

Report on the Specific Absorption Rate Testing of the A3119

Apple Inc.
Model: A3119

In accordance with FCC 47 CFR 2.1093 and
RSS 102 Issue 5

FCC ID: BCGA3119 IC: 579C-A3119

Prepared for: Apple Inc
One Apple Park Way
Cupertino
California
95014
USA



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Document Number: 75960544-09 | Issue: 01

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Jon Kenny	Technical Director	Authorised Signatory	26 April 2024

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EXECUTIVE SUMMARY

A sample of this product was tested and found to be compliant with FCC 47 CFR 2.1093 and RSS 102 Issue 5 for the tests detailed in section 1.



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Registered in Scotland at East Kilbride,
Glasgow G75 0QF, United Kingdom
Registered number: SC215164

TÜV SÜD Ltd is a
TÜV SÜD Group Company

Phone: +44 (0) 1489 558100
Fax: +44 (0) 1489 558101
www.tuv-sud.co.uk

TÜV SÜD
Octagon House
Concorde Way
Fareham
Hampshire PO15 5RL
United Kingdom



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SECTION 1

REPORT SUMMARY

Specific Absorption Rate Testing of the A3119



1.1 INTRODUCTION

The information contained in this report is intended to show verification of the Specific Absorption Rate testing of the keyboard to the requirements of FCC 47 CFR 2.1093 and RSS 102 Issue 5.

Objective	To determine the Equipment Under Test's (EUT) compliance with the requirements specified within FCC 47 CFR 2.1093 and RSS 102 Issue 5.
Applicant	Apple Inc
EUT/Sample Identification	Refer to section 1.2
Test Specification/Issue/Date	FCC 47 CFR 2.1093 and RSS 102 Issue 5.
Start of Test	18-April-2024
Finish of Test	18-April-2024
Related Document(s)	KDB 865664 - D01 v01r04 KDB 447498 - D01 v06 IEC-IEEE 62209-1528:2020 FCC 47 CFR 1.1310
Name of Engineer(s)	Shahanas Shan Valentinas Luza

1.2 IDENTIFICATION OF THE EUT

The table below details identification of the EUT(s) that have been used to carry out the testing within this report.

Model: A3119			
Serial Number	Hardware Version	Software Version	Firmware
F0TH2S002M30000N1B (Radiated)	REV1.0	2.50	-
F0TH2S002Q30000N1B (Radiated)	REV1.0	2.50	-
F0TH2X001F30000N1B (Conducted)	REV1.0	2.50	-

Table 1



1.3 BRIEF SUMMARY OF RESULTS

The measurements shown in this report were made to the requirements of FCC 47 CFR 2.1093 and RSS-102 Issue 5.

1.3.1 Summary of Maximum Values

The maximum 1g volume averaged stand-alone SAR found during this Assessment:

Max 1g SAR (W/kg) Body	0.041(Measured)	0.044 (Scaled)
The maximum 1g volume averaged SAR level measured for all the tests performed did not exceed the limits for General Population/Uncontrolled Exposure (W/kg) Partial Body of 1.6 W/kg.		

Table 2

The maximum 1g volume averaged stand-alone Reported SAR found during this assessment for each supported mode:

Technology	Band	Test Configuration	Max Reported SAR (W/kg)
Bluetooth	2450MHz	Body	0.044
The maximum 1g volume averaged SAR level measured for all the tests performed did not exceed the limits for General Population/Uncontrolled Exposure (W/kg) Partial Body of 1.6 W/kg.			

Table 3



1.4 TEST RESULTS SUMMARY

1.4.1 Results Summary Tables

Bluetooth - BDR - DH5
 Specific Absorption Rate (SAR) 1g Results

Test Position	Channel Number	Frequency (MHz)	Measured Average Power (dBm)	Tune Up (dBm)	Measured 10g SAR (W/kg)	Scaled 10g SAR (W/kg)	Scan Figure Number
0mm Top Edge	39	2441	5.36	5.50	0.019	0.020	-
0mm Bottom Edge	39	2441	5.36	5.50	0.000	0.000	-
0mm Front	39	2441	5.36	5.50	0.030	0.031	-
0mm Back	39	2441	5.36	5.50	0.039	0.040	-
0mm Left Edge	39	2441	5.36	5.50	0.006	0.006	-
0mm Right Edge	39	2441	5.36	5.50	0.000	0.000	-
0mm Back	0	2402	5.19	5.50	0.037	0.040	-
0mm Back	78	2480	5.21	5.50	0.041	0.044	C.1
Limit for General Population (Uncontrolled Exposure) 1.6 W/kg (1g)							

Table 4



1.4.2 Technical Description

The equipment under test (EUT) was a wireless Keyboard.

1.4.3 Test Configuration and Modes of Operation

The testing was performed with an integral battery supplied and manufactured by Apple Inc.

Supported technologies are Bluetooth (BDR/EDR).

For each scan, the device was configured into a continuous transmission test mode at a maximum power defined by the customer.

Conducted power measurements were performed on a modified device (accessible conducted port) and the measured SAR results were power scaled to the maximum declared tune-up level.

For each antenna, all of the faces were assessed for SAR.

For SAR assessment, the relevant surfaces of the device were placed against an Elliptical phantom with a 0mm separation distance.

The Elliptical Flat Phantom dimensions are 600mm major axis and 400mm minor axis with a shell thickness of 2mm. The phantom was filled to a minimum depth of 150mm with the appropriate liquid. The dielectric properties were in accordance with the requirements specified in KDB 865665.

Included in this report are descriptions of the test method; the equipment used and an analysis of the test uncertainties applicable and diagrams indicating the locations of maximum SAR for each relevant test position.

1.4.4 Antenna Location Diagram

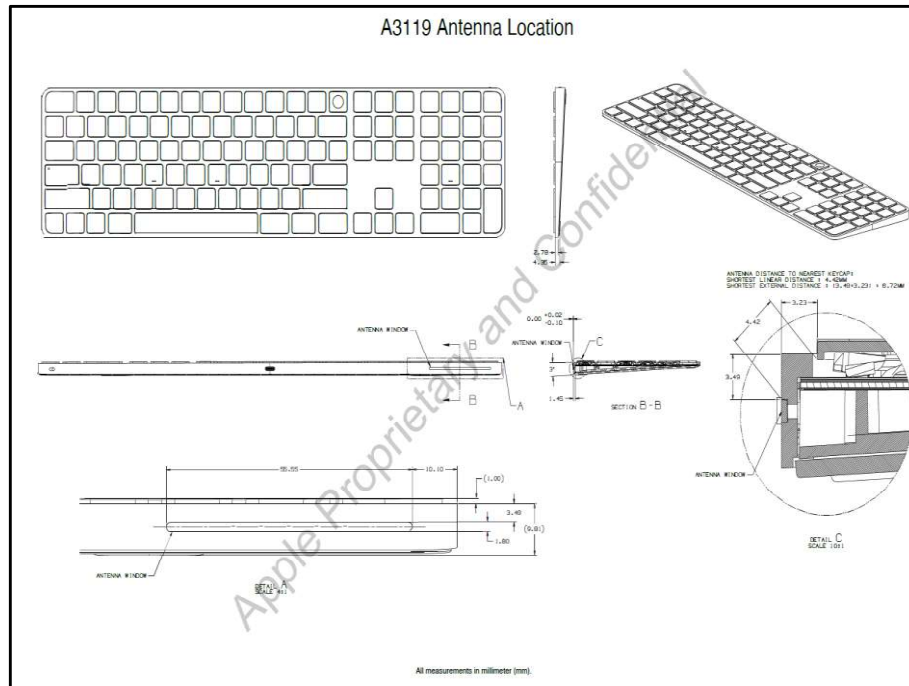


Figure 1



1.5 POWER TABLES (TUNE UP VALUES)

Note: All values in dBm
NS= Not Supported

2.4 GHz Bluetooth

Technology	BDR	EDR
Bluetooth	5.50	3.50

Table 5



1.6 CONDUCTED POWER MEASUREMENTS

1.6.1 Method

Conducted power measurements were made using a power sensor.

1.6.2 Measured Results

Bluetooth

Technology	Channel	Modulation	Duty Cycle (%)	Packet Type	Frequency (MHz)	Measured Power (dBm)	Tune Up (dBm)
BR	0	GFSK	77	DH5	2402	5.19	5.50
BR	39	GFSK	77	DH5	2441	5.36	5.50
BR	78	GFSK	77	DH5	2480	5.21	5.50

Table 6

Technology	Channel	Modulation	Duty Cycle (%)	Packet Type	Frequency (MHz)	Measured Power (dBm)	Tune Up (dBm)
EDR	0	$\pi/4$ DQPSK	77	2-DH5	2402	3.13	3.50
EDR	39	$\pi/4$ DQPSK	77	2-DH5	2441	3.35	3.50
EDR	78	$\pi/4$ DQPSK	77	2-DH5	2480	3.22	3.50
EDR	0	8-DPSK	77	3-DH5	2402	3.14	3.50
EDR	39	8-DPSK	77	3-DH5	2441	3.36	3.50
EDR	78	8-DPSK	77	3-DH5	2480	3.22	3.50

Table 7



SECTION 2

TEST DETAILS

Specific Absorption Rate Testing of the A3119

2.1 DASY6 MEASUREMENT SYSTEM

2.1.1 System Description

The DASY6 system for performing compliance tests consists of the following items:

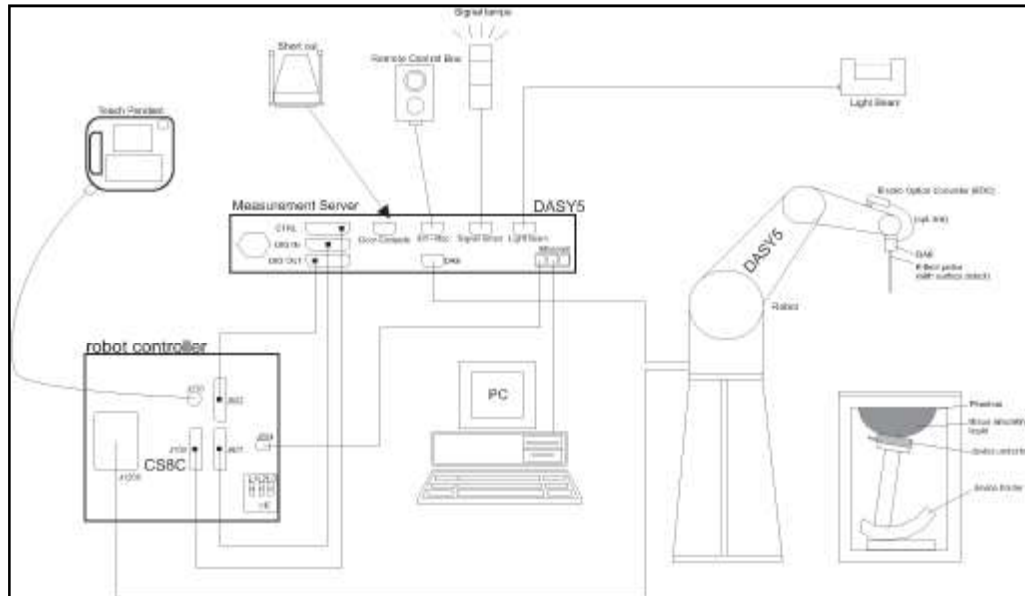


Figure 2 - System Description Diagram

A standard high precision 6-axis robot (Stäubli TX=RX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).

An isotropic field probe optimized and calibrated for the targeted measurement.

A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.

The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.

The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.

The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.

A computer running the DASY6 software to display and interact with the robot and information.

There is a remote control and a teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.

The phantom, the device holder and other accessories according to the targeted measurement.



2.1.2 Probe Specification

The probes used by the DASY system are isotropic E-field probes, constructed with a symmetric design and a triangular core. The probes have built-in shielding against static charges and are contained within a PEEK enclosure material. These probes are specially designed and calibrated for use in liquids with high permittivity. The frequency range of the probes are from 6 MHz to 6 GHz.

2.1.3 Data Acquisition Electronics

The data acquisition electronics (DAE4 or DAE3) consist 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 with a control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information, as well as an optical uplink for commands and the clock.

The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection. The input impedance of both the DAE4 as well as of the DAE3 box is 200MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

2.1.4 SAR Evaluation Description

The cDASY6 software includes all numerical procedures necessary to evaluate the spatial peak SAR values.

Fast Area Scan:

The Fast Area Scan provides an easy, time efficient and accurate way to define the optimal power reference location. The location of the power reference and power drift measurements for the subsequent Area, Fast Volume and Zoom Scans will be automatically set at the maximum of the Fast Area Scan.

Area Scan:

Area Scans are used to determine the peak location of the measured field before doing a finer measurement around the hotspot. Peak location can be found accurately even on coarse grids using the advanced interpolation routines implemented in cDASY6 Module SAR. Area Scans measure a two dimensional volume covering the full device under test area. cDASY6 Module SAR uses Fast Averaged SAR algorithm to compute the 1g and 10g of simulated tissue from the Area Scan.

Fast Volume Scans:

Fast Volume Scans are 3D scans used to assess the peak spatial SAR values within an averaging volume containing 1g and 10g of simulated tissue. It is compatible with any phantom. For regular phantoms, the measurement grid is generated by projecting a plane onto the phantom surface as for Area and Zoom scans. For specific phantoms, the measurement grid is generated by a conformal offset to the phantom surface at the desired distances. The grid extents can be set by the end user to cover the DUT dimensions or the whole measurable area of the phantom.

Zoom Scan:

Zoom scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1g and 10g of simulated tissue. Zoom scans measure a three dimensional volume (cube). The bottom face of the cube is Centred on the maximum of the preceding Area Scan in the same measurement group. For maxima at border of the phantom, the zoom scan can be enabled to automatically extend in order to ensure correct evaluation of peak spatial SAR.

Zoom Scans can be performed in two different modes:

- Smart Mode: the grid settings are adjusted on the fly based on the distribution being measured to fulfill to the IEC 62209-2 Amendment 1 criteria on grid resolution.
- Custom Mode: the user specifies the grid settings to be used. In both modes, Zoom Scans are always anchored to the peak location of the preceding Fast Area / Area / Fast Volume Scan.



SECTION 3

TEST EQUIPMENT USED



3.1 TEST EQUIPMENT USED

The following test equipment was used at TÜV SÜD Product Service:

Instrument Description	Manufacturer	Model Type	TE Number	Cal Period (months)	Calibration Due Date
Measurement server	Speag	DASY 8	6492	-	TU
Robot Mounting Platform	Speag	MP6C	6493	-	TU
Robot	Stäubli	TX2 90XL	6494	-	TU
Body Phantom	Speag	ELI V8.0	6491	-	TU
Dosimetric SAR Probe	Speag	EX3DV4	6498	12	14-Feb-2025
Data Acquisition Electronics	Speag	DAE4ip	6500	12	13-Feb-2025
Validation Dipole 2450MHz	Speag	D2450V2	5329	12	05-Jun-2024
Power Source	Speag	SE UMS 160 CB	6504	12	07-Feb-2025
Thermometer	LKM Electronics	-	4697	12	04-Sep-2024
ENA Series network analyser	Keysight Technologies	E5063A	5018	12	10-Oct-2024
Hygrometer	PCE Instruments	PCE-THB-40	5474	12	21-Apr-2024
Dielectric Assessment Kit	Speag	DAK-3.5	6502	-	TU
Signal Conditioning Unit	TUV SUD	SPECTRUM_SCU001	6517	12	22-Feb-2025
USB Wideband Power Sensor	Boonton	Power Sensor	6585	12	20-Feb-2025
SCU Cable Assembly	TUV SUD	Cable Assembly	6526	12	22-Feb-2025
Tissue Simulant Liquid	Speag	600-10000V6-Batch 5	-	-	Note 1

Table 8

TU - Traceability Unscheduled

Note 1: The calibration dates for the relevant batches of TSL can be found in the fluid parameter tables within this report.



3.2 TEST SOFTWARE

The following software was used to control the TÜV SÜD Product Service DASY System.

Instrument	Version Number
DASY System	cDASY6 Module SAR V16.2.2.1588

Table 9



3.3 TEST VERIFICATION

3.3.1 System Performance Check Results

Prior to formal testing being performed a System Check was performed in accordance with KDB 865664 and IEC-IEEE 62209-1528 the results were compared against the calibration certificates of each corresponding system verification dipole. The following results were obtained and within the $\pm 10\%$ acceptance criteria.

System Performance Check Results

Date	Frequency (MHz)	Fluid Type	Measured Max 1g SAR (W/kg) *	Max 1g SAR Target (W/kg)	Percentage Deviation from Target 1g (%)
18/04/2024	2450	HBBL 5	50.68	52.20	-2.91%

Table 10

*Normalised to a forward power of 1W.



3.4 DIELECTRIC PROPERTIES OF SIMULANT LIQUIDS

The fluid properties of the simulant fluids used during routine SAR evaluation meet the dielectric properties required KDB 865664 and IEC-IEEE 62209- 1528:2020.

The dielectric properties of the tissue simulant liquids used are within the $\pm 10\%$ acceptance criteria for the SAR testing at TÜV SÜD Product Service and are as follows:

Fluid Type and Frequency	Relative Permittivity Measured	Relative Permittivity Target	Conductivity Measured (S/m)	Conductivity Target (S/m)	Date	Fluid Temperature °C
2450	39.12	39.20	1.79	1.80	17/04/2024	20.98°C

Table 11



3.5 TEST CONDITIONS

3.5.1 Test Laboratory Conditions

Ambient temperature: Within +18.00°C to +25.00°C.

The actual temperature during the testing ranged from 19.05C to 20.98C.

The actual humidity during the testing ranged from 43.05% to 43.60% RH.

The temperature of the fluid during testing does not deviate by more than 2°C for each set of tests.

3.5.2 Test Fluid Temperature Range

Frequency	Body / Head Fluid	Min Temperature °C	Max Temperature °C
2450 MHz	Head	19.05	20.98

Table 12

3.6 MEASUREMENT UNCERTAINTY

SAR Measurements, 300 MHz to 3 GHz

Source of Uncertainty	Uncertainty \pm %	Probability distribution	Div	c_i (1g)	Standard Uncertainty \pm % (1g)
Measurement System Errors					
Probe Calibration	12.0	Normal	2.00	1.00	6.0
Probe Calibration Drift	1.7	Rectangular	1.73	1.00	1.0
Probe Linearity	4.7	Rectangular	1.73	1.00	2.7
Broadband Signal	3.0	Rectangular	1.73	1.00	1.7
Probe Isotropy	7.6	Rectangular	1.73	1.00	4.4
Data Acquisition	0.3	Normal	1.00	1.00	0.3
RF Ambient	1.8	Normal	1.00	1.00	1.8
Probe Positioning	0.2	Normal	1.00	0.14	0.0
Data Processing	1.2	Normal	1.00	1.00	1.2
Phantom and Device errors					
Liquid Conductivity Meas.	2.5	Normal	1.00	0.78	2.0
Liquid Conductivity Temp	3.3	Rectangular	1.73	0.78	1.5
Phantom Permittivity	14.0	Rectangular	1.73	0.00	0.0
Distance DUT - TSL	2.0	Normal	1.00	2.00	4.0
Device Positioning ($\pm 0.5\text{mm}$)	1.0	Normal	1.00	1.00	1.0
Device Holder	3.6	Normal	1.00	1.00	3.6
Device Modulation	2.4	Rectangular	1.73	1.00	1.4
Time-average SAR	2.6	Rectangular	1.73	1.00	1.5
DUT Drift	5.0	Normal	1.00	1.00	5.0
Correction to the SAR results					
Deviation to Target	1.9	Normal	1.00	1.00	1.9
SAR Scaling	0.0	Rectangular	1.73	1.00	0.0
Combined Standard Uncertainty		RSS			11.8
Expanded Standard Uncertainty		K=2			23.7

Table 13



3.6.1 Decision Rule

Accuracy Method

Determination of conformity with the specification limits is based on the decision rule according to IEC Guide 115:2007, Clause 4.4.3 and 4.5.1. (Procedure 2). The measurement results are directly compared with the test limit to determine conformance with the requirements of the standard.

Risk: The uncertainty of measurement about the measured result is negligible with regard to the final pass/fail decision. The measurement result can be directly compared with the test limit to determine conformance with the requirement (compare IEC Guide 115). The level of risk to falsely accept and falsely reject items is further described in ILAC-G8.”



SECTION 4

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4.1 ACCREDITATION, DISCLAIMERS AND COPYRIGHT



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ANNEX A

PROBE CALIBRATION REPORT



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



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

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

Accreditation No.: SCS 0108

Client
TÜV SÜD
Fareham, United Kingdom

Certificate No. **EX-7805_Feb24**

CALIBRATION CERTIFICATE

Object **EX3DV4 - SN:7805**

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

Calibration date **February 14, 2024**

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 NRP2	SN: 104778	30-Mar-23 (No. 217-03804/03805)	Mar-24
Power sensor NRP-Z91	SN: 103244	30-Mar-23 (No. 217-03804)	Mar-24
OCP DAK-3.5 (weighted)	SN: 1249	05-Oct-23 (OCP-DAK3.5-1249_Oct23)	Oct-24
OCP DAK-12	SN: 1016	05-Oct-23 (OCP-DAK12-1016_Oct23)	Oct-24
Reference 20 dB Attenuator	SN: CC2552 (20x)	30-Mar-23 (No. 217-03809)	Mar-24
DAE4	SN: 660	16-Mar-23 (No. DAE4-660_Mar23)	Mar-24
Reference Probe EX3DV4	SN: 7349	03-Nov-23 (No. EX3-7349_Nov23)	Nov-24

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

	Name	Function	Signature
Calibrated by	Jeffrey Katzman	Laboratory Technician	
Approved by	Sven Kühn	Technical Manager	
This calibration certificate shall not be reproduced except in full without written approval of the laboratory.			
Issued: February 14, 2024			

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



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

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

Accreditation No.: SCS 0108

Glossary

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

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}**: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E²-field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z}** = NORM_{x,y,z} * frequency_response (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- DCP_{x,y,z}**: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal. DCP does not depend on frequency nor media.
- PAR**: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,y,z}**: A, B, C, D are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- ConvF and Boundary Effect Parameters**: Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to NORM_{x,y,z} * ConvF whereby the uncertainty corresponds to that given for ConvF. A frequency dependent ConvF is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- Spherical isotropy (3D deviation from isotropy)**: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- Sensor Offset**: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- Connector Angle**: The angle is assessed using the information gained by determining the NORM_x (no uncertainty required).



EX3DV4 - SN:7805

February 14, 2024

Parameters of Probe: EX3DV4 - SN:7805

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k = 2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.62	0.61	0.71	$\pm 10.1\%$
DCP (mV) ^B	106.5	106.8	106.3	$\pm 4.7\%$

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Max dev.	Max Unc ^E k = 2
0	CW	X	0.00	0.00	1.00	0.00	143.0	$\pm 2.5\%$	$\pm 4.7\%$
		Y	0.00	0.00	1.00		131.9		
		Z	0.00	0.00	1.00		121.0		
10352	Pulse Waveform (200Hz, 10%)	X	1.54	60.76	6.34	10.00	60.0	$\pm 3.0\%$	$\pm 9.6\%$
		Y	1.39	60.12	6.21		60.0		
		Z	1.47	60.41	6.23		60.0		
10353	Pulse Waveform (200Hz, 20%)	X	22.00	74.00	9.00	6.99	80.0	$\pm 2.7\%$	$\pm 9.6\%$
		Y	0.82	60.00	5.11		80.0		
		Z	0.83	60.00	4.93		80.0		
10354	Pulse Waveform (200Hz, 40%)	X	0.04	125.69	0.10	3.98	95.0	$\pm 3.0\%$	$\pm 9.6\%$
		Y	0.41	158.60	17.89		95.0		
		Z	24.00	72.00	7.00		95.0		
10355	Pulse Waveform (200Hz, 60%)	X	7.72	159.15	26.25	2.22	120.0	$\pm 1.5\%$	$\pm 9.6\%$
		Y	0.33	60.00	3.30		120.0		
		Z	9.77	158.08	12.75		120.0		
10387	QPSK Waveform, 1 MHz	X	0.57	65.44	13.50	1.00	150.0	$\pm 2.8\%$	$\pm 9.6\%$
		Y	0.94	73.38	18.15		150.0		
		Z	0.55	64.20	12.89		150.0		
10388	QPSK Waveform, 10 MHz	X	1.40	67.23	14.48	0.00	150.0	$\pm 0.9\%$	$\pm 9.6\%$
		Y	1.76	70.92	16.71		150.0		
		Z	1.36	66.42	14.19		150.0		
10396	64-QAM Waveform, 100 kHz	X	1.63	64.08	15.63	3.01	150.0	$\pm 0.9\%$	$\pm 9.6\%$
		Y	1.84	66.27	16.88		150.0		
		Z	1.71	64.70	15.80		150.0		
10399	64-QAM Waveform, 40 MHz	X	2.87	66.92	15.41	0.00	150.0	$\pm 1.3\%$	$\pm 9.6\%$
		Y	2.94	67.43	15.91		150.0		
		Z	2.82	66.49	15.20		150.0		
10414	WLAN CCDF, 64-QAM, 40 MHz	X	3.82	66.52	15.49	0.00	150.0	$\pm 2.1\%$	$\pm 9.6\%$
		Y	3.97	67.19	16.00		150.0		
		Z	3.77	66.07	15.29		150.0		

Note: For details on UID parameters see Appendix

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

^A The uncertainties of Norm X,Y,Z do not affect the E²-field uncertainty inside TSL (see Pages 5 and 6).

^B Linearization parameter uncertainty for maximum specified field strength.

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



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Parameters of Probe: EX3DV4 - SN:7805

Sensor Model Parameters

	C1 fF	C2 fF	α V^{-1}	T1 $ms V^{-2}$	T2 $ms V^{-1}$	T3 ms	T4 V^{-2}	T5 V^{-1}	T6
x	8.8	62.84	32.91	4.19	0.00	4.90	0.50	0.00	1.00
y	9.0	63.68	32.62	4.61	0.00	4.90	0.56	0.00	1.00
z	9.2	65.89	32.77	3.99	0.00	4.90	0.58	0.00	1.00

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle	-7.5°
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.



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Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity ^F (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unc (k = 2)
300	45.3	0.87	11.45	11.45	11.45	0.09	1.00	±13.3%
450	43.5	0.87	10.69	10.69	10.69	0.16	1.30	±13.3%
750	41.9	0.89	9.05	9.34	9.03	0.41	1.27	±11.0%
835	41.5	0.90	8.86	9.29	8.74	0.41	1.27	±11.0%
900	41.5	0.97	8.70	9.27	8.67	0.41	1.27	±11.0%
1300	40.8	1.14	8.19	8.60	8.26	0.34	1.27	±11.0%
1450	40.5	1.20	8.08	8.45	8.15	0.34	1.27	±11.0%
1640	40.2	1.31	7.98	8.33	7.98	0.34	1.27	±11.0%
1750	40.1	1.37	7.83	8.33	7.87	0.28	1.27	±11.0%
1810	40.0	1.40	7.80	8.24	7.84	0.29	1.27	±11.0%
1900	40.0	1.40	7.71	8.12	7.76	0.30	1.27	±11.0%
1950	40.0	1.40	7.63	8.07	7.69	0.30	1.27	±11.0%
2000	40.0	1.40	7.45	7.86	7.51	0.30	1.27	±11.0%
2100	39.8	1.49	7.36	7.76	7.42	0.30	1.27	±11.0%
2300	39.5	1.67	7.21	7.59	7.28	0.32	1.27	±11.0%
2450	39.2	1.80	7.05	7.42	7.11	0.31	1.27	±11.0%
2550	39.1	1.91	6.98	7.33	7.03	0.30	1.27	±11.0%
2600	39.0	1.96	6.91	7.26	6.98	0.30	1.27	±11.0%
3300	38.2	2.71	6.65	6.94	6.70	0.34	1.27	±13.1%
3500	37.9	2.91	6.55	6.85	6.60	0.34	1.27	±13.1%
3700	37.7	3.12	6.47	6.79	6.52	0.34	1.27	±13.1%
4100	37.2	3.53	6.29	6.59	6.32	0.35	1.27	±13.1%
5200	36.0	4.66	5.18	5.44	5.21	0.31	1.60	±13.1%
5300	35.9	4.76	5.01	5.20	4.98	0.35	1.55	±13.1%
5500	35.6	4.96	4.75	4.91	4.69	0.42	1.49	±13.1%
5600	35.5	5.07	4.56	4.72	4.53	0.39	1.67	±13.1%
5800	35.3	5.27	4.63	4.77	4.63	0.36	1.86	±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 The probes are calibrated using tissue simulating liquids (TSL) that deviate for ϵ and σ by less than ±5% from the target values (typically better than ±3%) and are valid for TSL with deviations of up to ±10% if SAR correction is applied.

^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.



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Parameters of Probe: EX3DV4 - SN:7805

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) ^C	Relative Permittivity ^F	Conductivity ^F (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha ^G	Depth ^G (mm)	Unc (k = 2)
6500	34.5	6.07	5.02	5.22	4.99	0.20	2.00	±18.6%

^C Frequency validity at 6.5 GHz is -600/+700 MHz, and ±700 MHz at or above 7 GHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.

^F The probes are calibrated using tissue simulating liquids (TSL) that deviate for ϵ and σ by less than ±10% from the target values (typically better than ±6%) and are valid for TSL with deviations of up to ±10%.

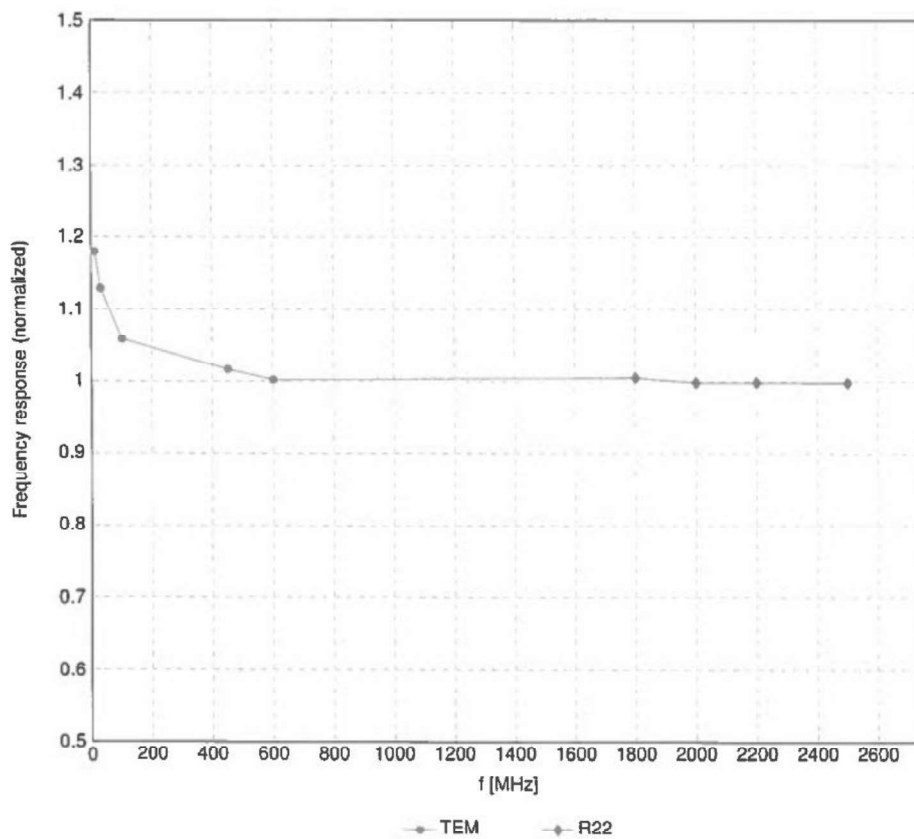
^G Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ±1% for frequencies below 3 GHz; below ±2% for frequencies between 3–6 GHz; and below ±4% for frequencies between 6–10 GHz at any distance larger than half the probe tip diameter from the boundary.

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Frequency Response of E-Field

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

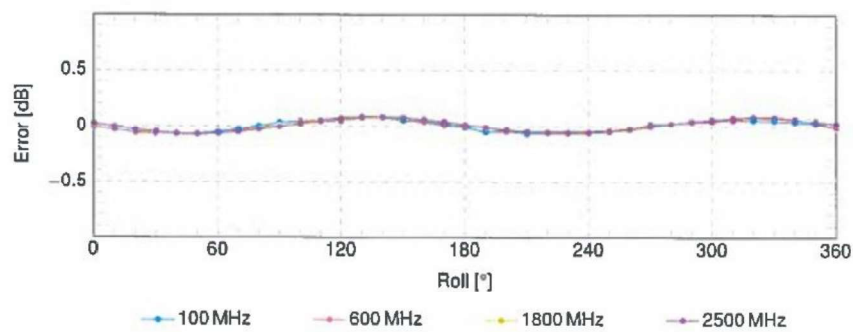
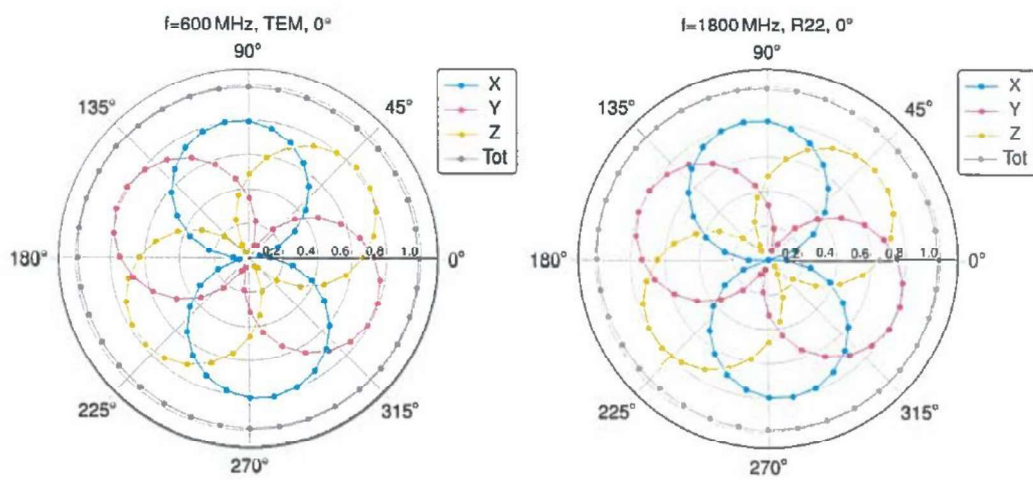


Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

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



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

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