is limited to EN-DC operations only (NSA), with LTE Bands 2/4/5/7/12/13/14/25/26/30/66/71/41/48 acting as anchor bands, SAR tests for NR Bands and LTE Anchors Bands were performed separately due to limitations in SAR probe calibration factors. the detail EN-DC combination include in section3.3
2. 5G NR support SCS 15KHz / 30KHz, DFT-s/CP-OFDM, PI/2 BPSK/QPSK/16QAM/64QAM/256QAM and support Bandwidth include in section3.3
3. For 5G NR test procedure was following step similar FCC KDB 941225 D05:
   a. For DFT-s-OFDM and CP-OFDM output power measurement reduction, according to 38.101 maximum power reduction for power class 2 and 3, the CP-OFDM mode will not higher than DFT-s-OFDM mode, therefore, similar FCC KDB 941225 D05 procedure for other modulation output power for each RB allocation configuration is > not ½ dB higher than the same configuration in DFT-s-Pi/2 BPSK and the reported SAR for the DFT-s-Pi/2 BPSK configuration is ≤ 1.45 W/kg; CP-OFDM measurement is unnecessary.
   b. For DFT-s-OFDM output power measurement reduction, according to 38.101 maximum power reduction for power class 3, full measurement on Pi/2 BPSK/QPSK/16QAM/64QMA/256QAM with larger bandwidth, for smaller bandwidth output power also spot check 1RB 1offset configuration at Pi/2 BPSK to ensure output power will not ½ dB higher than largest supported bandwidth.
   c. SAR testing start with the largest channel bandwidth and measure SAR for PI/2 BPSK with 1 RB allocation, using the RB offset and required test channel combination with the highest maximum output power for RB offsets at the upper edge, middle and lower edge of each required test channel.
   d. 50% RB allocation for PI/2 BPSK SAR testing follows 1RB PI/2 BPSK allocation procedure
   e. PI/2 BPSK with 100% RB allocation, SAR is not required when the highest maximum output power for 100 % RB allocation is less than the highest maximum output power in 50% and 1 RB allocations and the highest reported SAR for 1 RB and 50% RB allocation are ≤ 0.8 W/kg. Otherwise, SAR is measured for the highest output power channel; and if the reported SAR is > 1.45 W/kg, the remaining required test channels must also be tested.
   f. QPSK/16QAM/64QAM/256QAM output powers are not ½ dB higher than the same configuration in PI/2 BPSK, also reported SAR for the PI/2 BPSK configuration is less than 1.45 W/kg, QPSK/16QAM/64QAM/256QAM SAR testing are not required.
   g. Smaller bandwidth output power for each RB allocation configuration for this device will not ½ dB higher than the same configuration in the largest supported bandwidth, and the reported SAR for the largest supported bandwidth is ≤ 1.45 W/kg, smaller bandwidth SAR testing is not required for this device.
4. FR1 band 2/5/38/78 SAR test was covered by Band 25/26/41/77; according to April 2015 TCB workshop, SAR test for overlapping FR1 bands can be reduced if
   a. the maximum output power, including tolerance, for the smaller band is ≤ the larger band to qualify for the SAR test exclusion
   b. the channel bandwidth and other operating parameters for the smaller band are fully supported by the larger band
5. Due to test setup limitations, SAR testing for NR was performed using Factory Test Mode software to establish the connection and perform SAR with 100% duty cycle. The Qualcomm QRCT program was used to establish the connection.

3GPP 38.101 MPR FOR EN-DC

Table 6.2.2-1 Maximum power reduction (MPR) for power class 3

Modulation		MPR (dB)		
		Edge RB allocations	Outer RB allocations	Inner RB allocations
DFT-s-OFDM	Pi/2 BPSK	≤ 3.5[1]	≤ 1.2[1]	≤ 0.2[1]
		≤ 0.5[2]	≤ 0.5[2]	0[2]
	QPSK	≤ 1		0
	16 QAM	≤ 2		≤ 1
	64 QAM	≤ 2.5		
	256 QAM	≤ 4.5		
CP-OFDM	QPSK	≤ 3		≤ 1.5
	16 QAM	≤ 3		≤ 2
	64 QAM	≤ 3.5		
	256 QAM	≤ 6.5		

NOTE 1: Applicable for UE operating in TDD mode with Pi/2 BPSK modulation and UE indicates support for UE capability *powerBoosting-pi2BPSK* and if the IE *powerBoostPi2BPSK* is set to 1 and 40 % or less slots in radio frame are used for UL transmission for bands n40, n41, n77, n78 and n79. The reference power of 0 dB MPR is 26 dBm.

NOTE 2: Applicable for UE operating in FDD mode, or in TDD mode in bands other than n40, n41, n77, n78 and n79 with Pi/2 BPSK modulation and if the IE *powerBoostPi2BPSK* is set to 0 and if more than 40 % of slots in radio frame are used for UL transmission for bands n40, n41, n77, n78 and n79.

Table 6.2.2-2 Maximum power reduction (MPR) for power class 2

Modulation		MPR (dB)		
		Edge RB allocations	Outer RB allocations	Inner RB allocations
DFT-s-OFDM	Pi/2 BPSK	≤ 3.5	≤ 0.5	0
	QPSK	≤ 3.5	≤ 1	0
	16 QAM	≤ 3.5	≤ 2	≤ 1
	64 QAM	≤ 3.5	≤ 2.5	
	256 QAM	≤ 4.5		
CP-OFDM	QPSK	≤ 3.5	≤ 3	≤ 1.5
	16 QAM	≤ 3.5	≤ 3	≤ 2
	64 QAM	≤ 3.5		
	256 QAM	≤ 6.5		

Table 9.1 FR1 Full Power Measurements

<n2 Ant0>

BW [MHz]	Modulation	RB Size	RB Offset	Power Low Ch. / Freq.	Power Middle Ch. / Freq.	Power High Ch. / Freq.	Tune-up limit (dBm)	MPR (dB)
Channel				372000	376000	380000	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				1860	1880	1900		
20	PI/2 BPSK	1	1	24.11	24.33	24.45	24.5	0.0
20	PI/2 BPSK	1	53	24.29	24.22	24.09		
20	PI/2 BPSK	1	104	24.29	24.22	24.18		
20	PI/2 BPSK	50	0	23.27	23.43	23.36	23.5	1.0
20	PI/2 BPSK	50	28	23.02	23.03	23.09		
20	PI/2 BPSK	50	56	23.32	23.39	23.09		
20	PI/2 BPSK	100	0	23.47	23.21	23.18	23.5	1.0
20	QPSK	1	1	24.17	24.18	24.44	24.5	0.0
20	QPSK	1	53	24.08	24.30	24.19		
20	QPSK	1	104	24.25	24.24	24.31		
20	QPSK	50	0	23.26	23.40	23.27	23.5	1.0
20	QPSK	50	28	23.24	23.40	23.19		
20	QPSK	50	56	23.04	23.15	23.47		
20	QPSK	100	0	23.32	23.02	23.01	23.5	1.0
20	16QAM	1	1	24.10	24.47	24.31	24.5	0.0
20	16QAM	1	53	24.25	24.33	24.43		
20	16QAM	1	104	24.35	24.04	24.08		
20	16QAM	50	0	23.08	23.10	23.07	23.5	1.0
20	16QAM	50	28	23.11	23.21	23.02		
20	16QAM	50	56	23.27	23.03	23.08		
20	16QAM	100	0	23.33	23.25	23.09	23.5	1.0
20	64QAM	1	1	24.15	24.20	24.37	24.5	0.0
20	64QAM	1	53	24.35	24.20	24.36		
20	64QAM	1	104	24.37	24.06	24.19		
20	64QAM	50	0	23.44	23.41	23.14	23.5	1.0
20	64QAM	50	28	23.48	23.49	23.27		
20	64QAM	50	56	23.20	23.12	23.46		
20	64QAM	100	0	23.13	23.36	23.45	23.5	1.0
20	256QAM	1	1	24.09	24.19	24.21	24.5	0.0
20	256QAM	1	53	24.24	24.35	24.16		
20	256QAM	1	104	24.47	24.43	24.31		
20	256QAM	50	0	23.09	23.46	23.08	23.5	1.0
20	256QAM	50	28	23.09	23.34	23.06		
20	256QAM	50	56	23.42	23.00	23.16		
20	256QAM	100	0	23.01	23.48	23.32	23.5	1.0
Channel				371500	376000	380500	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				1857.5	1880	1902.5		
15	PI/2 BPSK	1	1	24.16	24.26	24.36	24.5	0.0
Channel				371000	376000	381000	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				1855	1880	1905		
10	PI/2 BPSK	1	1	24.23	24.49	24.01	24.5	0.0
Channel				370500	376000	381500	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				1852.5	1880	1907.5		
5	PI/2 BPSK	1	1	24.45	24.15	24.15	24.5	0.0

<n5 Ant0>

BW [MHz]	Modulation	RB Size	RB Offset	Power Low Ch. / Freq.	Power Middle Ch. / Freq.	Power High Ch. / Freq.	Tune-up limit (dBm)	MPR (dB)
Channel				166800	167300	167300	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				834	836.5	839		
20	PI/2 BPSK	1	1	23.83	23.63	23.71	24.0	0.0
20	PI/2 BPSK	1	53	23.85	23.95	23.81		
20	PI/2 BPSK	1	104	23.88	23.84	23.97		
20	PI/2 BPSK	50	0	22.58	22.60	22.67	23.0	1.0
20	PI/2 BPSK	50	28	22.83	22.95	22.86		
20	PI/2 BPSK	50	56	22.97	22.89	22.63		
20	PI/2 BPSK	100	0	22.73	22.59	22.87	23.0	1.0
20	QPSK	1	1	23.74	23.64	23.51	24.0	0.0
20	QPSK	1	53	23.64	23.96	23.96		
20	QPSK	1	104	23.50	23.80	23.83		
20	QPSK	50	0	22.88	22.93	22.69	23.0	1.0
20	QPSK	50	28	22.65	22.73	22.82		
20	QPSK	50	56	22.60	22.53	22.88		
20	QPSK	100	0	22.54	22.99	22.62	23.0	1.0
20	16QAM	1	1	23.57	23.99	23.56	24.0	0.0
20	16QAM	1	53	23.87	23.53	23.84		
20	16QAM	1	104	23.92	23.63	23.86		
20	16QAM	50	0	22.89	22.77	22.75	23.0	1.0
20	16QAM	50	28	22.51	22.58	22.95		
20	16QAM	50	56	22.87	22.58	22.94		
20	16QAM	100	0	22.70	22.88	22.62	23.0	1.0
20	64QAM	1	1	23.88	23.73	23.61	24.0	0.0
20	64QAM	1	53	23.82	23.88	23.70		
20	64QAM	1	104	23.59	23.87	23.97		
20	64QAM	50	0	22.66	22.74	22.81	23.0	1.0
20	64QAM	50	28	22.83	22.98	22.78		
20	64QAM	50	56	22.68	22.99	22.79		
20	64QAM	100	0	22.78	22.97	22.74	23.0	1.0
20	256QAM	1	1	23.78	23.90	23.99	24.0	0.0
20	256QAM	1	53	23.67	23.68	23.82		
20	256QAM	1	104	23.74	23.78	23.70		
20	256QAM	50	0	22.80	22.77	22.75	23.0	1.0
20	256QAM	50	28	22.68	22.57	22.60		
20	256QAM	50	56	22.98	22.96	22.90		
20	256QAM	100	0	22.98	22.71	22.60	23.0	1.0
Channel				166300	167300	167800	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				831.5	836.5	841.5		
15	PI/2 BPSK	1	1	23.96	23.51	23.61	24.0	0.0
Channel				165800	167300	168200	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				829	836.5	844		
10	PI/2 BPSK	1	1	23.99	23.84	23.59	24.0	0.0
Channel				165300	167300	168700	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				826.5	836.5	846.5		
5	PI/2 BPSK	1	1	23.77	23.96	23.70	24.0	0.0

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BW [MHz]	Modulation	RB Size	RB Offset	Power Low Ch. / Freq.	Power Middle Ch. / Freq.	Power High Ch. / Freq.	Tune-up limit (dBm)	MPR (dB)
Channel				637333	643113	646000	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				3560	3625	3690		
20	PI/2 BPSK	1	1	21.21	21.35	21.32		
20	PI/2 BPSK	1	53	21.33	21.22	21.02	21.5	0.0
20	PI/2 BPSK	1	104	21.28	21.45	21.41		
20	PI/2 BPSK	50	0	20.16	20.41	20.08		
20	PI/2 BPSK	50	28	20.12	20.19	20.49	20.5	1.0
20	PI/2 BPSK	50	56	20.12	20.19	20.15		
20	PI/2 BPSK	100	0	20.29	20.42	20.38	20.5	1.0
20	QPSK	1	1	21.24	21.47	21.40		
20	QPSK	1	53	21.46	21.24	21.09	21.5	0.0
20	QPSK	1	104	21.25	21.39	21.01		
20	QPSK	50	0	20.31	20.01	20.05		
20	QPSK	50	28	20.39	20.20	20.30	20.5	1.0
20	QPSK	50	56	20.42	20.04	20.21		
20	QPSK	100	0	20.48	20.47	20.31	20.5	1.0
20	16QAM	1	1	21.31	21.19	21.08		
20	16QAM	1	53	21.19	21.36	21.39	21.5	0.0
20	16QAM	1	104	21.31	21.42	21.19		
20	16QAM	50	0	20.40	20.39	20.46		
20	16QAM	50	28	20.31	20.02	20.48	20.5	1.0
20	16QAM	50	56	20.36	20.47	20.16		
20	16QAM	100	0	20.37	20.12	20.15	20.5	1.0
20	64QAM	1	1	21.36	21.09	21.44		
20	64QAM	1	53	21.36	21.05	21.08	21.5	0.0
20	64QAM	1	104	21.46	21.05	21.37		
20	64QAM	50	0	20.19	20.00	20.29		
20	64QAM	50	28	20.28	20.15	20.42	20.5	1.0
20	64QAM	50	56	20.31	20.30	20.32		
20	64QAM	100	0	20.19	20.18	20.37	20.5	1.0
20	256QAM	1	1	21.47	21.04	21.19		
20	256QAM	1	53	21.11	21.26	21.36	21.5	0.0
20	256QAM	1	104	21.43	21.12	21.17		
20	256QAM	50	0	20.19	20.48	20.07		
20	256QAM	50	28	20.18	20.32	20.30	20.5	1.0
20	256QAM	50	56	20.45	20.32	20.12		
20	256QAM	100	0	20.47	20.06	20.43	20.5	1.0
Channel				636833	643113	646500	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				3557.5	3625	3692.5		
15	PI/2 BPSK	1	1	21.06	21.48	21.05	21.5	0.0
Channel				636333	643113	647000	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				3555	3625	3695		
10	PI/2 BPSK	1	1	21.31	21.34	21.26	21.5	0.0
Channel				635833	643113	647000	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				3552.5	3625	3697.5		
5	PI/2 BPSK	1	1	21.33	21.30	21.01	21.5	0.0

<n66 Ant0>

BW [MHz]	Modulation	RB Size	RB Offset	Power Low Ch. / Freq.	Power Middle Ch. / Freq.	Power High Ch. / Freq.	Tune-up limit (dBm)	MPR (dB)
Channel				344000	349000	354000	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				1720	1745	1770		
20	PI/2 BPSK	1	1	24.03	24.14	24.32	24.5	0.0
20	PI/2 BPSK	1	53	24.34	24.44	24.00		
20	PI/2 BPSK	1	104	24.46	24.09	24.34		
20	PI/2 BPSK	50	0	23.31	23.25	23.29	23.5	1.0
20	PI/2 BPSK	50	28	23.49	23.16	23.04		
20	PI/2 BPSK	50	56	23.29	23.45	23.06		
20	PI/2 BPSK	100	0	23.36	23.20	23.01	23.5	1.0
20	QPSK	1	1	24.26	24.24	24.11	24.5	0.0
20	QPSK	1	53	24.02	24.10	24.33		
20	QPSK	1	104	24.02	24.39	24.01		
20	QPSK	50	0	23.02	23.01	23.02	23.5	1.0
20	QPSK	50	28	23.32	23.01	23.04		
20	QPSK	50	56	23.05	23.22	23.18		
20	QPSK	100	0	23.24	23.48	23.32	23.5	1.0
20	16QAM	1	1	24.21	24.16	24.23	24.5	0.0
20	16QAM	1	53	24.21	24.13	24.12		
20	16QAM	1	104	24.08	24.32	24.22		
20	16QAM	50	0	23.35	23.20	23.29	23.5	1.0
20	16QAM	50	28	23.11	23.12	23.31		
20	16QAM	50	56	23.35	23.21	23.14		
20	16QAM	100	0	23.31	23.05	23.14	23.5	1.0
20	64QAM	1	1	24.00	24.14	24.20	24.5	0.0
20	64QAM	1	53	24.06	24.05	24.20		
20	64QAM	1	104	24.16	24.20	24.46		
20	64QAM	50	0	23.02	23.12	23.18	23.5	1.0
20	64QAM	50	28	23.45	23.05	23.45		
20	64QAM	50	56	23.17	23.48	23.19		
20	64QAM	100	0	23.45	23.05	23.34	23.5	1.0
20	256QAM	1	1	24.50	24.33	24.50	24.5	0.0
20	256QAM	1	53	24.50	24.46	24.23		
20	256QAM	1	104	24.03	24.25	24.20		
20	256QAM	50	0	23.39	23.21	23.36	23.5	1.0
20	256QAM	50	28	23.49	23.50	23.43		
20	256QAM	50	56	23.15	23.02	23.17		
20	256QAM	100	0	23.13	23.42	23.05	23.5	1.0
Channel				343500	349000	354500	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				1717.5	1745	1772.5		
15	PI/2 BPSK	1	1	24.45	24.22	24.22	24.5	0.0
Channel				343000	349000	355000	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				1715	1745	1775		
10	PI/2 BPSK	1	1	24.26	24.13	24.35	24.5	0.0
Channel				342500	349000	355500	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				1712.5	1745	1777.5		
5	PI/2 BPSK	1	1	24.24	24.31	24.11	24.5	0.0

<n77 PC3 Ant4>

BW [MHz]	Modulation	RB Size	RB Offset	Power Low Ch. / Freq.	Power Middle Ch. / Freq.	Power High Ch. / Freq.	Tune-up limit (dBm)	MPR (dB)
Channel				620666	646720	679333	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				3310	3750	4190		
20	PI/2 BPSK	1	1	24.44	24.08	24.12	24.5	0.0
20	PI/2 BPSK	1	53	24.31	24.21	24.20		
20	PI/2 BPSK	1	104	24.48	24.12	24.32		
20	PI/2 BPSK	50	0	23.34	23.11	23.45	23.5	1.0
20	PI/2 BPSK	50	28	23.29	23.33	23.25		
20	PI/2 BPSK	50	56	23.29	23.35	23.02		
20	PI/2 BPSK	100	0	23.06	23.12	23.43	23.5	1.0
20	QPSK	1	1	24.11	24.26	24.09	24.5	0.0
20	QPSK	1	53	24.00	24.21	24.06		
20	QPSK	1	104	24.08	24.27	24.27		
20	QPSK	50	0	23.01	23.34	23.19	23.5	1.0
20	QPSK	50	28	23.48	23.48	23.43		
20	QPSK	50	56	23.30	23.08	23.49		
20	QPSK	100	0	23.30	23.17	23.29	23.5	1.0
20	16QAM	1	1	24.04	24.32	24.47	24.5	0.0
20	16QAM	1	53	24.27	24.15	24.48		
20	16QAM	1	104	24.47	24.19	24.47		
20	16QAM	50	0	23.01	23.33	23.36	23.5	1.0
20	16QAM	50	28	23.01	23.46	23.10		
20	16QAM	50	56	23.22	23.19	23.06		
20	16QAM	100	0	23.21	23.32	23.11	23.5	1.0
20	64QAM	1	1	24.16	24.04	24.36	24.5	0.0
20	64QAM	1	53	24.09	24.11	24.23		
20	64QAM	1	104	24.24	24.09	24.07		
20	64QAM	50	0	23.08	23.35	23.01	23.5	1.0
20	64QAM	50	28	23.20	23.29	23.05		
20	64QAM	50	56	23.17	23.45	23.13		
20	64QAM	100	0	23.11	23.06	23.46	23.5	1.0
20	256QAM	1	1	24.31	24.31	24.50	24.5	0.0
20	256QAM	1	53	24.06	24.31	24.33		
20	256QAM	1	104	24.32	24.09	24.08		
20	256QAM	50	0	23.10	23.10	23.36	23.5	1.0
20	256QAM	50	28	23.34	23.04	23.34		
20	256QAM	50	56	23.14	23.41	23.37		
20	256QAM	100	0	23.34	23.12	23.32	23.5	1.0
Channel				620166	646720	679833	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				3307.5	3750	4192.5		
15	PI/2 BPSK	1	1	24.35	24.16	24.13	24.5	0.0
Channel				619666	646720	680333	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				3305	3750	4195		
10	PI/2 BPSK	1	1	24.39	24.19	24.04	24.5	0.0
Channel				619166	646720	680833	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				3302.5	3750	4197.5		
5	PI/2 BPSK	1	1	24.37	24.14	24.32	24.5	0.0

<n77 PC2 Ant4>

BW [MHz]	Modulation	RB Size	RB Offset	Power Low Ch. / Freq.	Power Middle Ch. / Freq.	Power High Ch. / Freq.	Tune-up limit (dBm)	MPR (dB)
Channel				620666	646720	679333	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				3310	3750	4190		
20	PI/2 BPSK	1	1	25.87	25.72	25.51	26.0	0.0
20	PI/2 BPSK	1	53	25.73	25.87	25.68		
20	PI/2 BPSK	1	104	25.95	25.91	25.55		
20	PI/2 BPSK	50	0	24.93	24.51	24.57	25.0	1.0
20	PI/2 BPSK	50	28	24.87	24.67	24.84		
20	PI/2 BPSK	50	56	24.65	24.96	24.54		
20	PI/2 BPSK	100	0	24.94	24.67	24.65	25.0	1.0
20	QPSK	1	1	25.93	25.69	25.68	26.0	0.0
20	QPSK	1	53	25.68	25.80	25.84		
20	QPSK	1	104	25.78	25.77	25.92		
20	QPSK	50	0	24.74	24.64	24.82	25.0	1.0
20	QPSK	50	28	24.85	24.58	24.68		
20	QPSK	50	56	24.60	24.98	24.97		
20	QPSK	100	0	24.81	24.85	24.68	25.0	1.0
20	16QAM	1	1	25.50	25.74	25.70	26.0	0.0
20	16QAM	1	53	25.67	25.84	25.83		
20	16QAM	1	104	25.93	25.98	25.56		
20	16QAM	50	0	24.71	24.90	24.71	25.0	1.0
20	16QAM	50	28	24.96	24.60	24.78		
20	16QAM	50	56	24.97	24.63	24.96		
20	16QAM	100	0	24.55	24.56	24.59	25.0	1.0
20	64QAM	1	1	25.95	25.58	25.88	26.0	0.0
20	64QAM	1	53	25.79	25.89	25.62		
20	64QAM	1	104	25.66	25.94	25.61		
20	64QAM	50	0	24.98	24.54	24.71	25.0	1.0
20	64QAM	50	28	24.79	24.58	24.80		
20	64QAM	50	56	24.61	24.74	24.96		
20	64QAM	100	0	24.78	24.72	24.52	25.0	1.0
20	256QAM	1	1	25.95	25.70	25.78	26.0	0.0
20	256QAM	1	53	25.79	25.66	25.57		
20	256QAM	1	104	25.51	25.71	25.81		
20	256QAM	50	0	24.66	24.85	24.82	25.0	1.0
20	256QAM	50	28	24.95	24.75	24.90		
20	256QAM	50	56	24.56	24.85	24.93		
20	256QAM	100	0	24.56	24.79	24.81	25.0	1.0
Channel				620166	646720	679833	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				3307.5	3750	4192.5		
15	PI/2 BPSK	1	1	25.56	25.59	25.65	26.0	0.0
Channel				619666	646720	680333	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				3305	3750	4195		
10	PI/2 BPSK	1	1	25.79	25.97	25.50	26.0	0.0
Channel				619166	646720	680833	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				3302.5	3750	4197.5		
5	PI/2 BPSK	1	1	25.85	25.91	25.75	26.0	0.0

Table 9.2 FR1 Backoff Power Measurements

<n2 Ant0>

BW [MHz]	Modulation	RB Size	RB Offset	Power Low Ch. / Freq.	Power Middle Ch. / Freq.	Power High Ch. / Freq.	Tune-up limit (dBm)	MPR (dB)
Channel				372000	376000	380000	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				1860	1880	1900		
20	PI/2 BPSK	1	1	17.20	17.21	17.40	17.5	0.0
20	PI/2 BPSK	1	53	17.31	17.16	17.37		
20	PI/2 BPSK	1	104	17.13	17.06	17.34		
20	PI/2 BPSK	50	0	16.19	16.47	16.09	16.5	1.0
20	PI/2 BPSK	50	28	16.34	16.05	16.31		
20	PI/2 BPSK	50	56	16.44	16.33	16.11		
20	PI/2 BPSK	100	0	16.46	16.26	16.09	16.5	1.0
20	QPSK	1	1	17.46	17.28	17.47	17.5	0.0
20	QPSK	1	53	17.32	17.04	17.48		
20	QPSK	1	104	17.08	17.24	17.03		
20	QPSK	50	0	16.42	16.32	16.21	16.5	1.0
20	QPSK	50	28	16.15	16.15	16.45		
20	QPSK	50	56	16.14	16.47	16.07		
20	QPSK	100	0	16.22	16.07	16.29	16.5	1.0
20	16QAM	1	1	17.19	17.08	17.02	17.5	0.0
20	16QAM	1	53	17.01	17.48	17.21		
20	16QAM	1	104	17.35	17.08	17.06		
20	16QAM	50	0	16.07	16.26	16.41	16.5	1.0
20	16QAM	50	28	16.05	16.44	16.37		
20	16QAM	50	56	16.17	16.15	16.43		
20	16QAM	100	0	16.07	16.44	16.10	16.5	1.0
20	64QAM	1	1	17.16	17.15	17.34	17.5	0.0
20	64QAM	1	53	17.29	17.31	17.45		
20	64QAM	1	104	17.36	17.06	17.34		
20	64QAM	50	0	16.22	16.30	16.35	16.5	1.0
20	64QAM	50	28	16.48	16.38	16.14		
20	64QAM	50	56	16.28	16.33	16.33		
20	64QAM	100	0	16.12	16.24	16.31	16.5	1.0
20	256QAM	1	1	17.36	17.48	17.25	17.5	0.0
20	256QAM	1	53	17.08	17.35	17.45		
20	256QAM	1	104	17.10	17.44	17.16		
20	256QAM	50	0	16.09	16.29	16.01	16.5	1.0
20	256QAM	50	28	16.04	16.38	16.30		
20	256QAM	50	56	16.35	16.13	16.18		
20	256QAM	100	0	16.20	16.03	16.06	16.5	1.0
Channel				371500	376000	380500	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				1857.5	1880	1902.5		
15	PI/2 BPSK	1	1	17.35	17.48	17.18	17.5	0.0
Channel				371000	376000	381000	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				1855	1880	1905		
10	PI/2 BPSK	1	1	17.23	17.42	17.08	17.5	0.0
Channel				370500	376000	381500	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				1852.5	1880	1907.5		
5	PI/2 BPSK	1	1	17.35	17.26	17.46	17.5	0.0

<n66 Ant0>

BW [MHz]	Modulation	RB Size	RB Offset	Power Low Ch. / Freq.	Power Middle Ch. / Freq.	Power High Ch. / Freq.	Tune-up limit (dBm)	MPR (dB)
Channel				344000	349000	354000	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				1720	1745	1770		
20	PI/2 BPSK	1	1	19.49	19.34	19.36		
20	PI/2 BPSK	1	53	19.28	19.28	19.07	19.5	0.0
20	PI/2 BPSK	1	104	19.46	19.20	19.19		
20	PI/2 BPSK	50	0	18.42	18.24	18.38		
20	PI/2 BPSK	50	28	18.23	18.05	18.42	18.5	1.0
20	PI/2 BPSK	50	56	18.36	18.25	18.13		
20	PI/2 BPSK	100	0	18.37	18.46	18.09	18.5	1.0
20	QPSK	1	1	19.39	19.37	19.08		
20	QPSK	1	53	19.04	19.33	19.33	19.5	0.0
20	QPSK	1	104	19.32	19.07	19.27		
20	QPSK	50	0	18.36	18.12	18.12		
20	QPSK	50	28	18.38	18.07	18.28	18.5	1.0
20	QPSK	50	56	18.46	18.36	18.41		
20	QPSK	100	0	18.13	18.21	18.37	18.5	1.0
20	16QAM	1	1	19.45	19.28	19.06		
20	16QAM	1	53	19.48	19.07	19.32	19.5	0.0
20	16QAM	1	104	19.32	19.45	19.45		
20	16QAM	50	0	18.39	18.47	18.37		
20	16QAM	50	28	18.21	18.11	18.06	18.5	1.0
20	16QAM	50	56	18.35	18.03	18.17		
20	16QAM	100	0	18.14	18.20	18.25	18.5	1.0
20	64QAM	1	1	19.10	19.10	19.32		
20	64QAM	1	53	19.18	19.45	19.45	19.5	0.0
20	64QAM	1	104	19.03	19.31	19.16		
20	64QAM	50	0	18.41	18.43	18.08		
20	64QAM	50	28	18.50	18.50	18.20	18.5	1.0
20	64QAM	50	56	18.20	18.15	18.16		
20	64QAM	100	0	18.30	18.42	18.49	18.5	1.0
20	256QAM	1	1	19.00	19.09	19.07		
20	256QAM	1	53	19.15	19.30	19.19	19.5	0.0
20	256QAM	1	104	19.10	19.29	19.30		
20	256QAM	50	0	18.28	18.29	18.39		
20	256QAM	50	28	18.34	18.10	18.17	18.5	1.0
20	256QAM	50	56	18.46	18.22	18.34		
20	256QAM	100	0	18.32	18.28	18.32	18.5	1.0
Channel				343500	349000	354500	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				1717.5	1745	1772.5		
15	PI/2 BPSK	1	1	19.14	19.26	19.43	19.5	0.0
Channel				343000	349000	355000	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				1715	1745	1775		
10	PI/2 BPSK	1	1	19.46	19.35	19.15	19.5	0.0
Channel				342500	349000	355500	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				1712.5	1745	1777.5		
5	PI/2 BPSK	1	1	19.07	19.10	19.49	19.5	0.0

<n77 PC2 & PC3 Ant4>

BW [MHz]	Modulation	RB Size	RB Offset	Power Low Ch. / Freq.	Power Middle Ch. / Freq.	Power High Ch. / Freq.	Tune-up limit (dBm)	MPR (dB)
Channel				620666	646720	679333	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				3310	3750	4190		
20	PI/2 BPSK	1	1	21.15	21.48	21.23	21.5	0.0
20	PI/2 BPSK	1	53	21.09	21.43	21.04		
20	PI/2 BPSK	1	104	21.15	21.40	21.14		
20	PI/2 BPSK	50	0	20.38	20.20	20.13	20.5	1.0
20	PI/2 BPSK	50	28	20.30	20.29	20.45		
20	PI/2 BPSK	50	56	20.16	20.16	20.13		
20	PI/2 BPSK	100	0	20.23	20.33	20.31	20.5	1.0
20	QPSK	1	1	21.39	21.07	21.19	21.5	0.0
20	QPSK	1	53	21.23	21.26	21.03		
20	QPSK	1	104	21.26	21.23	21.16		
20	QPSK	50	0	20.41	20.30	20.02	20.5	1.0
20	QPSK	50	28	20.35	20.10	20.05		
20	QPSK	50	56	20.23	20.41	20.36		
20	QPSK	100	0	20.46	20.47	20.20	20.5	1.0
20	16QAM	1	1	21.23	21.19	21.12	21.5	0.0
20	16QAM	1	53	21.44	21.03	21.29		
20	16QAM	1	104	21.22	21.40	21.11		
20	16QAM	50	0	20.03	20.04	20.03	20.5	1.0
20	16QAM	50	28	20.28	20.20	20.26		
20	16QAM	50	56	20.46	20.48	20.07		
20	16QAM	100	0	20.16	20.47	20.18	20.5	1.0
20	64QAM	1	1	21.04	21.06	21.02	21.5	0.0
20	64QAM	1	53	21.20	21.05	21.44		
20	64QAM	1	104	21.07	21.33	21.07		
20	64QAM	50	0	20.22	20.34	20.14	20.5	1.0
20	64QAM	50	28	20.16	20.27	20.22		
20	64QAM	50	56	20.08	20.32	20.38		
20	64QAM	100	0	20.46	20.39	20.40	20.5	1.0
20	256QAM	1	1	21.29	21.41	21.15	21.5	0.0
20	256QAM	1	53	21.31	21.29	21.31		
20	256QAM	1	104	21.27	21.35	21.19		
20	256QAM	50	0	20.39	20.10	20.49	20.5	1.0
20	256QAM	50	28	20.41	20.40	20.36		
20	256QAM	50	56	20.32	20.32	20.13		
20	256QAM	100	0	20.24	20.23	20.44	20.5	1.0
Channel				620166	646720	679833	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				3307.5	3750	4192.5		
15	PI/2 BPSK	1	1	21.22	21.28	21.21	21.5	0.0
Channel				619666	646720	680333	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				3305	3750	4195		
10	PI/2 BPSK	1	1	21.17	21.20	21.45	21.5	0.0
Channel				619166	646720	680833	Tune-up limit (dBm)	MPR (dB)
Frequency (MHz)				3302.5	3750	4197.5		
5	PI/2 BPSK	1	1	21.26	21.49	21.25	21.5	0.0

9. SAR Test Results

General Note:

1. Per KDB 447498 D01v06, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.
   a. Tune-up scaling Factor = tune-up limit power (mW) / EUT RF power (mW), where tune-up limit is the maximum rated power among all production units.
   b. For SAR testing of WLAN signal with non-100% duty cycle, the measured SAR is scaled-up by the duty cycle scaling factor which is equal to "1/(duty cycle)"
   c. For WWAN: Reported SAR(W/kg)= Measured SAR(W/kg)*Tune-up Scaling Factor
2. Per KDB 447498 D01v06, for each exposure position, testing of other required channels within the operating mode of a frequency band is not required when the *reported* 1-g or 10-g SAR for the mid-band or highest output power channel is:
   - ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
   - ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
   - ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz
3. Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥0.8W/kg.

FR1 Note:

1. For 5G NR test procedure was following step similar FCC KDB 941225 D05:
   a. SAR testing start with the largest channel bandwidth and measure SAR for PI/2 BPSK with 1 RB allocation, using the RB offset and required test channel combination with the highest maximum output power for RB offsets at the upper edge, middle and lower edge of each required test channel.
   b. 50% RB allocation for PI/2 BPSK SAR testing follows 1RB PI/2 BPSK allocation procedure
   c. PI/2 BPSK with 100% RB allocation, SAR is not required when the highest maximum output power for 100 % RB allocation is less than the highest maximum output power in 50% and 1 RB allocations and the highest reported SAR for 1 RB and 50% RB allocation are ≤ 0.8 W/kg. Otherwise, SAR is measured for the highest output power channel; and if the reported SAR is > 1.45 W/kg, the remaining required test channels must also be tested.
   d. QPSK/16QAM/64QAM/256QAM output powers are not ½ dB higher than the same configuration in PI/2 BPSK, also reported SAR for the PI/2 BPSK configuration is less than 1.45 W/kg, QPSK/16QAM/64QAM/256QAM SAR testing are not required.
   e. Smaller bandwidth output power for each RB allocation configuration for this device will not ½ dB higher than the same configuration in the largest supported bandwidth, and the reported SAR for the largest supported bandwidth is ≤ 1.45 W/kg, smaller bandwidth SAR testing is not required for this device
   f. For 5G FR1 n5/n12/n41/n71 the maximum bandwidth does not support three non-overlapping channels, when a device supports overlapping channel assignment in a channel bandwidth configuration, the middle channel of the group of overlapping channels should be selected for testing.
2. Due to test setup limitations, SAR testing for NR was performed using Factory Test Mode software to establish the connection and perform SAR with 100% duty cycle. The Qualcomm QRCT program was used to establish the connection.

Plot No.	Band	BW (MHz)	Modulation	RB Size	RB offset	Test Position	Gap (mm)	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit	Measured 1g SAR (W/kg)	Reported 1g SAR (W/kg)	Referenced Data
	FR1 Band 2_Ant 0	20M	BPSK	1	53	Side A	10mm	376000	1880	17.16	17.50	0.259	0.28	
	FR1 Band 2_Ant 0	20M	BPSK	50	28		10mm	376000	1880	16.05	16.50	0.202	0.22	
	FR1 Band 2_Ant 0	20M	BPSK	1	53	Side B	10mm	376000	1880	17.16	17.50	0.0521	0.06	
	FR1 Band 2_Ant 0	20M	BPSK	50	28		10mm	376000	1880	16.05	16.50	0.0498	0.06	
	FR1 Band 2_Ant 0	20M	BPSK	1	53	Side C	10mm	376000	1880	17.16	17.50	0.296	0.32	
	FR1 Band 2_Ant 0	20M	BPSK	50	28		10mm	376000	1880	16.05	16.50	0.235	0.26	
	FR1 Band 2_Ant 0	20M	BPSK	1	53	Side D	10mm	376000	1880	17.16	17.50	0.138	0.15	
	FR1 Band 2_Ant 0	20M	BPSK	50	28		10mm	376000	1880	16.05	16.50	0.101	0.11	
	FR1 Band 2_Ant 0	20M	BPSK	1	53	Side F	10mm	372000	1860	17.31	17.50	0.733	0.77	
1	FR1 Band 2_Ant 0	20M	BPSK	1	53		10mm	376000	1880	17.16	17.50	0.806	0.87	0.86
	FR1 Band 2_Ant 0	20M	BPSK	1	53		10mm	380000	1900	17.37	17.50	0.701	0.72	
	FR1 Band 2_Ant 0	20M	BPSK	50	28		10mm	376000	1880	16.05	16.50	0.726	0.81	
	FR1 Band 5_Ant 0	10M	BPSK	1	53	Side A	10mm	167300	836.5	23.95	24.00	0.392	0.40	
	FR1 Band 5_Ant 0	10M	BPSK	50	28		10mm	167300	836.5	22.95	23.00	0.327	0.33	
	FR1 Band 5_Ant 0	10M	BPSK	1	53	Side B	10mm	167300	836.5	23.95	24.00	0.324	0.33	
	FR1 Band 5_Ant 0	10M	BPSK	50	28		10mm	167300	836.5	22.95	23.00	0.259	0.26	
2	FR1 Band 5_Ant 0	10M	BPSK	1	53	Side C	10mm	167300	836.5	23.95	24.00	0.486	0.49	0.54
	FR1 Band 5_Ant 0	10M	BPSK	50	28		10mm	167300	836.5	22.95	23.00	0.418	0.42	
	FR1 Band 5_Ant 0	10M	BPSK	1	53	Side D	10mm	167300	836.5	23.95	24.00	0.199	0.20	
	FR1 Band 5_Ant 0	10M	BPSK	50	28		10mm	167300	836.5	22.95	23.00	0.138	0.14	
	FR1 Band 5_Ant 0	10M	BPSK	1	53	Side F	10mm	167300	836.5	23.95	24.00	0.0345	0.03	
	FR1 Band 5_Ant 0	10M	BPSK	50	28		10mm	167300	836.5	22.95	23.00	0.0276	0.03	
3	FR1 Band 48_Ant 4	20M	BPSK	1	53	Side A	10mm	643113	3625	21.22	21.50	0.830	0.89	0.90
4	FR1 Band 66_Ant 0	20M	BPSK	1	53	Side F	10mm	349000	1745	19.07	19.50	0.811	0.90	0.89
5	FR1 Band 77_Ant 4	20M	BPSK	1	53	Side B	10mm	646720	3750	21.43	21.50	0.723	0.74	0.74

10. Simultaneous Transmission Analysis

All the data below is referenced from the original reports under FCC ID: PKRISGM3000A in report numbers SAR.20220610 and SAR.20220611 for the 3G/4G/WiFi and FR1. The FR2 data is from the report number SAR.20220615 contained in this filing. The data listed in the tables below was extracted from these reports.

Sim-Tx configuration

No.	Simultaneous Transmission Configuration	Exposure Positions
		Body
1	UMTS + 2.4 GHz Wifi 0 + 2.4 GHz WiFi 1	Yes
2	UMTS + 5 GHz Wifi 0 + 5 GHz WiFi 1	Yes
3	LTE + 2.4 GHz Wifi 0 + 2.4 GHz WiFi 1	Yes
4	LTE + 5 GHz Wifi 0 + 5 GHz WiFi 1	Yes
5	FR1 + 2.4 GHz Wifi 0 + 2.4 GHz WiFi 1	Yes
6	FR1 + 5 GHz Wifi 0 + 5 GHz WiFi 1	Yes
7	LTE + FR2 + 2.4 GHz WiFi 0 + 2.4 GHz WiFi 1	Yes
8	LTE + FR2 + 5 GHz WiFi 0 + 5 GHz WiFi 1	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

WWAN Band	Exposure Position	1 WWAN 1g SAR (W/kg)	2 2.4GHz Wi-Fi 0 1g SAR (W/kg)	3 2.4GHz Wi-Fi 1 1g SAR (W/kg)	4 5GHz Wi-Fi 0 1g SAR (W/kg)	5 5GHz Wi-Fi 1 1g SAR (W/kg)	**1+2+3 Summed 1g SAR (W/kg)**	**1+4+5 Summed 1g SAR (W/kg)**
WCDMA II Ant 0	Side A	0.24	0.19	0.20	0.22	0.19	0.63	0.65
	Side B	0.01		0.09		0.21	0.10	0.22
	Side C	0.28	0.13	0.18	0.25	0.21	0.59	0.74
	Side D	0.16	0.21		0.26		0.37	0.42
	Side E		0.04		0.17		0.04	0.17
	Side F	0.87		0.07		0.17	0.94	1.04
WCDMA IV Ant 0	Side A	0.73	0.19	0.20	0.22	0.19	1.12	1.14
	Side B	0.09		0.09		0.21	0.18	0.30
	Side C	0.88	0.13	0.18	0.25	0.21	1.19	1.34
	Side D	0.03	0.21		0.26		0.24	0.29
	Side E		0.04		0.17		0.04	0.17
	Side F	0.60		0.07		0.17	0.67	0.77
WCDMA V Ant 0	Side A	0.88	0.19	0.20	0.22	0.19	1.27	1.29
	Side B	0.58		0.09		0.21	0.67	0.79
	Side C	0.87	0.13	0.18	0.25	0.21	1.18	1.33
	Side D	0.40	0.21		0.26		0.61	0.66
	Side E		0.04		0.17		0.04	0.17
	Side F	0.07		0.07		0.17	0.14	0.24
LTE Band 2 Ant 0	Side A	0.19	0.19	0.20	0.22	0.19	0.58	0.60
	Side B	0.18		0.09		0.21	0.27	0.39
	Side C	0.40	0.13	0.18	0.25	0.21	0.71	0.86
	Side D	0.54	0.21		0.26		0.75	0.80
	Side E		0.04		0.17		0.04	0.17
	Side F	0.80		0.07		0.17	0.87	0.97
LTE Band 5 Ant 0	Side A	0.75	0.19	0.20	0.22	0.19	1.14	1.16
	Side B	0.48		0.09		0.21	0.57	0.69
	Side C	0.78	0.13	0.18	0.25	0.21	1.09	1.24
	Side D	0.35	0.21		0.26		0.56	0.61
	Side E		0.04		0.17		0.04	0.17
	Side F	0.08		0.07		0.17	0.15	0.25
LTE Band 7 Ant 0	Side A	0.60	0.19	0.20	0.22	0.19	0.99	1.01
	Side B	0.03		0.09		0.21	0.12	0.24
	Side C	0.26	0.13	0.18	0.25	0.21	0.57	0.72
	Side D	0.10	0.21		0.26		0.31	0.36
	Side E		0.04		0.17		0.04	0.17
	Side F	0.84		0.07		0.17	0.91	1.01
LTE Band 12 Ant 0	Side A	0.17	0.19	0.20	0.22	0.19	0.56	0.58
	Side B	0.10		0.09		0.21	0.19	0.31
	Side C	0.16	0.13	0.18	0.25	0.21	0.47	0.62
	Side D	0.10	0.21		0.26		0.31	0.36
	Side E		0.04		0.17		0.04	0.17
	Side F	0.09		0.07		0.17	0.16	0.26
LTE Band 13 Ant 0	Side A	0.50	0.19	0.20	0.22	0.19	0.89	0.91
	Side B	0.35		0.09		0.21	0.44	0.56
	Side C	0.44	0.13	0.18	0.25	0.21	0.75	0.90
	Side D	0.24	0.21		0.26		0.45	0.50
	Side E		0.04		0.17		0.04	0.17
	Side F	0.06		0.07		0.17	0.13	0.23

WWAN Band	Exposure Position	1	2	3	4	5	1+2+3 Summed 1g SAR (W/kg)	1+4+5 Summed 1g SAR (W/kg)
		WWAN	2.4GHz Wi-Fi 0	2.4GHz Wi-Fi 1	5GHz Wi-Fi 0	5GHz Wi-Fi 1		
		1g SAR (W/kg)	1g SAR (W/kg)	1g SAR (W/kg)	1g SAR (W/kg)	1g SAR (W/kg)		
LTE Band 48 Ant 4	Side A	0.61	0.19	0.20	0.22	0.19	1.00	1.02
	Side B	0.14		0.09		0.21	0.23	0.35
	Side C	0.33	0.13	0.18	0.25	0.21	0.64	0.79
	Side D		0.21		0.26		0.21	0.26
	Side E		0.04		0.17		0.04	0.17
	Side F	0.68		0.07		0.17	0.75	0.85
LTE Band 66 Ant 0	Side A	0.52	0.19	0.20	0.22	0.19	0.91	0.93
	Side B	0.06		0.09		0.21	0.15	0.27
	Side C	0.66	0.13	0.18	0.25	0.21	0.97	1.12
	Side D	0.19	0.21		0.26		0.40	0.45
	Side E		0.04		0.17		0.04	0.17
	Side F	0.80		0.07		0.17	0.87	0.97
FR1 Band n2 Ant 0	Side A	0.28	0.19	0.20	0.22	0.19	0.67	0.69
	Side B	0.06		0.09		0.21	0.15	0.27
	Side C	0.32	0.13	0.18	0.25	0.21	0.63	0.78
	Side D	0.15	0.21		0.26		0.36	0.41
	Side E		0.04		0.17		0.04	0.17
	Side F	0.87		0.07		0.17	0.94	1.04
FR1 Band n5 Ant 0	Side A	0.40	0.19	0.20	0.22	0.19	0.79	0.81
	Side B	0.33		0.09		0.21	0.42	0.54
	Side C	0.49	0.13	0.18	0.25	0.21	0.80	0.95
	Side D	0.20	0.21		0.26		0.41	0.46
	Side E		0.04		0.17		0.04	0.17
	Side F	0.03		0.07		0.17	0.10	0.20
FR1 Band n48 Ant 4	Side A	0.90	0.19	0.20	0.22	0.19	1.29	1.31
	Side B	0.74		0.09		0.21	0.83	0.95
	Side C	0.39	0.13	0.18	0.25	0.21	0.70	0.85
	Side D		0.21		0.26		0.21	0.26
	Side E		0.04		0.17		0.04	0.17
	Side F	0.64		0.07		0.17	0.71	0.81
FR1 Band n66 Ant 0	Side A	0.68	0.19	0.20	0.22	0.19	1.07	1.09
	Side B	0.10		0.09		0.21	0.19	0.31
	Side C	0.83	0.13	0.18	0.25	0.21	1.14	1.29
	Side D	0.20	0.21		0.26		0.41	0.46
	Side E		0.04		0.17		0.04	0.17
	Side F	0.89		0.07		0.17	0.96	1.06
FR1 Band n77 Ant 4	Side A	0.69	0.19	0.20	0.22	0.19	1.08	1.10
	Side B	0.74		0.09		0.21	0.83	0.95
	Side C	0.34	0.13	0.18	0.25	0.21	0.65	0.80
	Side D		0.21		0.26		0.21	0.26
	Side E		0.04		0.17		0.04	0.17
	Side F	0.51		0.07		0.17	0.58	0.68

LTE UL CA	SAR_1	SAR_2	WiFi Sum of Tx0 and Tx1	Total
2A-4A	0.14	0.31	0.47	0.92
2A-5A	0.14	0.38	0.47	0.99
2A-13A	0.33	0.26	0.47	1.06
2A-66A	0.14	0.32	0.47	0.93
4A-5A	0.37	0.38	0.47	1.22
4A-13A	0.31	0.26	0.47	1.04
5A-66A	0.38	0.35	0.47	1.20
13A-66A	0.26	0.32	0.47	1.05

FR1 UL ENDC-LTE (NSA)	SAR_1	SAR_2	WiFi Sum of Tx0 and Tx1	Total
5A-n2A	0.38	0.38	0.47	1.23
13A-n2A	0.26	0.54	0.47	1.27
66A-n2A	0.35	0.54	0.47	1.36
2A-n5A	0.14	0.50	0.47	1.11
48A-n5A	0.34	0.54	0.47	1.35
66A-n5A	0.35	0.50	0.47	1.32
2A-n66A	0.14	0.41	0.47	1.02
5A-n66A	0.38	0.39	0.47	1.24
7A-n66A	0.43	0.41	0.47	1.31
13A-n66A	0.26	0.41	0.47	1.14
48A-n66A	0.34	0.38	0.47	1.19
2A-n77A	0.14	0.37	0.47	0.98
5A-n77A	0.35	0.37	0.47	1.19
7A-n77A	0.43	0.37	0.47	1.27
13A-n77A	0.26	0.37	0.47	1.10
66A-n77A	0.35	0.37	0.47	1.19

FR2 UL ENDC-LTE (NSA)		Ratio to Limit1	Ratio to Limit	WiFi Ratio of Tx0 and Tx1	Total
1CC	2A-n260A	0.09	0.10	0.30	0.49
	5A-n260A	0.22	0.10	0.30	0.62
	13A-n260A	0.16	0.10	0.30	0.56
	48A-n260A	0.21	0.10	0.30	0.61
	66A-n260A	0.22	0.10	0.30	0.62
2CC	2A-n260G	0.09	0.26	0.30	0.65
	5A-n260G	0.22	0.26	0.30	0.78
	13A-n260G	0.16	0.26	0.30	0.72
	48A-n260G	0.21	0.26	0.30	0.77
	66A-n260G	0.22	0.26	0.30	0.78
1CC	2A-n261A	0.09	0.15	0.30	0.54
	5A-n261A	0.22	0.15	0.30	0.67
	13A-n261A	0.16	0.15	0.30	0.61
	48A-n261A	0.21	0.15	0.30	0.66
	66A-n261A	0.22	0.15	0.30	0.67
2CC	2A-n261G	0.09	0.27	0.30	0.66
	5A-n261G	0.22	0.27	0.30	0.79
	13A-n261G	0.16	0.27	0.30	0.73
	48A-n261G	0.21	0.27	0.30	0.78
	66A-n261G	0.22	0.27	0.30	0.79

11. Test Equipment List

Table 11.1 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
ELI5 Flat Phantom	N/A	N/A	1251
Device Holder	N/A	N/A	N/A
Data Acquisition Electronics 4	08/06/2022	08/06/2021	759
SPEAG E-Field Probe EX3DV4	01/14/2023	01/14/2022	7530
Speag Validation Dipole D900V2	06/04/2023	06/04/2021	1d128
Speag Validation Dipole D1750V2	06/03/2023	06/03/2021	1061
Speag Validation Dipole D1900V2	06/04/2023	06/04/2021	5d147
Speag Validation Dipole D3500V2	04/13/2023	04/13/2021	1061
Speag Validation Dipole D3700V2	04/13/2023	04/13/2021	1024
Agilent N1911A Power Meter	03/16/2023	03/16/2022	GB45100254
Agilent N1922A Power Sensor	03/17/2023	03/17/2022	MY45240464
Agilent (HP) 8561E Spectrum Analyzer	03/17/2023	03/17/2022	31720068
Agilent (HP) 83752A Synthesized Sweeper	03/17/2023	03/17/2022	3610A01048
Agilent (HP) 8753C Vector Network Analyzer	03/17/2023	03/17/2022	3135A01724
Agilent (HP) 85047A S-Parameter Test Set	03/16/2023	03/16/2022	2904A00595
Anritsu MT8821C	N/A	N/A	6201381721
Aprel Dielectric Probe Assembly	N/A	N/A	0011
Head Equivalent Matter (900 MHz)	N/A	N/A	N/A
Head Equivalent Matter (1750 MHz)	N/A	N/A	N/A
Head Equivalent Matter (1900 MHz)	N/A	N/A	N/A
Head Equivalent Matter (3-6 GHz)	N/A	N/A	N/A

12. 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.

13. 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 Validation Plots and Data

****
Test Result for UIM Dielectric Parameter
Fri 10/Jun/2022
Freq Frequency(GHz)
eH Limits for Head Epsilon
sH Limits for Head Sigma
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	eH	sH	Test_e	Test_s
0.8000	41.68	0.90	41.25	0.91
0.8100	41.63	0.90	41.20	0.92
0.8200	41.58	0.90	41.14	0.93
0.8300	41.53	0.90	41.19	0.93
0.8340	41.518	0.904	41.178	0.934*
0.8365	41.511	0.907	41.171	0.937*
0.8390	41.503	0.909	41.163	0.939*
0.8400	41.50	0.91	41.16	0.94
0.8500	41.50	0.92	41.14	0.95
0.8600	41.50	0.93	41.12	0.96
0.8700	41.50	0.94	41.10	0.97
0.8800	41.50	0.95	41.09	0.98
0.8900	41.50	0.96	41.08	0.99
0.9000	41.50	0.97	41.07	1.00
0.9100	41.50	0.98	41.06	1.01
0.9200	41.49	0.98	41.05	1.01

* value interpolated

****
Test Result for UIM Dielectric Parameter
Sat 11/Jun/2022
Freq Frequency(GHz)
eH Limits for Head Epsilon
sH Limits for Head Sigma
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	eH	sH	Test_e	Test_s
1.7000	40.16	1.34	39.45	1.37
1.7100	40.14	1.35	39.43	1.38
1.7200	40.13	1.35	39.41	1.39
1.7300	40.11	1.36	39.39	1.39
1.7400	40.09	1.37	39.37	1.40
1.7450	40.085	1.37	39.36	1.405*
1.7500	40.08	1.37	39.35	1.41
1.7600	40.06	1.38	39.33	1.42
1.7700	40.05	1.38	39.31	1.43
1.7800	40.03	1.39	39.29	1.43
1.7900	40.02	1.39	39.27	1.44

* value interpolated

****
Test Result for UIM Dielectric Parameter
Fri 10/Jun/2022
Freq   Frequency(GHz)
eH Limits for Head Epsilon
sH Limits for Head Sigma
Test_e Epsilon of UIM
Test_s Sigma of UIM
****

Freq	eH	sH	Test_e	Test_s
1.8500	40.00	1.40	39.80	1.42
1.8600	40.00	1.40	39.78	1.43
1.8700	40.00	1.40	39.76	1.43
1.8800	40.00	1.40	39.74	1.44
1.8900	40.00	1.40	39.72	1.44
1.9000	40.00	1.40	39.70	1.44
1.9100	40.00	1.40	39.68	1.45
1.9200	40.00	1.40	39.67	1.46

* value interpolated

****
Test Result for UIM Dielectric Parameter
Sat 11/Jun/2022
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
3.5000	37.93	2.91	37.10	2.92
3.5200	37.91	2.93	37.08	2.94
3.5400	37.88	2.95	37.05	2.96
3.5600	37.86	2.97	37.03	2.98
3.5800	37.84	2.99	37.01	3.00
3.6000	37.81	3.02	36.98	3.03
3.6033	37.807	3.023	36.977	3.033*
3.6200	37.79	3.04	36.96	3.05
3.6400	37.77	3.06	36.94	3.07
3.6600	37.75	3.08	36.92	3.09
3.6800	37.72	3.10	36.89	3.11
3.7000	37.70	3.12	36.87	3.13
3.7008	37.699	3.121	36.869	3.131*
3.7200	37.68	3.14	36.85	3.15
3.7400	37.65	3.17	36.82	3.18

* value interpolated

RF Exposure Lab

Plot 1

DUT: Dipole 900 MHz D900V2; Type: D900V2; Serial: D900V2 - SN:1d128

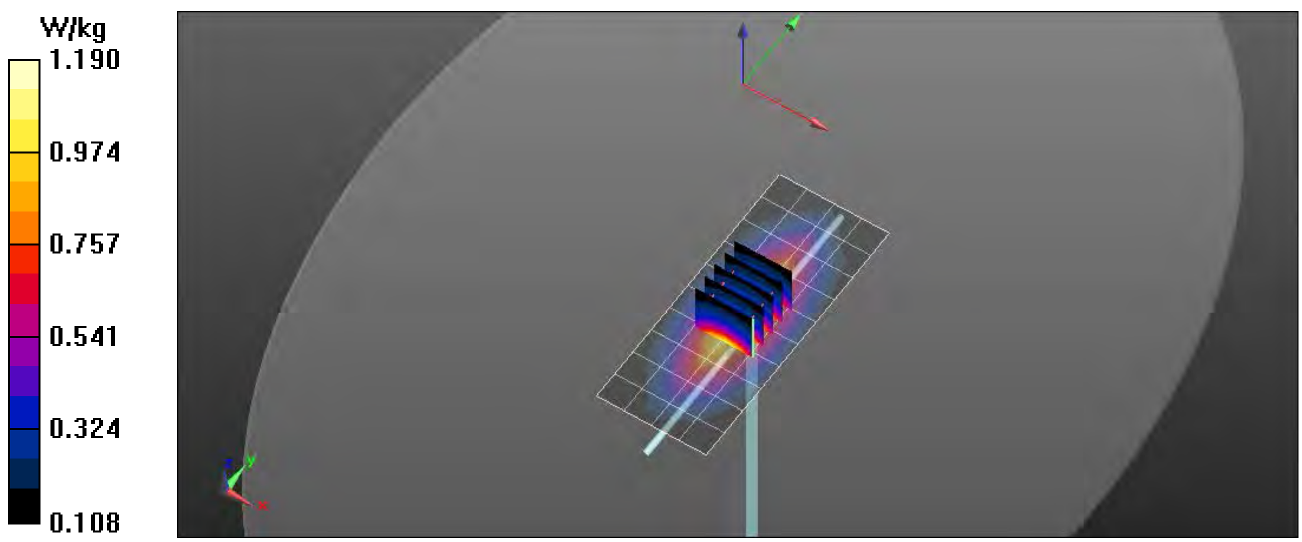
Communication System: CW; Frequency: 900 MHz; Duty Cycle: 1:1
Medium: HSL900; Medium parameters used: f = 900 MHz; σ = 1 S/m; ε_r = 41.06; ρ = 1000 kg/m^3
Phantom section: Flat Section

Test Date: Date: 6/10/2022; Ambient Temp: 23 °C; Tissue Temp: 21 °C
Probe: EX3DV4 - SN7530; ConvF(9.98, 9.98, 9.98); Calibrated: 1/14/2022;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn759; Calibrated: 8/6/2021
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: 1251
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

900 MHz Head/Verification/Area Scan (5x11x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 1.18 W/kg

900 MHz Head/Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 32.269 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 1.44 W/kg
P_{in}= 100 mW
SAR(1 g) = 1.18 W/kg; SAR(10 g) = 0.717 W/kg
Maximum value of SAR (measured) = 1.17 W/kg



RF Exposure Lab

Plot 2

DUT: Dipole 1750 MHz D1750V2; Type: D1750V2; Serial: D1750V2 - SN:1061

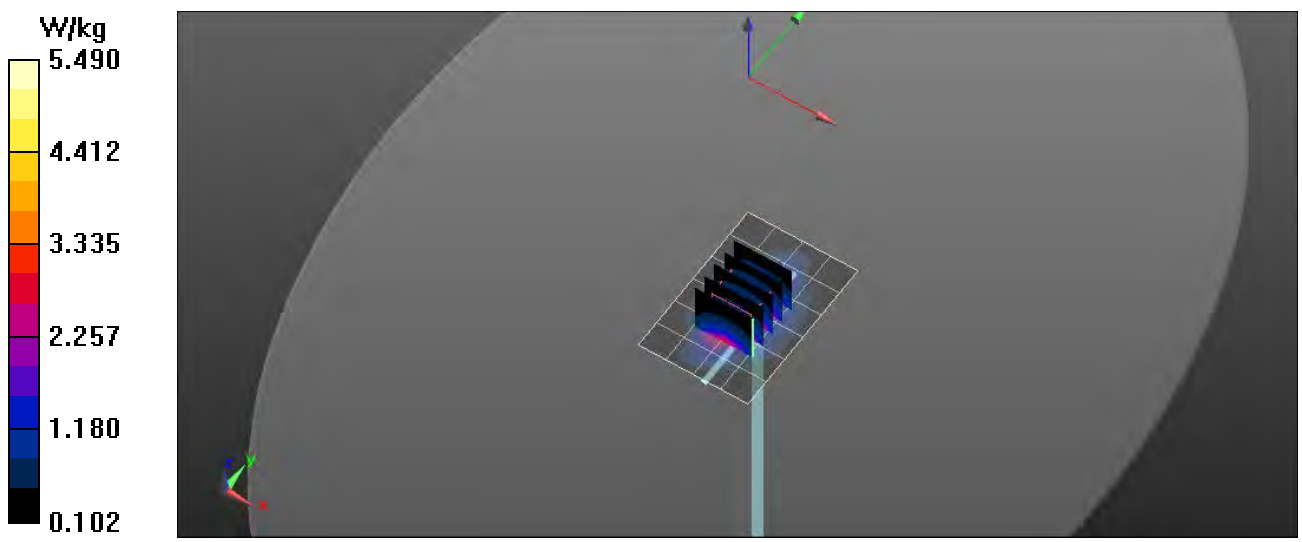
Communication System: CW; Frequency: 1750 MHz; Duty Cycle: 1:1
Medium: HSL1750; Medium parameters used: f = 1750 MHz; σ = 1.41 S/m; ε_r = 39.35; ρ = 1000 kg/m^3
Phantom section: Flat Section

Test Date: Date: 6/11/2022; Ambient Temp: 23 °C; Tissue Temp: 21 °C
Probe: EX3DV4 - SN7530; ConvF(8.42, 8.42, 8.42); Calibrated: 1/14/2022;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn759; Calibrated: 8/6/2021
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: 1251
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

1750 MHz Head/Verification/Area Scan (5x7x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 5.52 W/kg

1750 MHz Head/Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 36.476 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 6.92 W/kg
P_{in}= 100 mW
SAR(1 g) = 3.83 W/kg; SAR(10 g) = 2.01 W/kg
Maximum value of SAR (measured) = 5.49 W/kg



RF Exposure Lab

Plot 3

DUT: Dipole 1900 MHz D1900V2; Type: D1900V2; Serial: D1900V2 - SN: 5d147

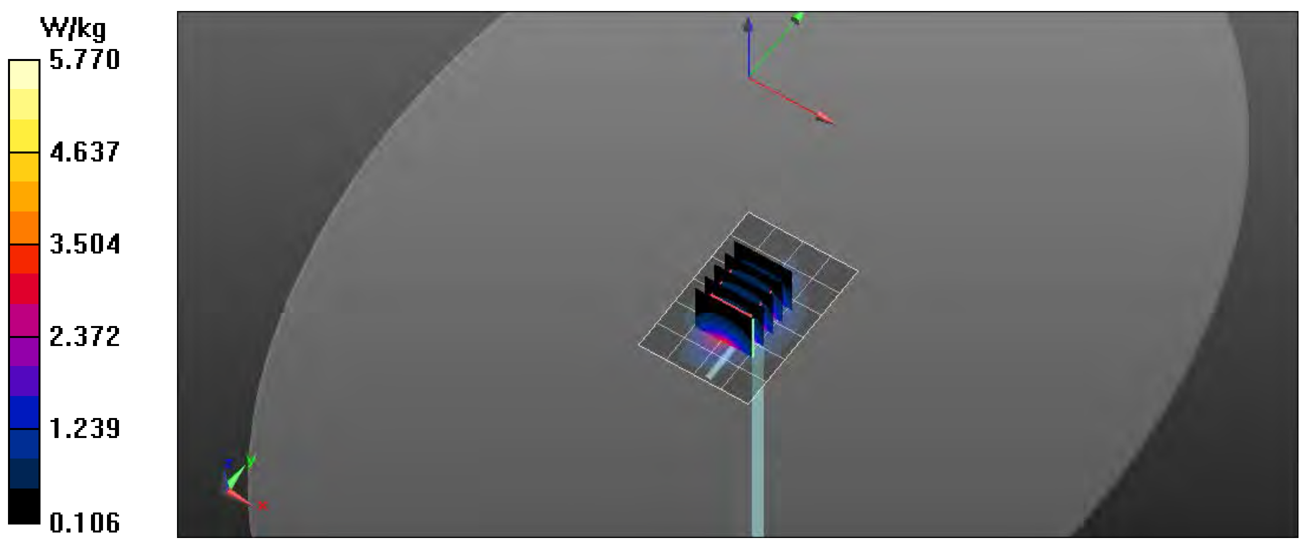
Communication System: CW; Frequency: 1900 MHz; Duty Cycle: 1:1
Medium: HSL1900; Medium parameters used: f = 1900 MHz; σ = 1.44 S/m; ε_r = 39.7; ρ = 1000 kg/m^3
Phantom section: Flat Section

Test Date: Date: 6/10/2022; Ambient Temp: 23 °C; Tissue Temp: 21 °C
Probe: EX3DV4 - SN7530; ConvF(8.06, 8.06, 8.06); Calibrated: 1/14/2022;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn759; Calibrated: 8/6/2021
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: 1251
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

1900 MHz Head/Verification/Area Scan (5x7x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 5.46 W/kg

1900 MHz Head/Verification/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 36.335 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 7.22 W/kg
P_{in}= 100 mW
SAR(1 g) = 4.15 W/kg; SAR(10 g) = 2.16 W/kg
Maximum value of SAR (measured) = 5.78 W/kg



Plot 4

DUT: Dipole D3500V2; Type: D3500V2; Serial: D3500V2 - SN: 1061

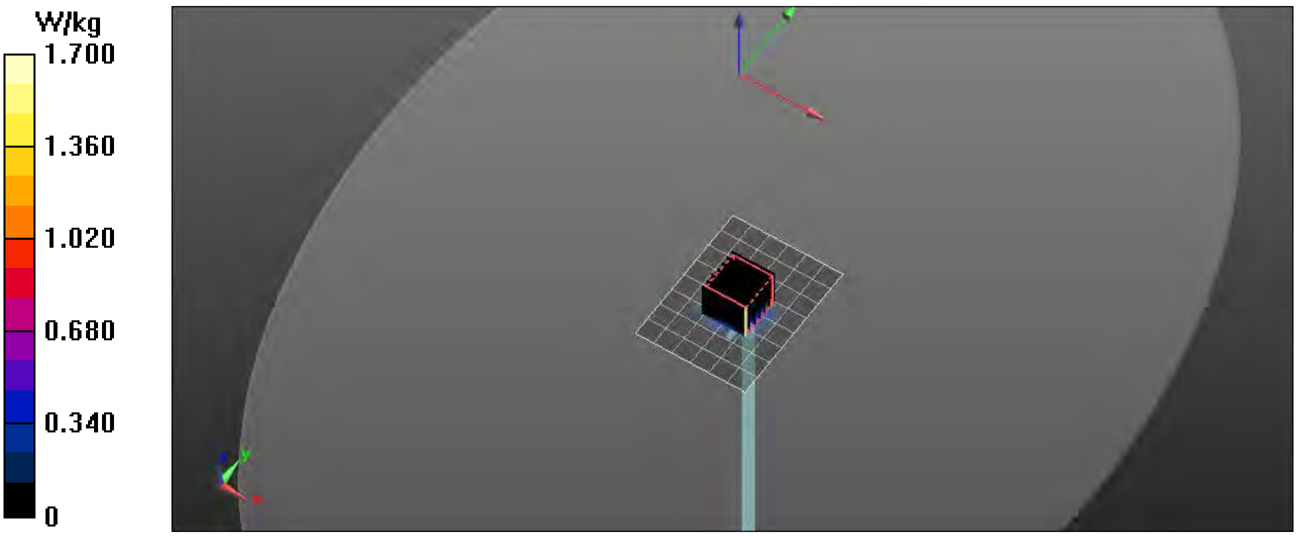
Communication System: CW; Frequency: 3500 MHz; Duty Cycle: 1:1
Medium: HSL 3-6 GHz; Medium parameters used: f = 3500 MHz; σ = 2.92 S/m; ε_r = 37.1; ρ = 1000 kg/m^3
Phantom section: Flat Section

Test Date: Date: 6/11/2022; Ambient Temp: 23 °C; Tissue Temp: 21 °C
Probe: EX3DV4 - SN7530; ConvF(7.1, 7.1, 7.1); Calibrated: 4/12/2022;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn759; Calibrated: 8/6/2021
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: 1251
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

3500 MHz Head/Verification/Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 1.69 W/kg

3500 MHz Head/Verification/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=4mm
Reference Value = 22.597 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 3.75 W/kg
P_{in}= 10 mW
SAR(1 g) = 0.679 W/kg; SAR(10 g) = 0.252 W/kg
Maximum value of SAR (measured) = 1.71 W/kg



RF Exposure Lab

Plot 5

DUT: Dipole D3700V2; Type: D3700V2; Serial: D3700V2 - SN:1024

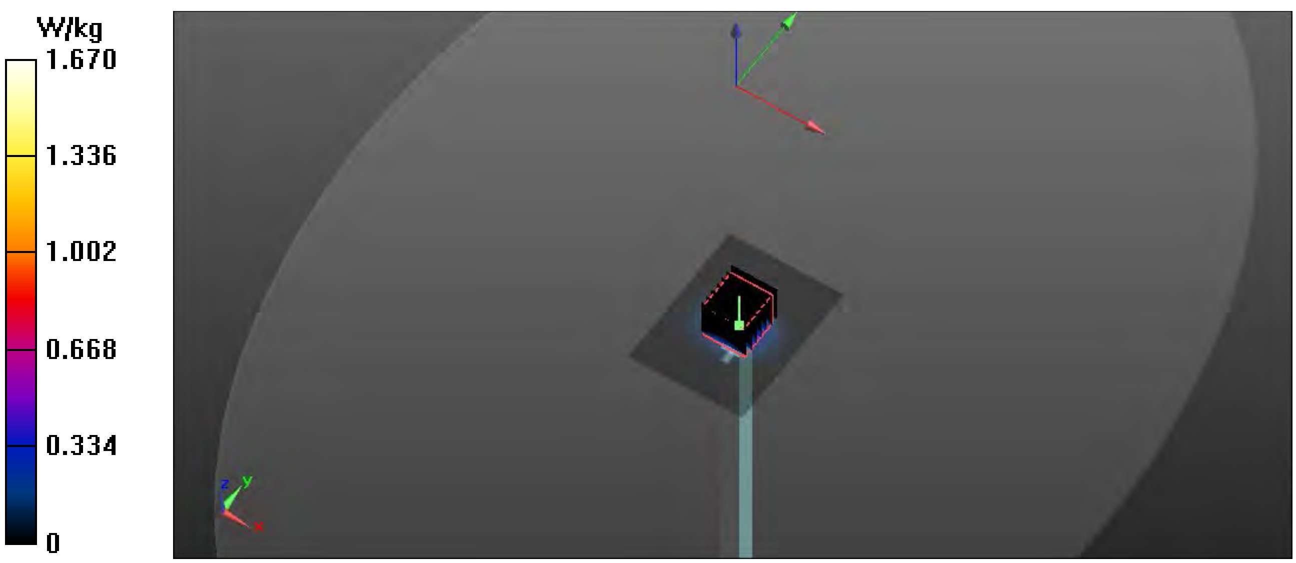
Communication System: CW; Frequency: 3700 MHz; Duty Cycle: 1:1
Medium: HSL 3-6 GHz; Medium parameters used: f = 3700 MHz; σ = 3.13 S/m; ε_r = 36.87; ρ = 1000 kg/m^3
Phantom section: Flat Section

Test Date: Date: 6/11/2022; Ambient Temp: 23 °C; Tissue Temp: 21 °C
Probe: EX3DV4 – SN7530; ConvF(6.9, 6.9, 6.9); Calibrated: 1/14/2022;
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn759; Calibrated: 8/6/2021
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: 1251
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

3700 MHz Head/Verification/Area Scan (61x81x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 1.66 W/kg

3700 MHz Head/Verification/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm
Reference Value = 22.149 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 3.44 W/kg
P_{in}= 10 mW
SAR(1 g) = 0.695 W/kg; SAR(10 g) = 0.2491 W/kg
Maximum value of SAR (measured) = 1.67 W/kg



Appendix B – SAR Test Data Plots

RF Exposure Lab

Plot 1

DUT: M3100; Type: Hotspot; Serial: BB110122F00067

Communication System: FR1 (NR, 1 RB, 20 MHz, BPSK); Frequency: 1880 MHz; Duty Cycle: 1:1
Medium: HSL1900; Medium parameters used: f = 1880 MHz; σ = 1.44 S/m; ε_r = 39.74; ρ = 1000 kg/m^3
Phantom section: Flat Section

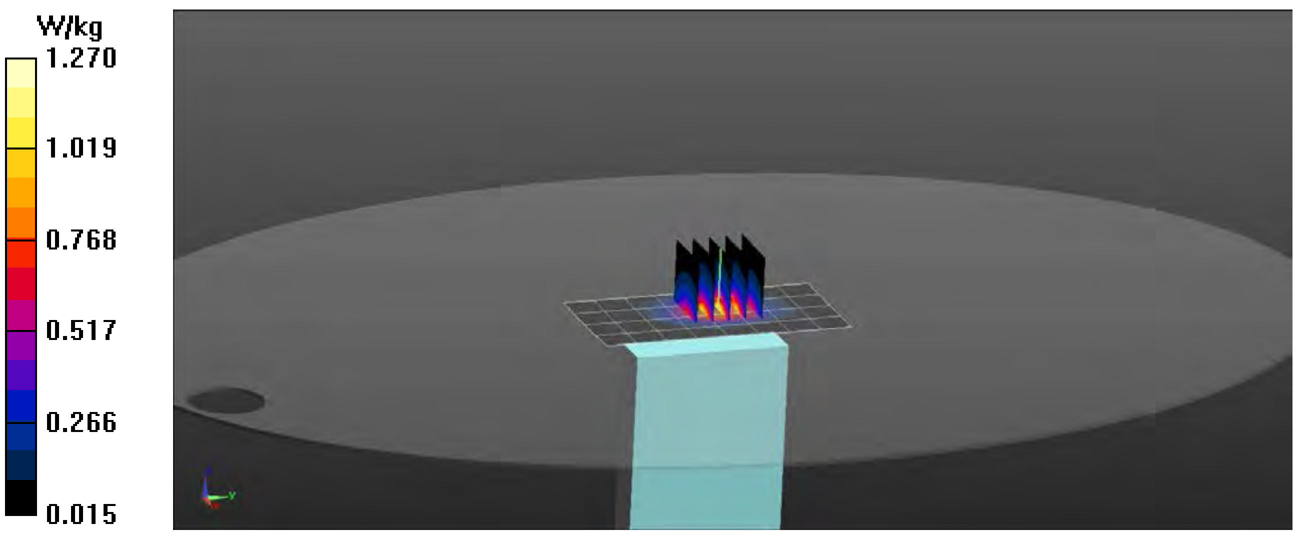
Test Date: Date: 6/10/2022; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 - SN7530; ConvF(8.06, 8.06, 8.06); Calibrated: 1/14/2022
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn759; Calibrated: 8/6/2021
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: 1251
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Procedure Notes:

Band n2 FR1/Side F 1 RB 53 Offset Ant 0 Mid/Area Scan (5x9x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 0.991 W/kg

Band n2 FR1/Side F 1 RB 53 Offset Ant 0 Mid/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 23.66 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 1.60 W/kg
SAR(1 g) = 0.806 W/kg
Maximum value of SAR (measured) = 1.27 W/kg



RF Exposure Lab

Plot 2

DUT: M3100; Type: Hotspot; Serial: BB110122F00067

Communication System: FR1 (NR, 1 RB, 20 MHz, BPSK); Frequency: 836.5 MHz; Duty Cycle: 1:1
Medium: HSL835; Medium parameters used (interpolated): f = 836.5 MHz; σ = 0.937 S/m; ε_r = 41.171; ρ = 1000 kg/m^3
Phantom section: Flat Section

Test Date: Date: 6/10/2022; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 - SN7530; ConvF(9.98, 9.98, 9.98); Calibrated: 1/14/2022
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn759; Calibrated: 8/6/2021
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: 1251
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

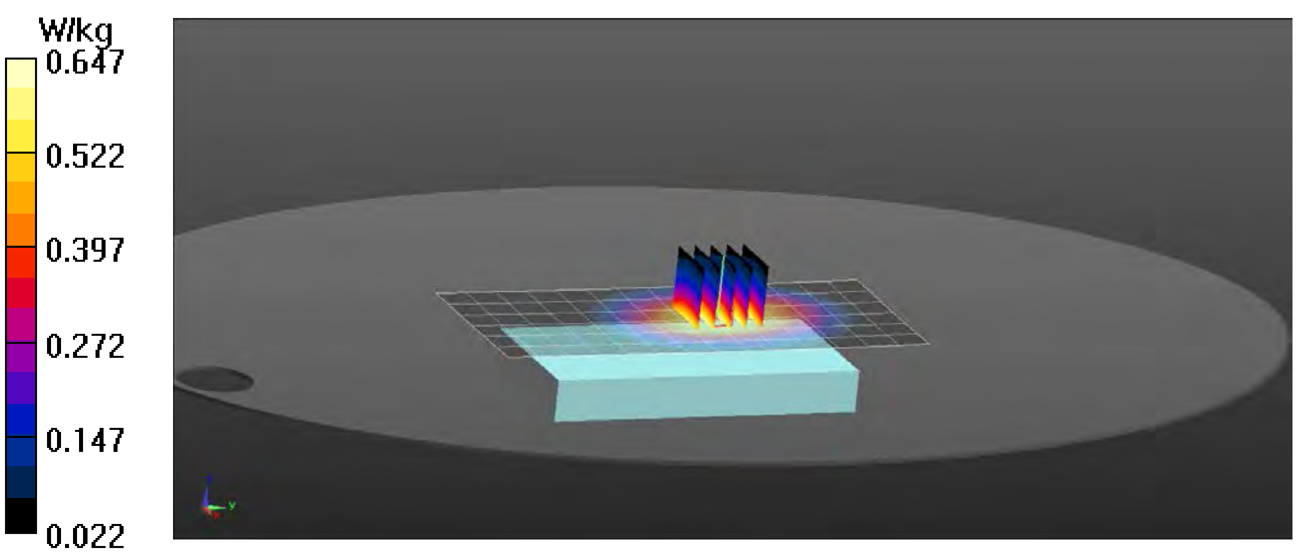
Procedure Notes:

Band n5 FR1/Side C 1 RB 53 Offset Ant 0 Mid/Area Scan (7x15x1): Measurement grid: dx=15mm, dy=15mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.646 W/kg

Band n5 FR1/Side C 1 RB 53 Offset Ant 0 Mid/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 22.30 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 0.785 W/kg
SAR(1 g) = 0.486 W/kg

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 0.647 W/kg



RF Exposure Lab

Plot 3

DUT: M3100; Type: Hotspot; Serial: BB110122F00067

Communication System: FR1 (NR, 1 RB, 20 MHz, BPSK); Frequency: 3625 MHz; Duty Cycle: 1:1
Medium: HSL3-6GHz; Medium parameters used (interpolated): f = 3625 MHz; σ = 3.06 S/m; ε_r = 36.95; ρ = 1000 kg/m^3
Phantom section: Flat Section

Test Date: Date: 6/11/2022; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 - SN7530; ConvF(7.1, 7.1, 7.1); Calibrated: 1/14/2022
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn759; Calibrated: 8/6/2021
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: 1251
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

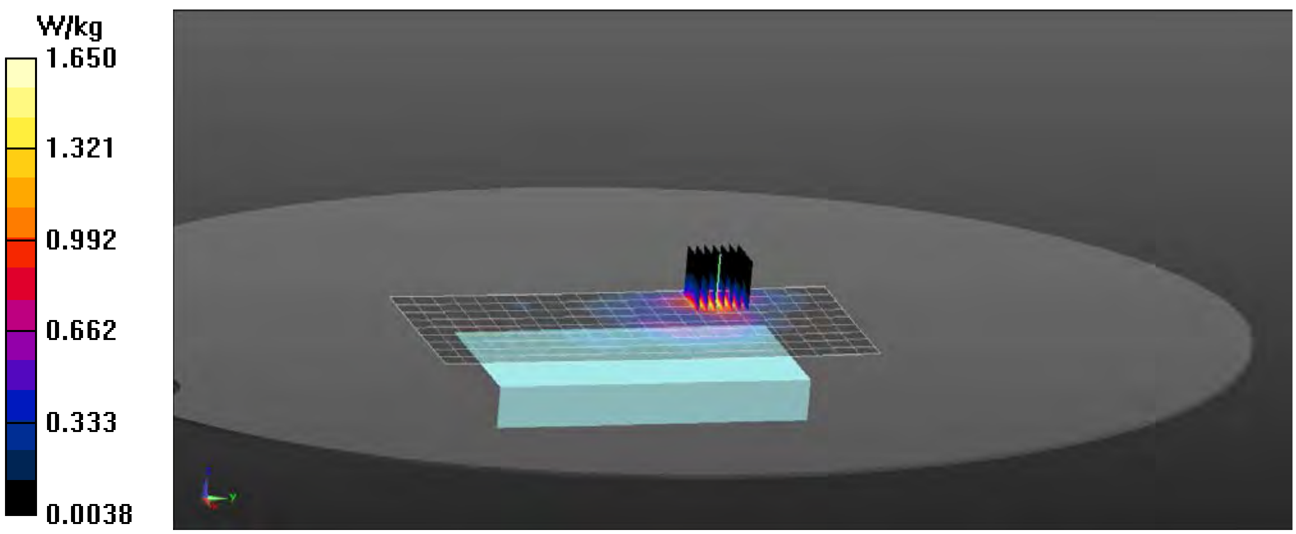
Procedure Notes:

Band n48 FR1/Side A 1 RB 53 Offset Ant 4 Mid/Area Scan (10x22x1): Measurement grid: dx=10mm, dy=10mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.57 W/kg

Band n48 FR1/Side A 1 RB 53 Offset Ant 4 Mid/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=4mm
Reference Value = 8.671 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 2.38 W/kg
SAR(1 g) = 0.830 W/kg

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.65 W/kg



RF Exposure Lab

Plot 4

DUT: M3100; Type: Hotspot; Serial: BB110122F00067

Communication System: FR1 (NR, 1 RB, 20 MHz, BPSK); Frequency: 1745 MHz; Duty Cycle: 1:1
Medium: HSL1750; Medium parameters used (interpolated): f = 1745 MHz; σ = 1.405 S/m; ε_r = 39.36; ρ = 1000 kg/m^3
Phantom section: Flat Section

Test Date: Date: 6/11/2022; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 - SN7530; ConvF(8.42, 8.42, 8.42); Calibrated: 1/14/2022
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn759; Calibrated: 8/6/2021
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: 1251
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

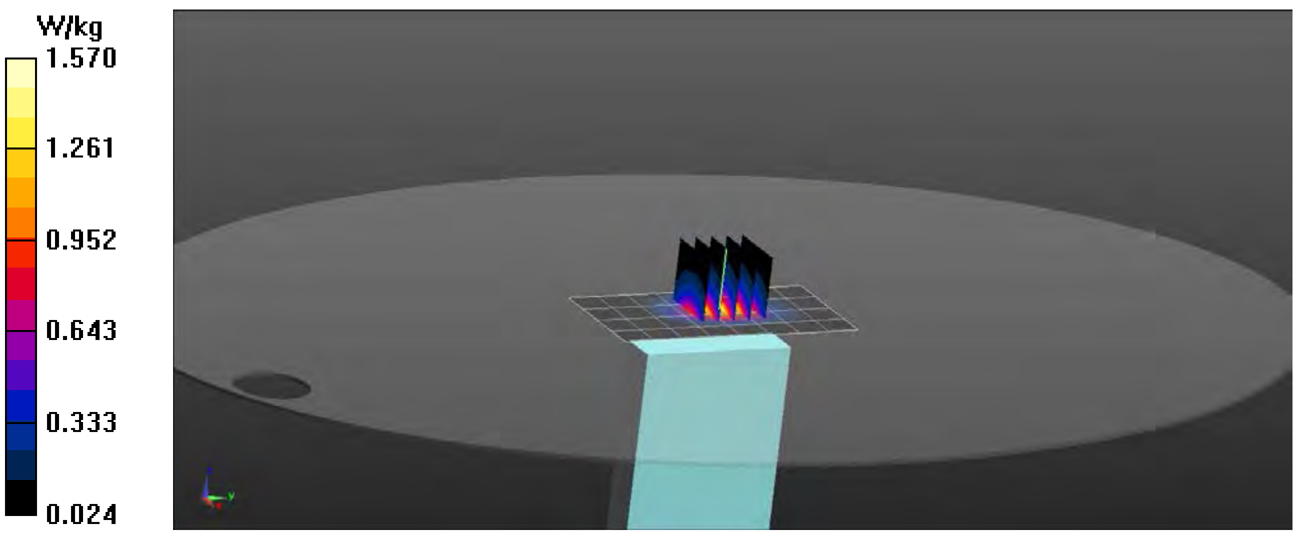
Procedure Notes:

Band n66 FR1/Side F 1 RB 53 Offset Ant 0 Mid/Area Scan (5x9x1): Measurement grid: dx=15mm, dy=15mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.26 W/kg

Band n66 FR1/Side F 1 RB 53 Offset Ant 0 Mid/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 26.95 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 1.97 W/kg
SAR(1 g) = 0.811 W/kg

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.57 W/kg



RF Exposure Lab

Plot 5

DUT: M3100; Type: Hotspot; Serial: BB110122F00067

Communication System: FR1 (NR, 1 RB, 20 MHz, BPSK); Frequency: 3750 MHz; Duty Cycle: 1:1
Medium: HSL3-6GHz; Medium parameters used (interpolated): f = 3750 MHz; σ = 3.19 S/m; ε_r = 36.81; ρ = 1000 kg/m^3
Phantom section: Flat Section

Test Date: Date: 6/11/2022; Ambient Temp: 23 °C; Tissue Temp: 21 °C

Probe: EX3DV4 - SN7530; ConvF(6.9, 6.9, 6.9); Calibrated: 1/14/2022
Sensor-Surface: 2mm (Mechanical Surface Detection)
Electronics: DAE4 Sn759; Calibrated: 8/6/2021
Phantom: ELI v5.0; Type: QDOVA002AA; Serial: TP:xxxx
Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

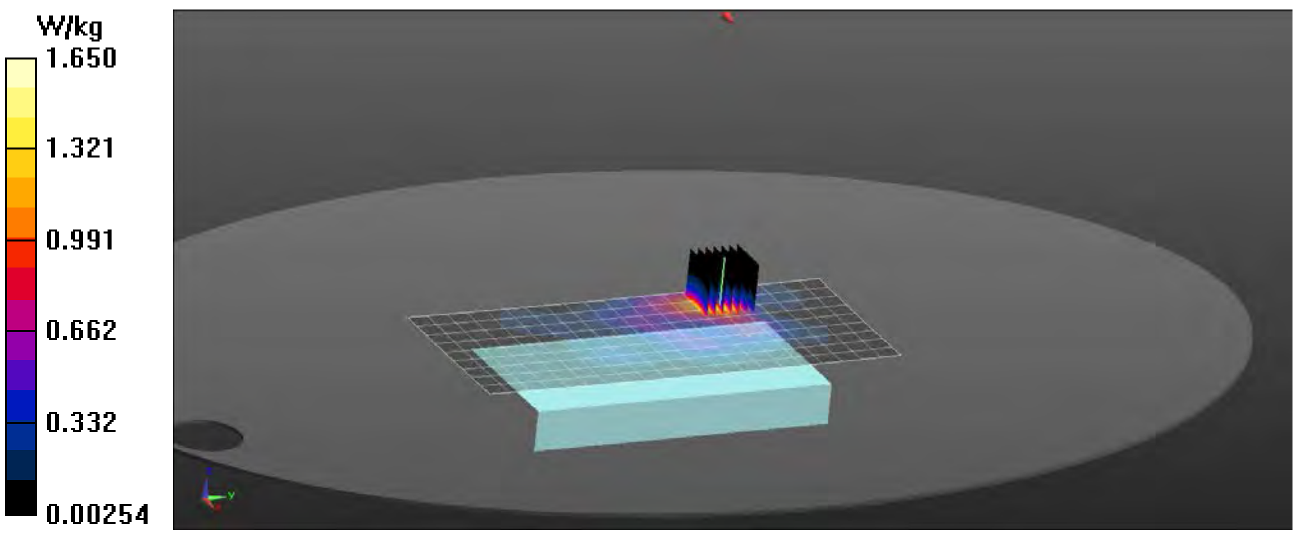
Procedure Notes:

Band n77 FR1/Side A 1 RB 53 Offset Ant 4 Mid/Area Scan (10x22x1): Measurement grid: dx=10mm, dy=10mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.52 W/kg

Band n77 FR1/Side A 1 RB 53 Offset Ant 4 Mid/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=4mm
Reference Value = 9.372 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 2.41 W/kg
SAR(1 g) = 0.723 W/kg

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.65 W/kg



Appendix C – SAR Test Setup Photos

Test Position Side A 10 mm Gap

Test Position Side A 20 mm Gap

Test Position Side B 10 mm Gap

Test Position Side C 10 mm Gap

Test Position Side C 20 mm Gap

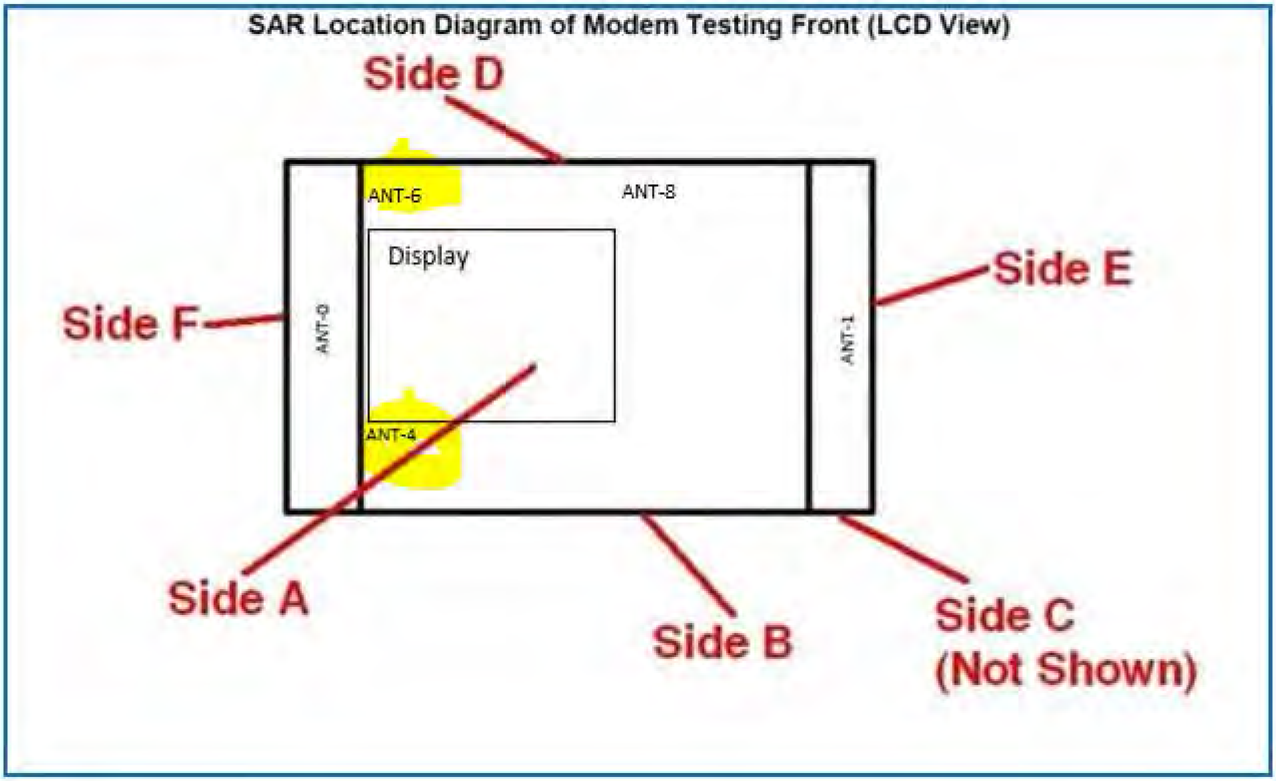
Test Position Side D 10 mm Gap

Test Position Side D 20 mm Gap

Test Position Side E 10 mm Gap

Test Position Side F 10 mm Gap

Test Position Side F 20 mm Gap



Test Positions

Antenna Locations

Front of Device

Back of Device

Appendix D – Probe Calibration Data Sheets

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

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

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

Accreditation No.: SCS 0108

Client RF Exposure Lab

Certificate No: EX3-7530_Jan22

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:7530
Calibration procedure(s)	QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v6, QA CAL-23.v5, QA CAL-25.v7 Calibration procedure for dosimetric E-field probes
Calibration date:	January 14, 2022

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	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: CC2552 (20x)	09-Apr-21 (No. 217-03343)	Apr-22
DAE4	SN: 660	13-Oct-21 (No. DAE4-660_Oct21)	Oct-22
Reference Probe ES3DV2	SN: 3013	27-Dec-21 (No. ES3-3013_Dec21)	Dec-22
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-20)	In house check: Jun-22
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-22

	Name	Function	Signature
Calibrated by:	Leif Klysner	Laboratory Technician	
Approved by:	Sven Kühn	Deputy Manager	

Issued: January 19, 2022

Glossary:

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

Calibration is Performed According to the Following Standards:

a) 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.
b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7530

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm (μV/(V/m)²)[A]	0.42	0.48	0.43	± 10.1 %
DCP (mV)[B]	99.3	99.7	98.7	

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Max dev.	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	159.3	±2.2 %	± 4.7 %
		Y	0.0	0.0	1.0		142.4		
		Z	0.0	0.0	1.0		141.6		

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 Pages 5 and 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7530

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-141.7
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.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7530

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
13	55.0	0.75	19.61	19.61	19.61	0.00	1.00	± 13.3 %
30	55.0	0.75	17.99	17.99	17.99	0.00	1.00	± 13.3 %
750	41.9	0.89	10.44	10.44	10.44	0.56	0.80	± 12.0 %
900	41.5	0.97	9.98	9.98	9.98	0.48	0.80	± 12.0 %
1300	40.8	1.14	9.27	9.27	9.27	0.40	0.95	± 12.0 %
1750	40.1	1.37	8.42	8.42	8.42	0.30	0.86	± 12.0 %
1900	40.0	1.40	8.06	8.06	8.06	0.30	0.86	± 12.0 %
2300	39.5	1.67	7.85	7.85	7.85	0.34	0.90	± 12.0 %
2450	39.2	1.80	7.65	7.65	7.65	0.33	0.90	± 12.0 %
2600	39.0	1.96	7.42	7.42	7.42	0.35	0.90	± 12.0 %
3300	38.2	2.71	7.12	7.12	7.12	0.35	1.30	± 13.1 %
3500	37.9	2.91	7.10	7.10	7.10	0.35	1.30	± 13.1 %
3700	37.7	3.12	6.90	6.90	6.90	0.35	1.30	± 13.1 %
3900	37.5	3.32	6.83	6.83	6.83	0.40	1.60	± 13.1 %
4200	37.1	3.63	6.38	6.38	6.38	0.40	1.70	± 13.1 %
5250	35.9	4.71	5.45	5.45	5.45	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.80	4.80	4.80	0.40	1.80	± 13.1 %
5750	35.4	5.22	4.98	4.98	4.98	0.40	1.80	± 13.1 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

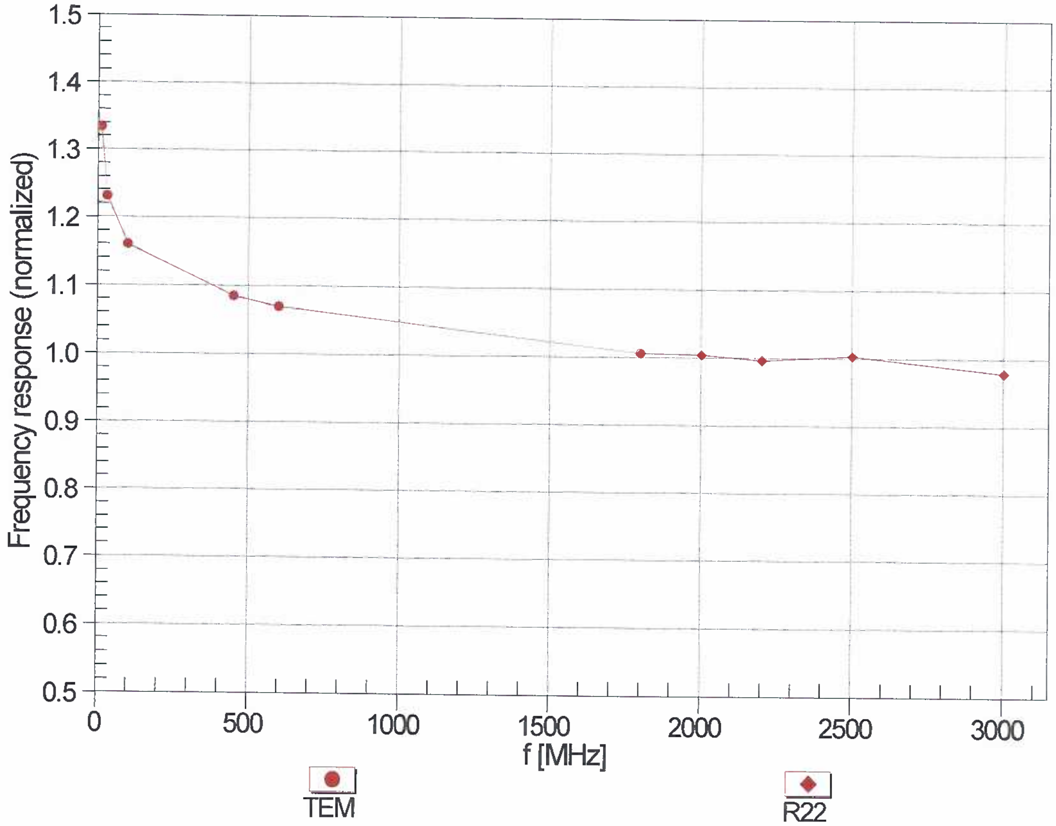
DASY/EASY - Parameters of Probe: EX3DV4 - SN:7530

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
6500	34.5	6.07	5.60	5.60	5.60	0.20	2.50	± 18.6 %

[C] Frequency validity above 6GHz is ± 700 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] At frequencies 6-10 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz; below ± 2% for frequencies between 3-6 GHz; and below ± 4% for frequencies between 6-10 GHz at any distance larger than half the probe tip diameter from the boundary.

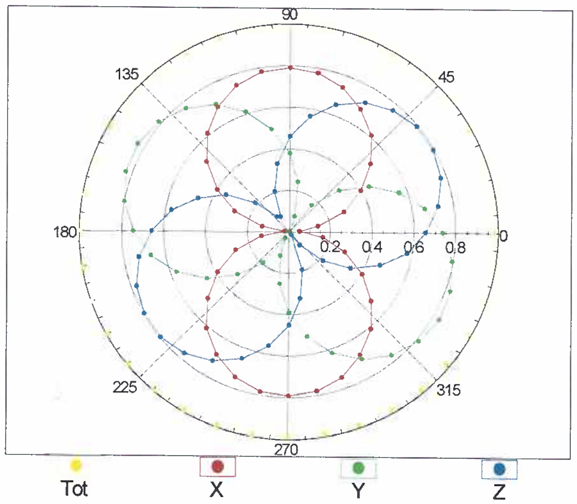
Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)



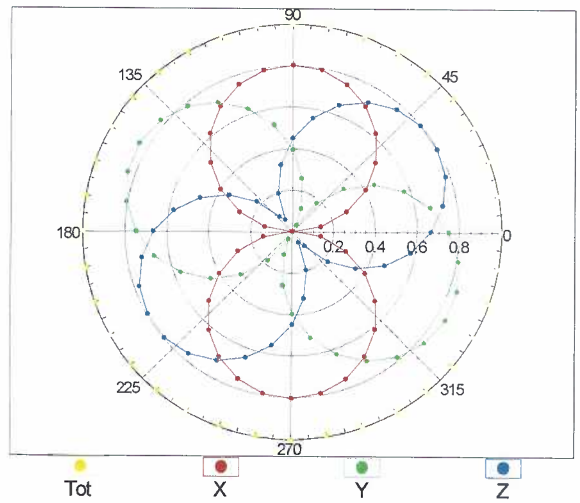
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

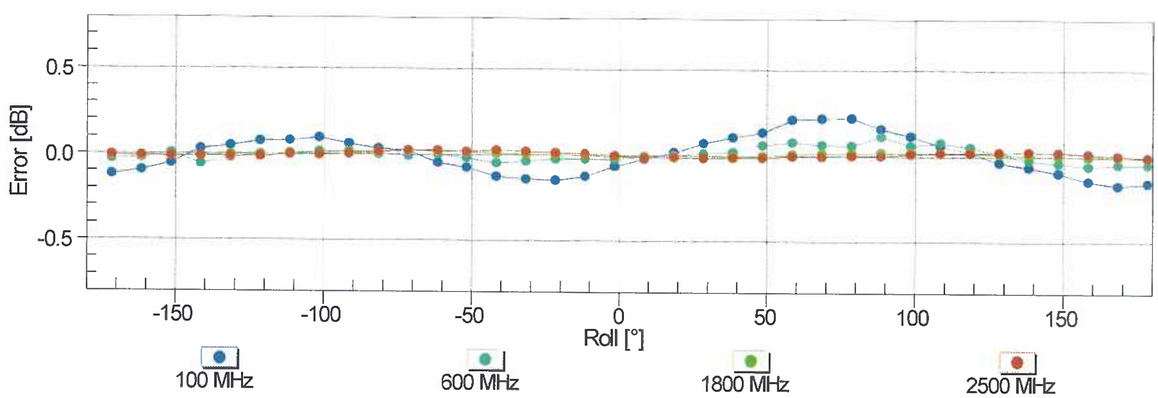
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



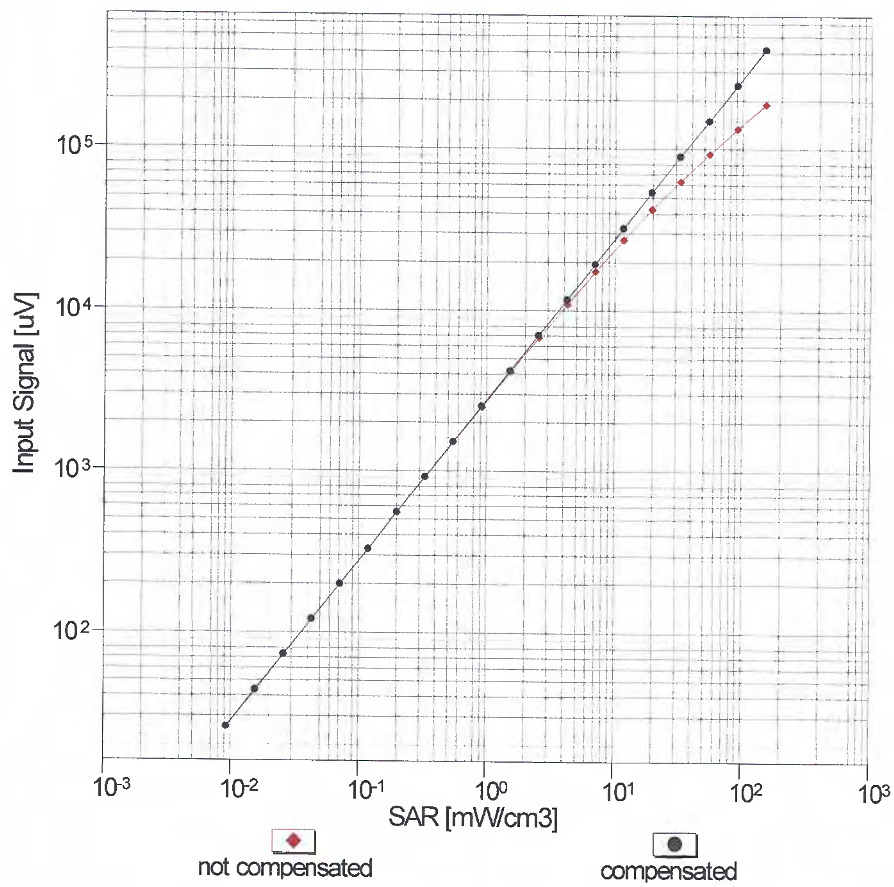
f=1800 MHz,R22

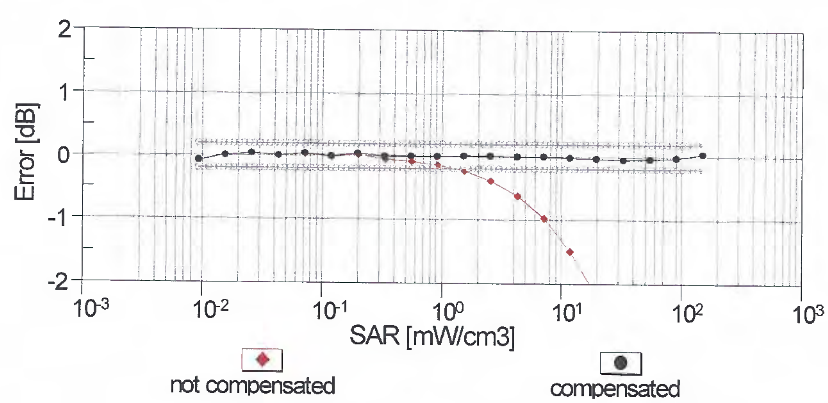




Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

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

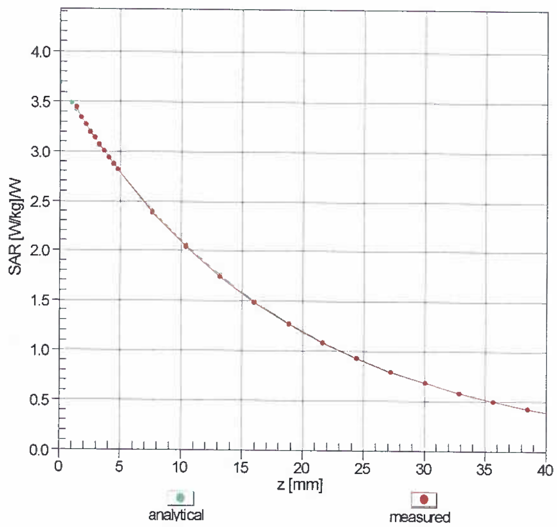




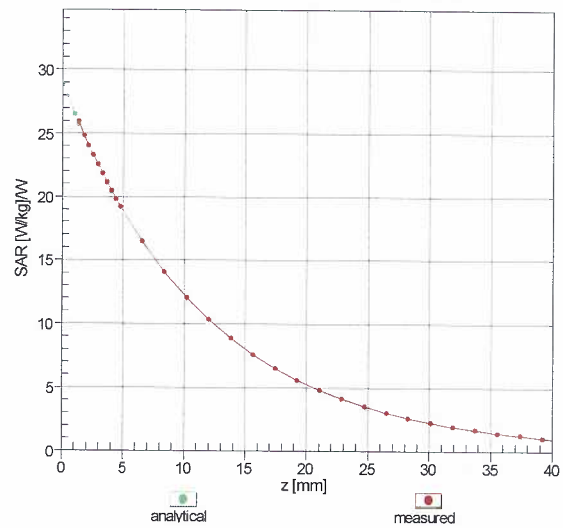
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment

f = 900 MHz,WGLS R9 (H_convF)

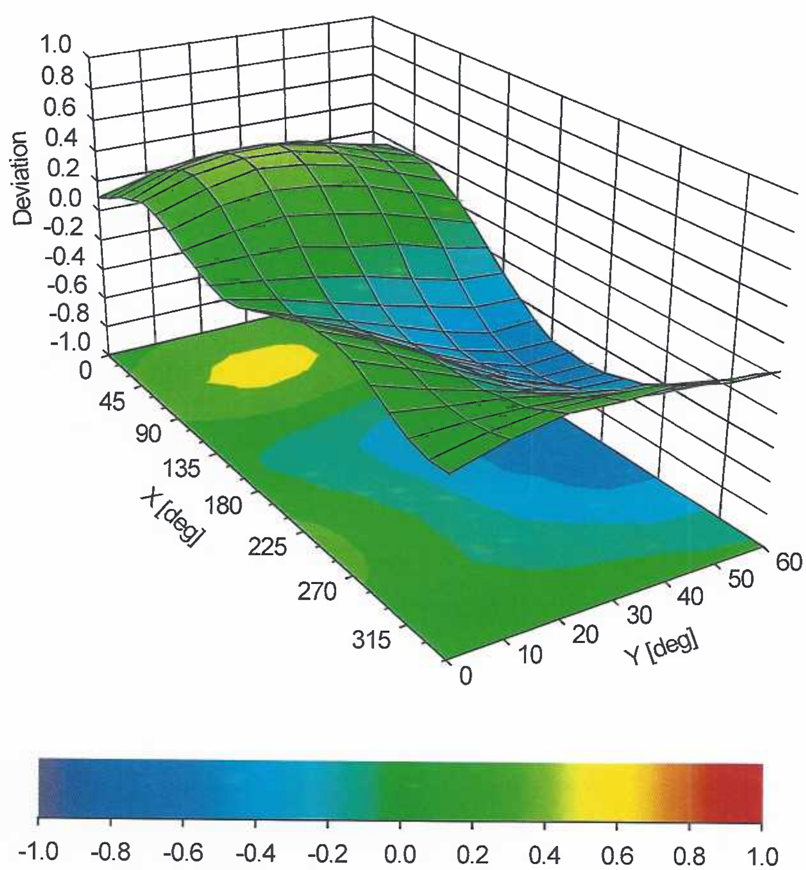


f = 1900 MHz,WGLS R22 (H_convF)



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



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

Appendix 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
Servizio svizzero di taratura
S Swiss Calibration Service

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

Accreditation No.: SCS 0108

Client RF Exposure Lab

Certificate No: D900V2-1d128_Jun21

CALIBRATION CERTIFICATE

Object: D900V2 - SN:1d128

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

Calibration date: June 04, 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 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	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:	Michael Weber	Laboratory Technician	M.Weber
Approved by:	Katja Pokovic	Technical Manager	

Issued: June 8, 2021

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	900 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	41.5	0.97 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	42.3 ± 6 %	0.96 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	2.76 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**11.2 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	1.77 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**7.14 W/kg ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	51.0 Ω - 0.6 jΩ
Return Loss	- 38.5 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.412 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.

D900V2 SN: 1d128 - Head						
Date of Measurement	Return Loss (dB)	Δ%	Impedance Real (Ω)	ΔΩ	Impedance Imaginary (jΩ)	ΔΩ
6/4/2021	-38.5		51.0		-0.6	
6/4/2022	-37.2	-3.4	52.3	1.3	-0.8	-0.2

DASY5 Validation Report for Head TSL

Date: 04.06.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 900 MHz; Type: D900V2; Serial: D900V2 - SN:1d128

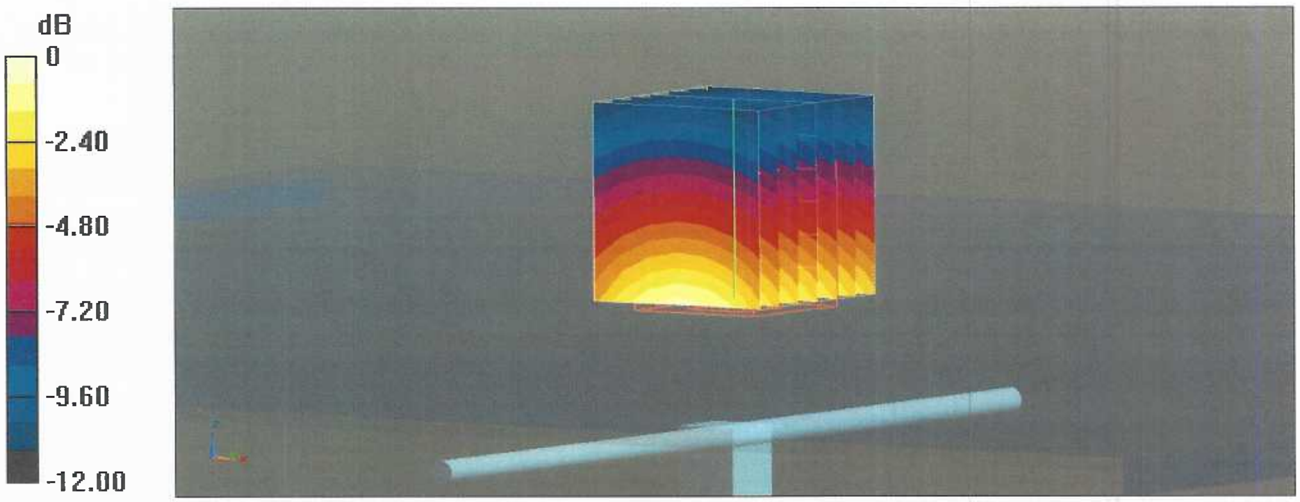
Communication System: UID 0 - CW; Frequency: 900 MHz
Medium parameters used: f = 900 MHz; σ = 0.96 S/m; ε_r = 42.3; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(9.62, 9.62, 9.62) @ 900 MHz; Calibrated: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 4.9 (front); Type: QD 00L P49 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

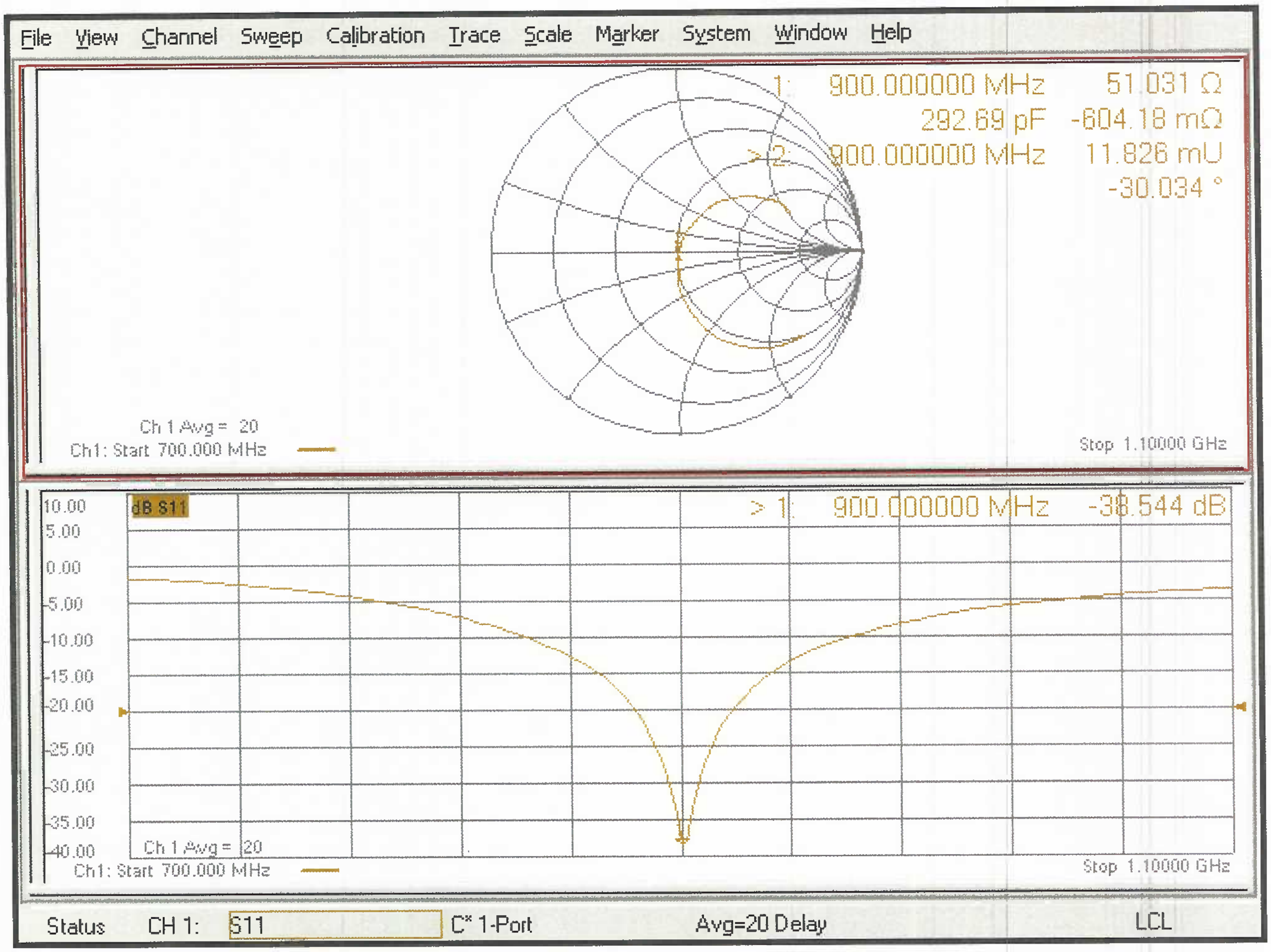
Dipole Calibration for Head Tissue/Pin=250 mW, d=15mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 65.79 V/m; Power Drift = 0.03 dB
Peak SAR (extrapolated) = 4.23 W/kg
SAR(1 g) = 2.76 W/kg; SAR(10 g) = 1.77 W/kg
Smallest distance from peaks to all points 3 dB below = 16 mm
Ratio of SAR at M2 to SAR at M1 = 65%
Maximum value of SAR (measured) = 3.74 W/kg



0 dB = 3.74 W/kg = 5.73 dBW/kg

Impedance Measurement Plot for Head TSL



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Accreditation No.: SCS 0108

Client RF Exposure Lab

Certificate No: D1750V2-1061_Jun21

CALIBRATION CERTIFICATE

Object: D1750V2 - SN:1061

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 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	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	
Approved by:	Katja Pokovic	Technical Manager	

Issued: June 8, 2021

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1750 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	40.1	1.37 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40.7 ± 6 %	1.37 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.38 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**37.7 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	4.93 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**19.8 W/kg ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	49.4 Ω + 0.0 jΩ
Return Loss	- 44.5 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.221 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.

D1750V2 SN: 1061 - Head						
Date of Measurement	Return Loss (dB)	Δ%	Impedance Real (Ω)	ΔΩ	Impedance Imaginary (jΩ)	ΔΩ
6/3/2021	-44.5		49.4		0.0	
6/4/2022	-42.3	-4.9	47.9	-1.5	-0.2	-0.2

DASY5 Validation Report for Head TSL

Date: 03.06.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1750 MHz; Type: D1750V2; Serial: D1750V2 - SN:1061

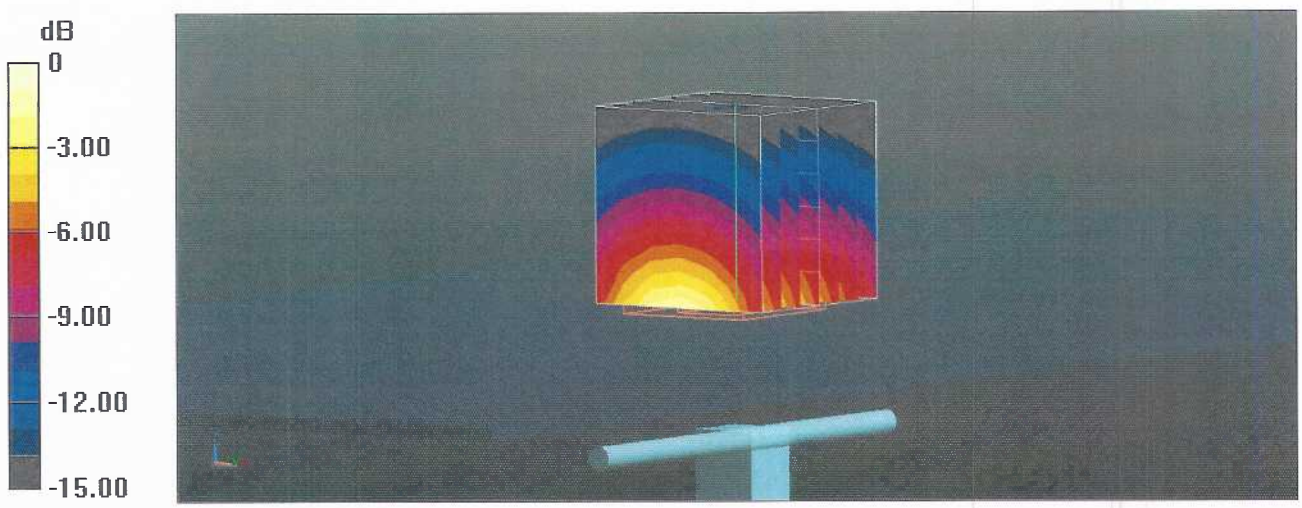
Communication System: UID 0 - CW; Frequency: 1750 MHz
Medium parameters used: f = 1750 MHz; σ = 1.37 S/m; ε_r = 40.7; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.67, 8.67, 8.67) @ 1750 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)

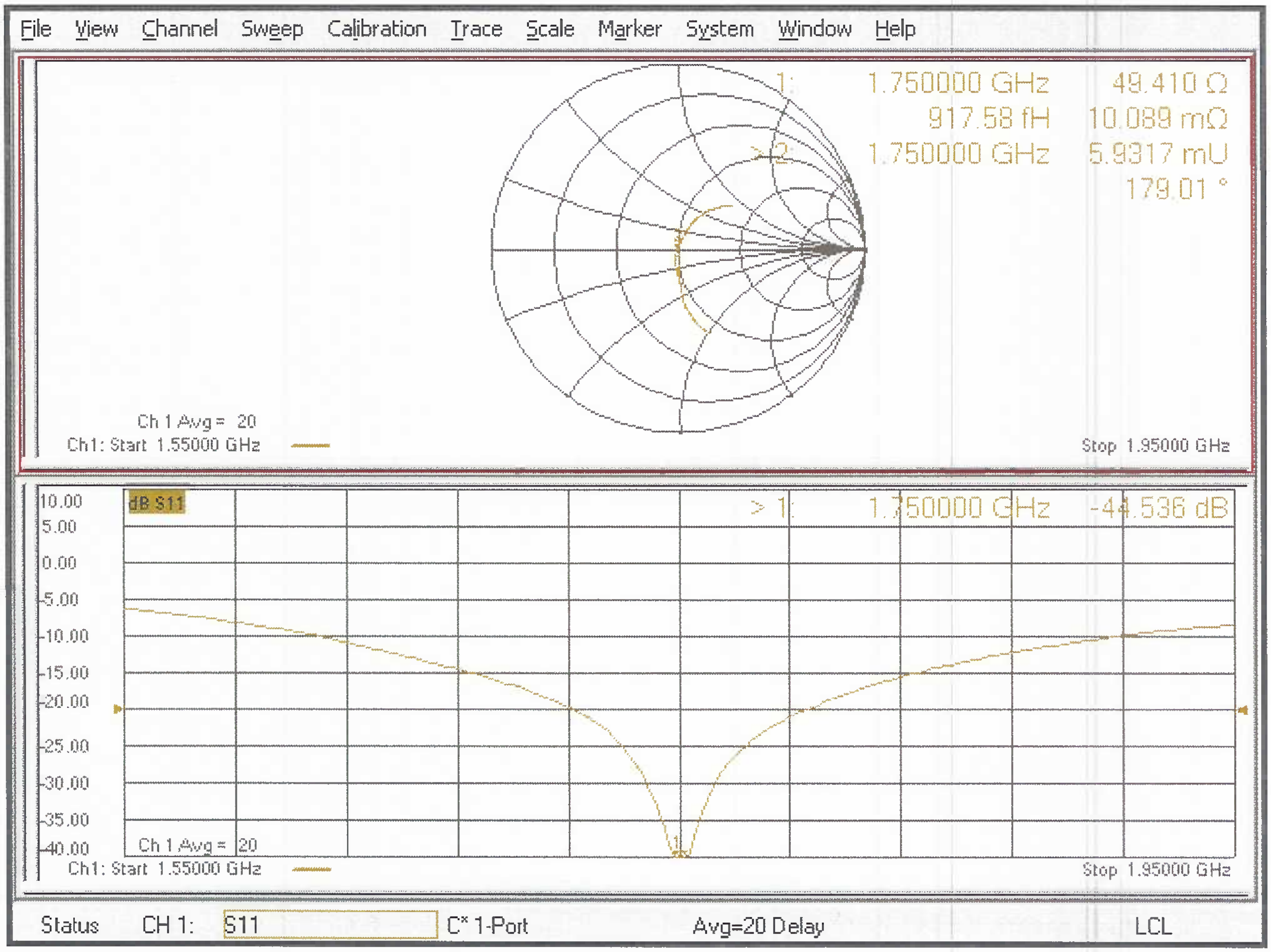
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 107.4 V/m; Power Drift = 0.08 dB
Peak SAR (extrapolated) = 17.5 W/kg
SAR(1 g) = 9.38 W/kg; SAR(10 g) = 4.93 W/kg
Smallest distance from peaks to all points 3 dB below = 9.1 mm
Ratio of SAR at M2 to SAR at M1 = 54%
Maximum value of SAR (measured) = 14.6 W/kg



0 dB = 14.6 W/kg = 11.64 dBW/kg

Impedance Measurement Plot for Head TSL



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Accreditation No.: SCS 0108

Client **RF Exposure Lab**

Certificate No: D1900V2-5d147_Jun21

CALIBRATION CERTIFICATE

Object	D1900V2 - SN:5d147
Calibration procedure(s)	QA CAL-05.v11 Calibration Procedure for SAR Validation Sources between 0.7-3 GHz
Calibration date:	June 04, 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 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	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:	Michael Weber	Laboratory Technician	M.Weber
Approved by:	Katja Pokovic	Technical Manager	

Issued: June 8, 2021

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	40.9 ± 6 %	1.41 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	10.1 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**40.4 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.28 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**21.1 W/kg ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.3 Ω + 5.4 jΩ
Return Loss	- 24.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.192 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.

D1900V2 SN: 5d147 - Head						
Date of Measurement	Return Loss (dB)	Δ%	Impedance Real (Ω)	ΔΩ	Impedance Imaginary (jΩ)	ΔΩ
6/4/2021	-24.2		53.3		5.4	
6/4/2022	-25.6	5.8	52.6	-0.7	5.7	0.3

DASY5 Validation Report for Head TSL

Date: 04.06.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:5d147

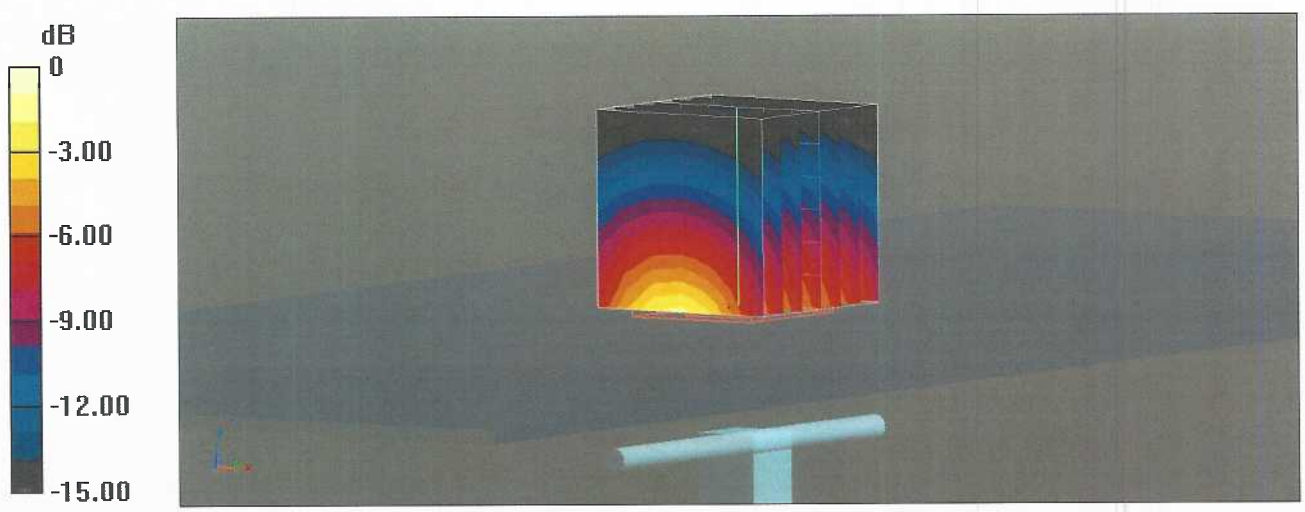
Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; σ = 1.41 S/m; ε_r = 40.9; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.43, 8.43, 8.43) @ 1900 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)

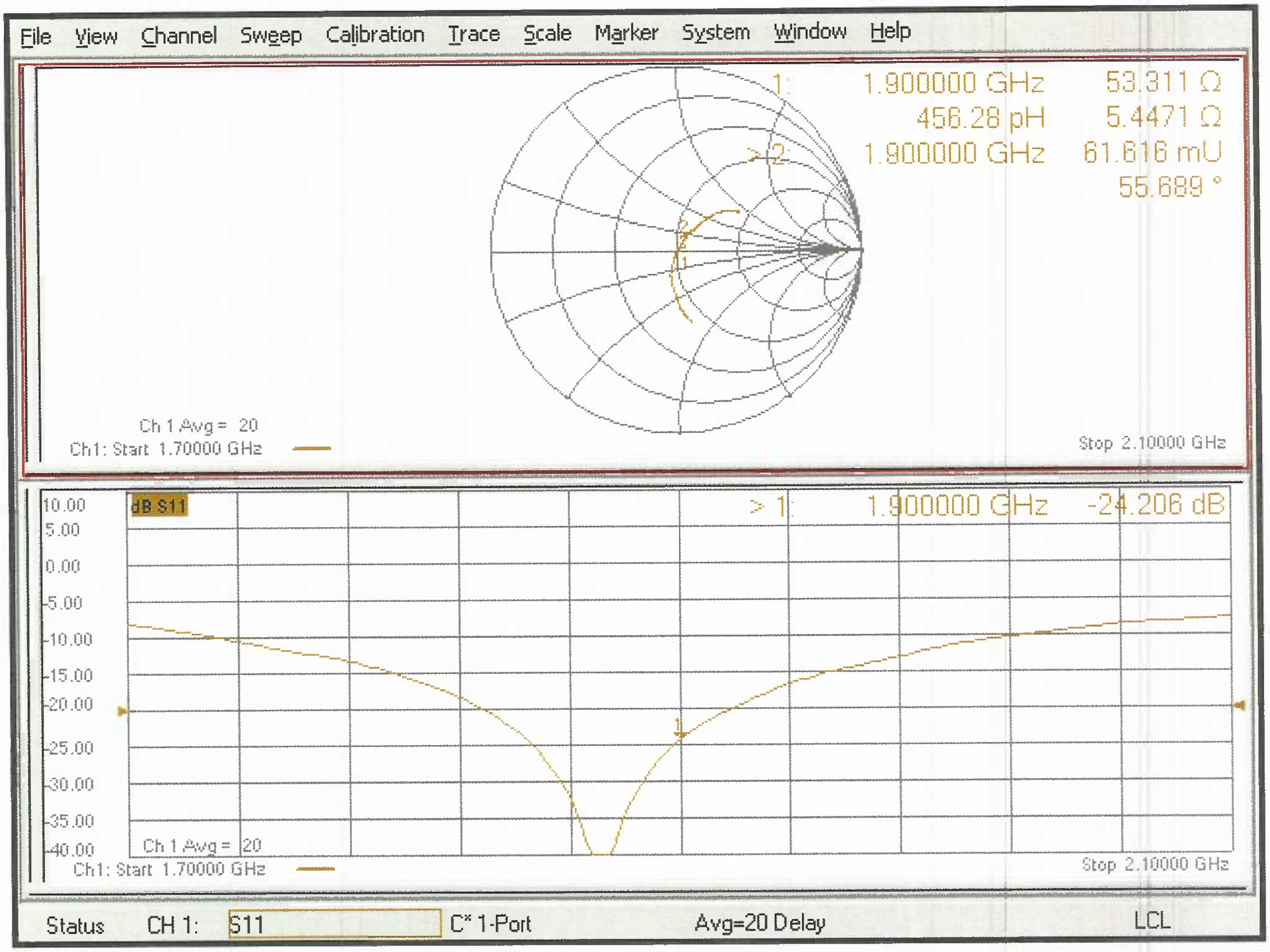
Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 110.2 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 18.7 W/kg
SAR(1 g) = 10.1 W/kg; SAR(10 g) = 5.28 W/kg
Smallest distance from peaks to all points 3 dB below = 10 mm
Ratio of SAR at M2 to SAR at M1 = 54.6%
Maximum value of SAR (measured) = 15.6 W/kg



0 dB = 15.6 W/kg = 11.93 dBW/kg

Impedance Measurement Plot for Head TSL



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Zeughausstrasse 43, 8004 Zurich, Switzerland

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Accreditation No.: SCS 0108

Client **RF Exposure Lab**

Certificate No: **D3500V2-1061_Apr21**

CALIBRATION CERTIFICATE

Object	D3500V2 - SN:1061
Calibration procedure(s)	QA CAL-22.v6 Calibration Procedure for SAR Validation Sources between 3-10 GHz
Calibration date:	April 13, 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 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	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

	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	M.Weber
Approved by:	Katja Pokovic	Technical Manager	

Issued: April 15, 2021

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

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	3500 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	37.9	2.91 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.3 ± 6 %	2.93 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.73 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**67.0 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.52 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**25.1 W/kg ± 19.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.5 Ω - 5.3 jΩ
Return Loss	- 24.2 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.134 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.

D3500V2 SN: 1061 - Head						
Date of Measurement	Return Loss (dB)	Δ%	Impedance Real (Ω)	ΔΩ	Impedance Imaginary (jΩ)	ΔΩ
4/13/2018	-24.2		53.5		-5.3	
4/22/2019	-23.9	-1.2	51.9	-1.6	-4.8	0.5

DASY5 Validation Report for Head TSL

Date: 13.04.2021

Test Laboratory: SPEAG, Zurich, Switzerland

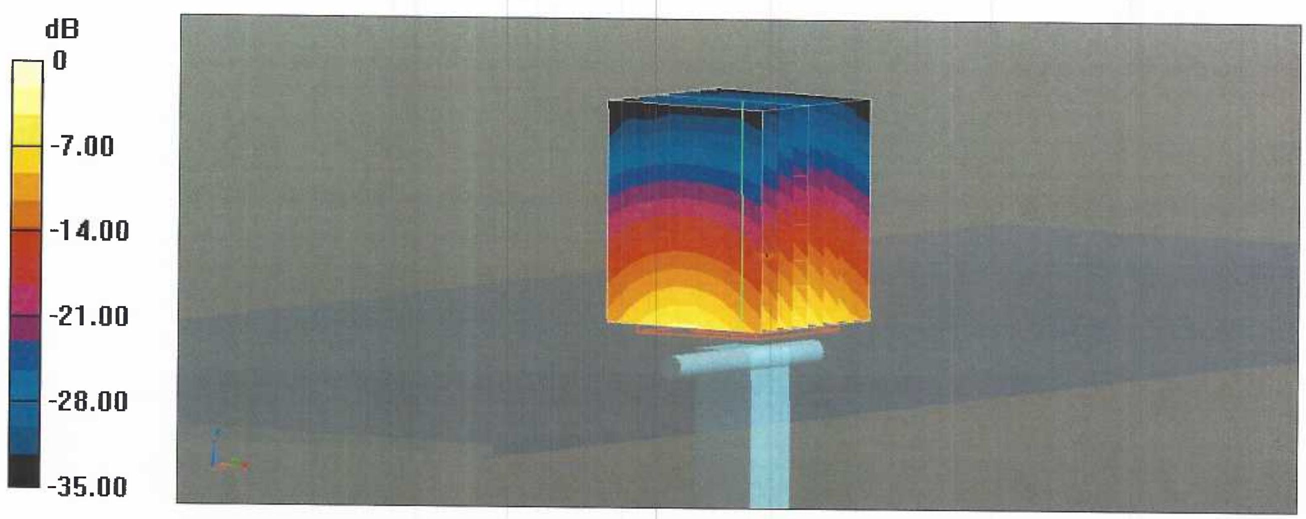
DUT: Dipole 3500 MHz; Type: D3500V2; Serial: D3500V2 - SN: 1061

Communication System: UID 0 - CW; Frequency: 3500 MHz
Medium parameters used: f = 3500 MHz; σ = 2.93 S/m; ε_r = 37.3; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

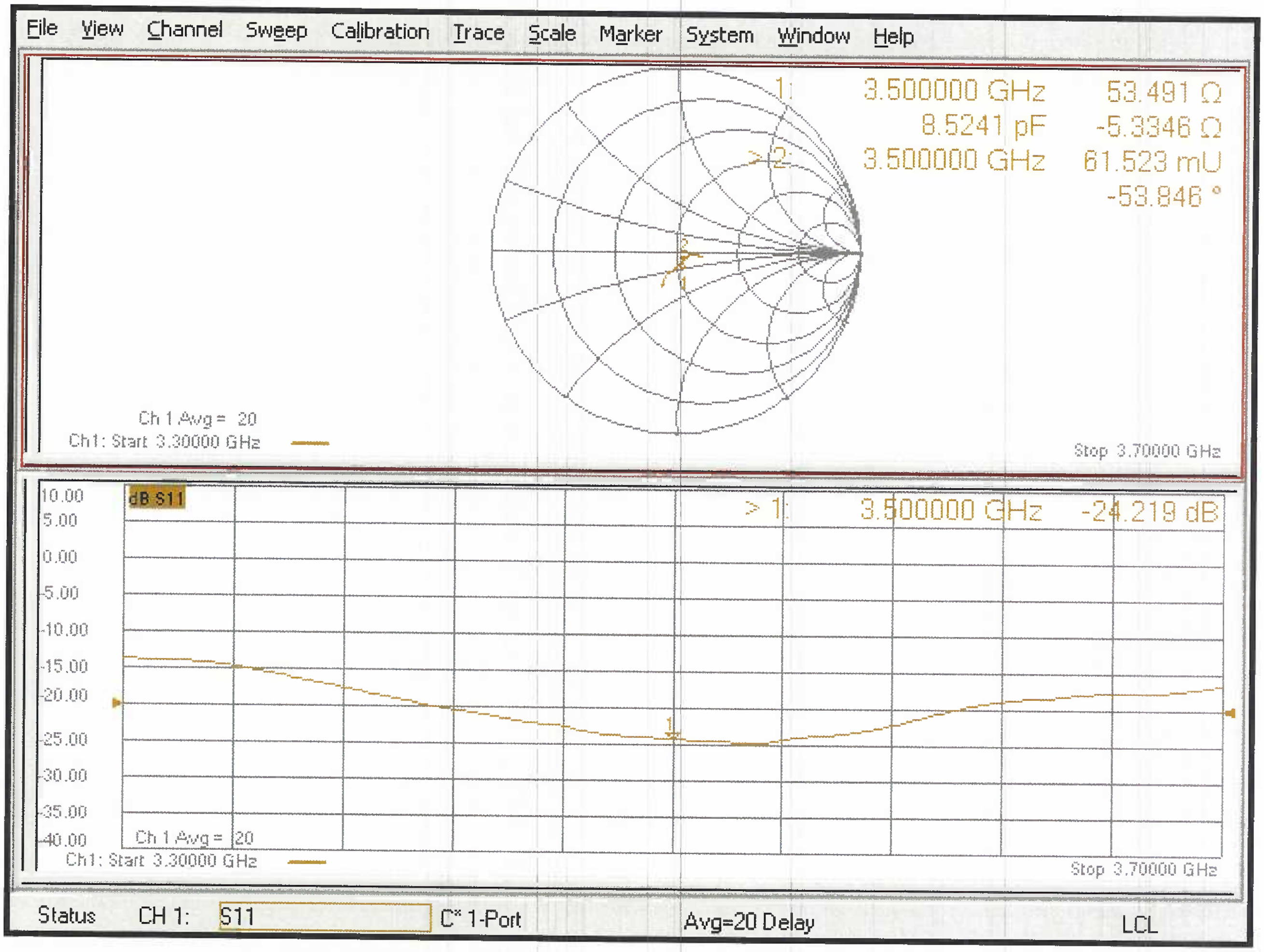
- Probe: EX3DV4 - SN3503; ConvF(7.91, 7.91, 7.91) @ 3500 MHz; Calibrated: 30.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm 3500/Zoom Scan, dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 72.28 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 18.2 W/kg
SAR(1 g) = 6.73 W/kg; SAR(10 g) = 2.52 W/kg
Smallest distance from peaks to all points 3 dB below = 8 mm
Ratio of SAR at M2 to SAR at M1 = 74.3%
Maximum value of SAR (measured) = 12.7 W/kg



0 dB = 12.7 W/kg = 11.05 dBW/kg

Impedance Measurement Plot for Head TSL



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

ilac-MRA

SWISS ACCREDITATION sas.admin.ch SCS 0108

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Accreditation No.: **SCS 0108**

Client **RF Exposure Lab**

Certificate No: **D3700V2-1024_Apr21**

CALIBRATION CERTIFICATE

Object	D3700V2 - SN:1024
Calibration procedure(s)	QA CAL-22.v6 Calibration Procedure for SAR Validation Sources between 3-10 GHz
Calibration date:	April 13, 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 ± 3)°C and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	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

	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	M.Weber
Approved by:	Katja Pokovic	Technical Manager	

Issued: April 15, 2021

Glossary:

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

Calibration is Performed According to the Following Standards:

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

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

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

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

Measurement Conditions

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

DASY Version	DASY5	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy = 4 mm, dz = 1.4 mm	Graded Ratio = 1.4 (Z direction)
Frequency	3700 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	37.7	3.12 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	37.0 ± 6 %	3.09 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	100 mW input power	6.85 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**68.3 W/kg ± 19.9 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	100 mW input power	2.47 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.6 W/kg ± 19.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	46.1 Ω + 2.2 jΩ
Return Loss	- 26.7 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.127 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.

D3700V2 SN: 1024 - Head						
Date of Measurement	Return Loss (dB)	Δ%	Impedance (Ω)	ΔΩ	Impedance Imaginary (jΩ)	ΔΩ
4/13/2021	-26.7		46.1		2.2	
4/13/2022	-25.3	-5.2	44.5	-1.6	1.8	-0.4

DASY5 Validation Report for Head TSL

Date: 13.04.2021

Test Laboratory: SPEAG, Zurich, Switzerland

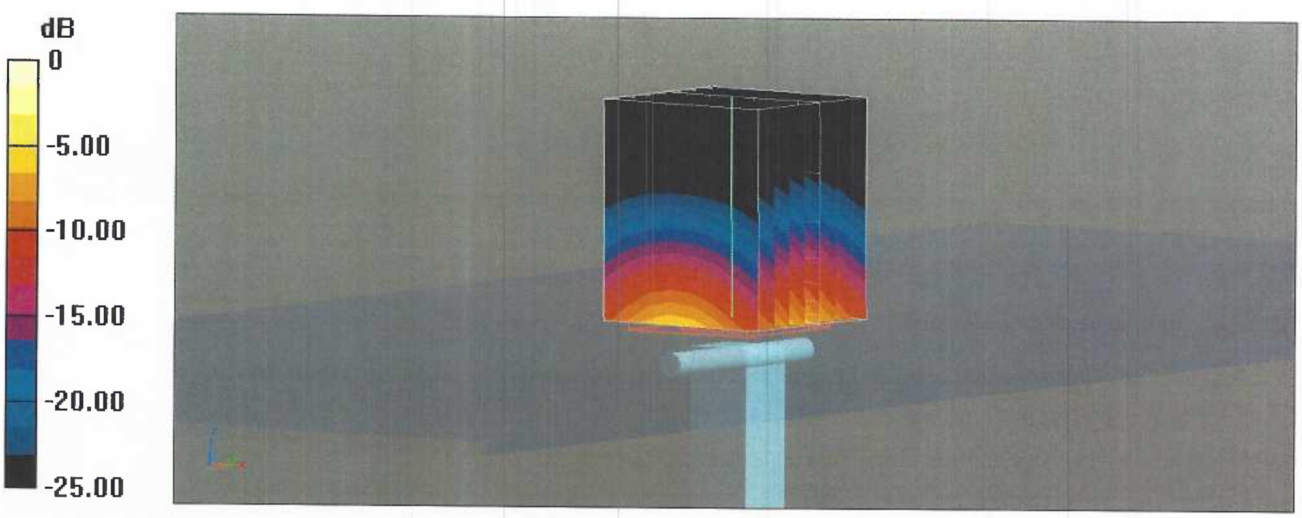
DUT: Dipole 3700 MHz; Type: D3700V2; Serial: D3700V2 - SN: 1024

Communication System: UID 0 - CW; Frequency: 3700 MHz
Medium parameters used: f = 3700 MHz; σ = 3.09 S/m; ε_r = 37; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

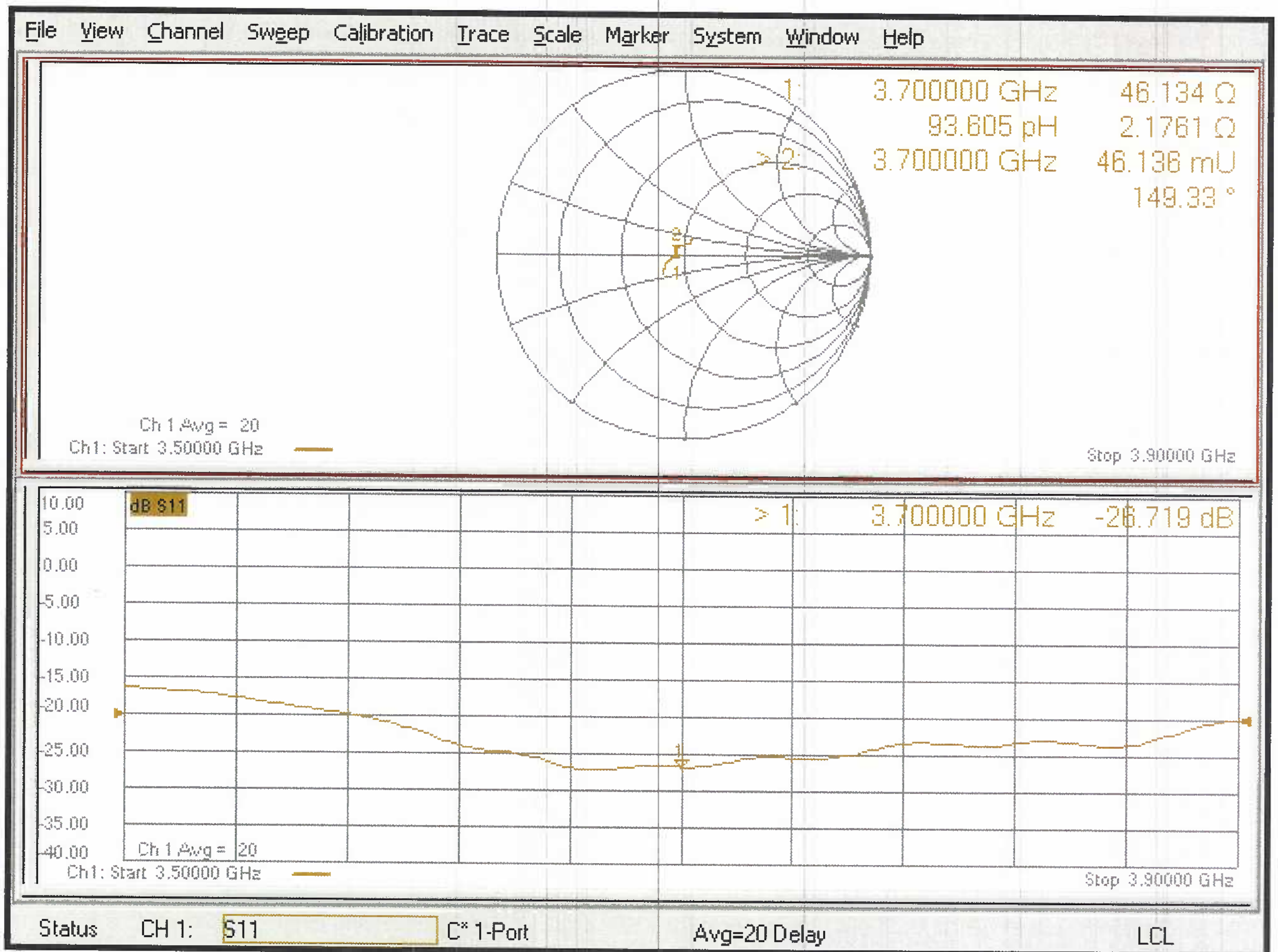
- Probe: EX3DV4 - SN3503; ConvF(7.73, 7.73, 7.73) @ 3700 MHz; Calibrated: 30.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Dipole Calibration for Head Tissue/Pin=100 mW, d=10mm 3700/Zoom Scan, dist=1.4mm (8x8x8)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 71.95 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 19.6 W/kg
SAR(1 g) = 6.85 W/kg; SAR(10 g) = 2.47 W/kg
Smallest distance from peaks to all points 3 dB below = 8 mm
Ratio of SAR at M2 to SAR at M1 = 73.2%
Maximum value of SAR (measured) = 13.7 W/kg



0 dB = 13.7 W/kg = 11.36 dBW/kg

Impedance Measurement Plot for Head TSL



Appendix F – DAE Calibration Data Sheets

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

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Accreditation No.: SCS 0108

Client **RF Exposure Lab**

Certificate No: DAE4-759_Aug21

CALIBRATION CERTIFICATE

Object	DAE4 - SD 000 D04 BM - SN: 759
Calibration procedure(s)	QA CAL-06.v30 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	August 06, 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 ± 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	07-Sep-20 (No:28647)	Sep-21

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Auto DAE Calibration Unit	SE UWS 053 AA 1001	07-Jan-21 (in house check)	In house check: Jan-22
Calibrator Box V2.1	SE UMS 006 AA 1002	07-Jan-21 (in house check)	In house check: Jan-22

	Name	Function	Signature
Calibrated by:	Adrian Gehring	Laboratory Technician	AG
Approved by:	Sven Kühn	Deputy Manager	i.V. Blum

Issued: August 6, 2021

Glossary

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

Methods Applied and Interpretation of Parameters

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

DC Voltage Measurement

A/D - Converter Resolution nominal

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

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

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

Calibration Factors	X	Y	Z
High Range	406.182 ± 0.02% (k=2)	406.040 ± 0.02% (k=2)	406.445 ± 0.02% (k=2)
Low Range	3.94427 ± 1.50% (k=2)	4.00885 ± 1.50% (k=2)	3.98588 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	215.0 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	199994.92	0.64	0.00
Channel X	+ Input	20001.02	-1.00	-0.00
Channel X	- Input	-19997.18	4.49	-0.02
Channel Y	+ Input	199992.26	-1.79	-0.00
Channel Y	+ Input	19999.15	-2.88	-0.01
Channel Y	- Input	-20000.35	1.33	-0.01
Channel Z	+ Input	199991.45	-2.41	-0.00
Channel Z	+ Input	20000.30	-1.58	-0.01
Channel Z	- Input	-20000.57	1.13	-0.01

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2001.40	0.21	0.01
Channel X	+ Input	201.61	0.02	0.01
Channel X	- Input	-198.67	-0.34	0.17
Channel Y	+ Input	2001.23	0.17	0.01
Channel Y	+ Input	202.03	0.61	0.30
Channel Y	- Input	-198.26	0.29	-0.15
Channel Z	+ Input	2001.20	0.24	0.01
Channel Z	+ Input	200.63	-0.68	-0.34
Channel Z	- Input	-199.57	-0.95	0.48

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	4.14	3.47
	- 200	-2.62	-3.68
Channel Y	200	8.10	7.77
	- 200	-8.17	-8.30
Channel Z	200	-15.31	-15.20
	- 200	14.52	14.37

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	-	-1.28	-2.90
Channel Y	200	7.84	-	-0.31
Channel Z	200	5.21	6.87	-

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	15741	17394
Channel Y	15669	15298
Channel Z	15954	14899

5. Input Offset Measurement

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

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	1.11	-0.52	2.46	0.59
Channel Y	0.42	-0.88	1.59	0.51
Channel Z	0.15	-1.20	1.36	0.61

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

Schmid & Partner Engineering AG

s p e a g

Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

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.

Date 28.4.2008 **Signature / Stamp**

s p e a g
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