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Bose Corporation
SAR TEST REPORT

SCOPE OF WORK
SPECIFIC ABSORPTION RATE – BT Earbuds

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SPECIFIC ABSORBTION RATE TEST REPORT

Report Number: 105400225LEX-001
Project Number: G105400225

Report Issue Date: 4/26/2023

Product Name: BT Earbuds

Standards: FCC Part 2.1093
RSS-102 Issue 5
IEC/IEEE 62209-1528:2020

Tested by:
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1 Introduction

At the request of Bose Corporation the BT Earbuds were evaluated for SAR in accordance with the requirements for FCC Part 2.1093 and RSS-102 Issue 5, and IEC/IEEE 62209-1528. Testing was performed in accordance with IEEE Std 1528:2013, IEC62209-2:2010, IEC/IEEE 1528, and the Office of Engineering and Technology KDB 447498. Testing was performed at the Intertek facility in Lexington, Kentucky. The FCC test site designation number was US1112. The SAR lab ISED company number was 2042M, CAB identifier US0127. The SAR lab A2LA certification number was 1926.01.

For the evaluation, the dosimetric assessment system DASY52 was used. The total uncertainty for the evaluation of the spatial peak SAR values averaged over a cube of 1g tissue mass had been assessed for this system to be ±22.2% from 300MHz – 3GHz and 24.6% from 3GHz – 6GHz.

The BT Earbuds were tested at the maximum output power measured by Intertek. Maximum output power measurements are tabulated under Section 8 Test Results. The maximum spatial peak SAR value for the sample device averaged over 1g is shown below.

Based on the worst-case data presented below, the BT Earbuds were found to be **compliant** with the 1.6 W/kg requirements for general population / uncontrolled exposure.

Table 1: Worst Case Reported SAR per Exposure Condition

Device Position	Transmit Mode	Separation Distance	Channel	Conducted Output Power (dBm)	Reported 1-g SAR (W/kg)	1-g SAR Limit (W/kg)
Left Earbud, Outside	QHS-P2	0mm	78	12.26	0.381 W/kg	1.6 W/kg
Right Earbud, Outside	QHS-P6	0mm	38	13.44	0.211 W/kg	1.6 W/kg

2 Test Site Description

The SAR test site located at 731 Enterprise Drive, Lexington KY 40510 is comprised of the SPEAG model DASY 5.2 automated near-field scanning system, which is a package, optimized for dosimetric evaluation of mobile radios [3]. This system is installed in an ambient-free shielded chamber. The ambient temperature is controlled to 22.0 ±2°C. During the SAR evaluations, the RF ambient conditions are monitored continuously for signals that might interfere with the test results. The tissue simulating liquid is also stored in this area in order to keep it at the same constant ambient temperature as the room.

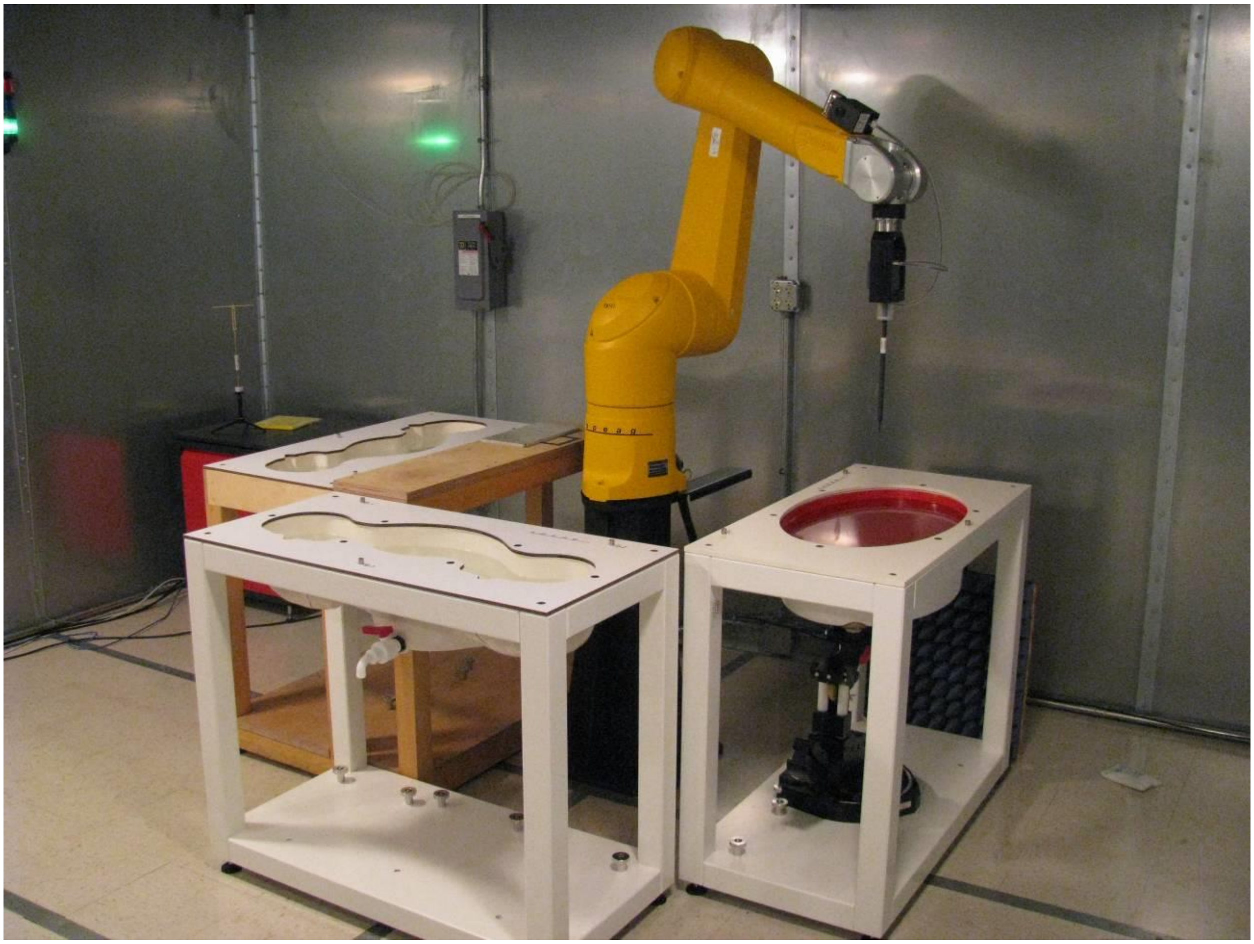


Figure 1: Intertek SAR Test Site

2.1 Measurement Equipment

The following major equipment/components were used for the SAR evaluation:

Table 2: Test Equipment Used for SAR Evaluation

Description	Asset	Manufacturer	Model	Cal. Date	Cal. Due
SAR Probe	3516	Speag	EXDV3	11/17/2022	11/17/2023
2450MHz Dipole	3013	Speag	D2450V2	11/15/2022	11/15/2023
DAE	3269	Speag	DAE4	11/10/2022	11/10/2023
Vector Signal Generator	3884	Rohde&Schwarz	SMBV100A	9/15/2022	9/15/2023
Network Analyzer	2538	Agilent	8753ES	4/5/2022	4/5/2023
USB Power Sensor	4022	Rohde & Schwarz	NRP-Z81	9/22/2022	9/22/2023
Dielectric Probe Kit	3968	Speag	DAK-3.5	11/14/2022	11/14/2023
Spectrum Analyzer	3065	Rohde & Schwarz	FSP3	9/16/2022	9/16/2023
SAM Twin Phantom	3619	Speag	QD 000 P40 C	Verify at Time of Use	Verify at Time of Use
6-axis robot	3608	Staubli	RX-909	Verify at Time of Use	Verify at Time of Use

2.2 Measurement Uncertainty

The Tables below includes the uncertainty budget suggested by the IEEE Std 1528-2013, IEC62209-2: 2010, and IEC/IEEE 62209-1528 as determined by SPEAG for the DASY5 measurement System.

Error Description	Uncertainty Value	Prob. Dist.	Div.	c_i (1g)	c_i (10g)	Std.Unc. (1g)	Std.Unc. (10g)	(v_i) v_{eff}
Measurement System								
Probe Calibration	±6.0%	N	1	1	1	±6.0%	±6.0%	∞
Axial Isotropy	±4.7%	R	√3	0.7	0.7	±1.9%	±1.9%	∞
Hemispherical Isotropy	±9.6%	R	√3	0.7	0.7	±3.9%	±3.9%	∞
Boundary Effect	±1.0%	R	√3	1	1	±0.6%	±0.6%	∞
Linearity	±4.7%	R	√3	1	1	±2.7%	±2.7%	∞
System Detection Limits	±1.0%	R	√3	1	1	±0.6%	±0.6%	∞
Modulation Response	±2.4%	R	√3	1	1	±1.4%	±1.4%	∞
Readout Electronics	±0.3%	N	1	1	1	±0.3%	±0.3%	∞
Response Time	±0.8%	R	√3	1	1	±0.5%	±0.5%	∞
Integration Time	±2.6%	R	√3	1	1	±1.5%	±1.5%	∞
RF Ambient Noise	±3.0%	R	√3	1	1	±1.7%	±1.7%	∞
RF Ambient Reflections	±3.0%	R	√3	1	1	±1.7%	±1.7%	∞
Probe Positioner	±0.4%	R	√3	1	1	±0.2%	±0.2%	∞
Probe Positioning	±2.9%	R	√3	1	1	±1.7%	±1.7%	∞
Max. SAR Eval.	±2.0%	R	√3	1	1	±1.2%	±1.2%	∞
Test sample Related								
Device Positioning	±2.9%	N	1	1	1	±2.9%	±2.9%	145
Device Holder	±3.6%	N	1	1	1	±3.6%	±3.6%	5
Power Drift	±5.0%	R	√3	1	1	±2.9%	±2.9%	∞
Power Scaling	±0.0%	R	√3	1	1	±0%	±0%	∞
Phantom and Setup								
Phantom Uncertainty	±6.1%	R	√3	1	1	±3.5%	±3.5%	∞
SAR Correction	±1.9%	R	√3	1	0.84	±1.1%	±0.9%	∞
Liquid Conductivity (mea.)	±2.5%	R	√3	0.78	0.71	±1.1%	±1.0%	∞
Liquid Permittivity (mea.)	±2.5%	R	√3	0.26	0.26	±0.3%	±0.4%	∞
Temp unc. - Conductivity	±3.4%	R	√3	0.78	0.71	±1.5%	±1.4%	∞
Temp unc. - Permittivity	±0.4%	R	√3	0.23	0.26	±0.1%	±0.1%	∞
Combined Standard Uncertainty						±11.2%	±11.1%	361
Expanded STD Uncertainty						**±22.3%**	**±22.2%**	

Notes:
Worst Case uncertainty budget for DASY5 assessed according to IEEE 1528-2013 and IEC/IEEE 62209-1528. The budget is valid for the frequency range 300 MHz – 3 GHz and represents a worst-case analysis. For specific tests and configurations, the uncertainty could be considerably smaller.

Error Description	Uncertainty Value	Prob. Dist.	Div.	c_i (1g)	c_i (10g)	Std.Unc. (1g)	Std.Unc. (10g)	(v_i) v_{eff}
Measurement System								
Probe Calibration	±6.55%	N	1	1	1	±6.55%	±6.55%	∞
Axial Isotropy	±4.7%	R	√3	0.7	0.7	±1.9%	±1.9%	∞
Hemispherical Isotropy	±9.6%	R	√3	0.7	0.7	±3.9%	±3.9%	∞
Boundary Effect	±2.0%	R	√3	1	1	±1.2%	±1.2%	∞
Linearity	±4.7%	R	√3	1	1	±2.7%	±2.7%	∞
System Detection Limits	±1.0%	R	√3	1	1	±0.6%	±0.6%	∞
Modulation Response	±2.4%	R	√3	1	1	±1.4%	±1.4%	∞
Readout Electronics	±0.3%	N	1	1	1	±0.3%	±0.3%	∞
Response Time	±0.8%	R	√3	1	1	±0.5%	±0.5%	∞
Integration Time	±2.6%	R	√3	1	1	±1.5%	±1.5%	∞
RF Ambient Noise	±3.0%	R	√3	1	1	±1.7%	±1.7%	∞
RF Ambient Reflections	±3.0%	R	√3	1	1	±1.7%	±1.7%	∞
Probe Positioner	±0.8%	R	√3	1	1	±0.5%	±0.5%	∞
Probe Positioning	±6.7%	R	√3	1	1	±3.9%	±3.9%	∞
Max. SAR Eval.	±4.0%	R	√3	1	1	±2.3%	±2.3%	∞
Test sample Related								
Device Positioning	±2.9%	N	1	1	1	±2.9%	±2.9%	145
Device Holder	±3.6%	N	1	1	1	±3.6%	±3.6%	5
Power Drift	±5.0%	R	√3	1	1	±2.9%	±2.9%	∞
Power Scaling	±0.0%	R	√3	1	1	±0%	±0%	∞
Phantom and Setup								
Phantom Uncertainty	±6.6%	R	√3	1	1	±3.8%	±3.8%	∞
SAR Correction	±1.9%	R	√3	1	0.84	±1.1%	±0.9%	∞
Liquid Conductivity (mea.)	±2.5%	R	√3	0.78	0.71	±1.1%	±1.0%	∞
Liquid Permittivity(mea.)	±2.5%	R	√3	0.26	0.26	±0.3%	±0.4%	∞
Temp unc. - Conductivity	±3.4%	R	√3	0.78	0.71	±1.5%	±1.4%	∞
Temp unc. - Permittivity	±0.4%	R	√3	0.23	0.26	±0.1%	±0.1%	∞
Combined Standard Uncertainty						±12.3%	±12.2%	748
Expanded STD Uncertainty						**±24.6%**	**±24.5%**	

Notes:
Worst Case uncertainty budget for DASY5 assessed according to IEEE 1528-2013 and IEC/IEEE 62209-1528. The budget is valid for the frequency range 3 GHz – 6 GHz and represents a worst-case analysis. Probe calibration error reflects uncertainty of the EX3D probe. For specific tests and configurations, the uncertainty could be considerably smaller.

Error Description	Uncertainty Value	Prob. Dist.	Div.	c_i (1g)	c_i (10g)	Std.Unc. (1g)	Std.Unc. (10g)	(v_i) v_{eff}
Measurement System								
Probe Calibration	±6.55%	N	1	1	1	±6.55%	±6.55%	∞
Axial Isotropy	±4.7%	R	√3	0.7	0.7	±1.9%	±1.9%	∞
Hemispherical Isotropy	±9.6%	R	√3	0.7	0.7	±3.9%	±3.9%	∞
Boundary Effect	±2.0%	R	√3	1	1	±1.2%	±1.2%	∞
Linearity	±4.7%	R	√3	1	1	±2.7%	±2.7%	∞
System Detection Limits	±1.0%	R	√3	1	1	±0.6%	±0.6%	∞
Modulation Response	±2.4%	R	√3	1	1	±1.4%	±1.4%	∞
Readout Electronics	±0.3%	N	1	1	1	±0.3%	±0.3%	∞
Response Time	±0.8%	R	√3	1	1	±0.5%	±0.5%	∞
Integration Time	±2.6%	R	√3	1	1	±1.5%	±1.5%	∞
RF Ambient Noise	±3.0%	R	√3	1	1	±1.7%	±1.7%	∞
RF Ambient Reflections	±3.0%	R	√3	1	1	±1.7%	±1.7%	∞
Probe Positioner	±0.8%	R	√3	1	1	±0.5%	±0.5%	∞
Probe Positioning	±6.7%	R	√3	1	1	±3.9%	±3.9%	∞
Post-Processing	±4.0%	R	√3	1	1	±2.3%	±2.3%	∞
Test sample Related								
Device Positioning	±2.9%	N	1	1	1	±2.9%	±2.9%	145
Device Holder	±3.6%	N	1	1	1	±3.6%	±3.6%	5
Power Drift	±5.0%	R	√3	1	1	±2.9%	±2.9%	∞
Power Scaling	±0.0%	R	√3	1	1	±0%	±0%	∞
Phantom and Setup								
Phantom Uncertainty	±7.9%	R	√3	1	1	±4.6%	±4.6%	∞
SAR Correction	±1.9%	R	√3	1	0.84	±1.1%	±0.9%	∞
Liquid Conductivity (mea.)	±2.5%	R	√3	0.78	0.71	±1.1%	±1.0%	∞
Liquid Permittivity (mea.)	±2.5%	R	√3	0.26	0.26	±0.3%	±0.4%	∞
Temp unc. - Conductivity	±3.4%	R	√3	0.78	0.71	±1.5%	±1.4%	∞
Temp unc. - Permittivity	±0.4%	R	√3	0.23	0.26	±0.1%	±0.1%	∞
Combined Standard Uncertainty						±12.5%	±12.5%	748
Expanded STD Uncertainty						**±25.1%**	**±25.0%**	

Notes:
Worst Case uncertainty budget for DASY5 assessed according to IEC62209-2: 2010. The budget is valid for the frequency range 30MHz – 6 GHz and represents a worst-case analysis. Probe calibration error reflects uncertainty of the EX3D probe. For specific tests and configurations, the uncertainty could be considerably smaller.

3 Description of Equipment under Test

Equipment Under Test	
Product Name	BT Earbuds
Model Number	BT Earbuds
Serial Number	Left: 084803M3051D018A1 Right: 084808M3051D031A1
FCCID	Left: A94408L Right: A94408R
ICID	Left: 3232A-408L Right: 3232A-408R
Supported Transmit Modes	Bluetooth: BDR, 2-EDR, 3-EDR Bluetooth Low Energy: 1Mbps, 2Mbps QHS™: 2Mbps, 6Mbps
Receive Date	3/28/2023
Test Start Date	3/28/2023
Test End Date	3/31/2023
Device Received Condition	Good
Test Sample Type	Production
Rated Voltage	3.6VDC (Battery)
Antenna Gains[1]	Left: 0.58 dBi Right: 0.86 dBi
Description of Equipment Under Test[1]	
Bluetooth wireless earbuds	

Operating Band	Technology	Modulation	Frequency Range (MHz)	Maximum Output Power (dBm)	Duty Cycle
2.4GHz ISM	Bluetooth, BDR	GFSK	2402 – 2480MHz	13.50	1:1
2.4GHz ISM	Bluetooth, 2-EDR	π/4-DQPSK	2402 – 2480MHz	13.50	1:1
2.4GHz ISM	Bluetooth, 3-EDR	8-DPSK	2402 – 2480MHz	13.50	1:1
2.4GHz ISM	BLE, 1Mbps	GFSK	2402 – 2480MHz	8.50	1:1
2.4GHz ISM	BLE, 2Mbps	GFSK	2402 – 2480MHz	8.50	1:1
2.4GHz ISM	QHS™, 2Mbps	Proprietary	2402 – 2480MHz	13.50	1:1
2.4GHz ISM	QHS™, 6Mbps	Proprietary	2402 – 2480MHz	13.50	1:1

[1] This information was provided by the client and may affect compliance. Intertek makes no claims of compliance for any device(s) other than those identified herein. Intertek cannot attest to the accuracy of any client-provided data.

4 System Verification

4.1 System Validation

Prior to the assessment, the system was verified to be within ±10% of the specifications by using the system validation kit. The system validation procedure tests the system against reference SAR values and the performance of probe, readout electronics and software. The test setup utilizes a phantom and reference dipole.

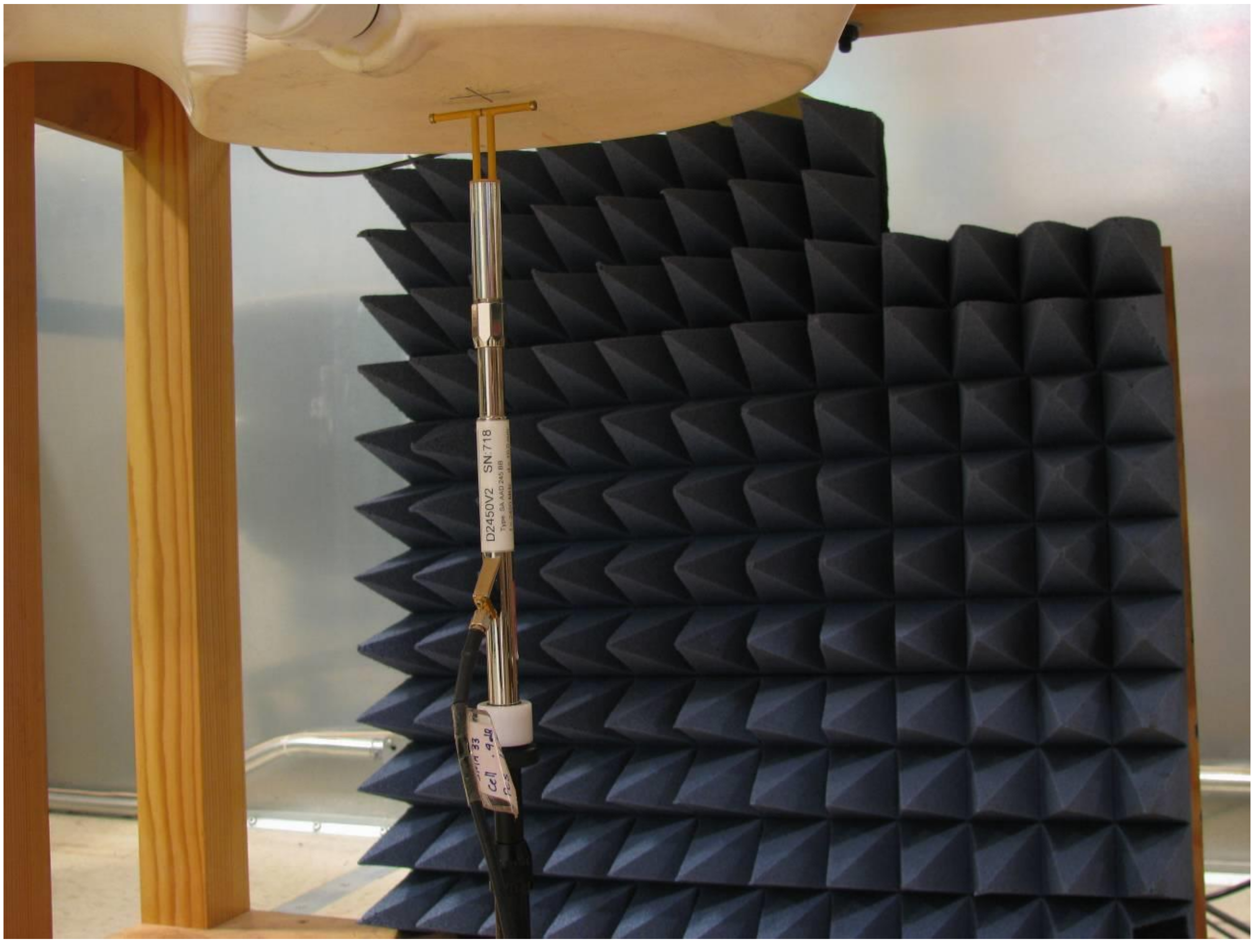


Figure 2: System Verification Setup

Table 3: Dipole Validation

Date	Ambient Temp (C)	Fluid Temp (C)	Frequency (MHz)	Dipole	Fluid Type	Phantom	Dipole Power Input (W)	Target Power (W)
3/28/2023	24.7	22.8	2450MHz	D2450V2	2450HSL	SAM Twin	0.25	1

Measured 10-g SAR (W/kg)	Adjusted 10-g SAR (W/kg)	Cal. Lab 10-g SAR (W/kg)	10-g SAR % Error	Measured 1-g SAR (W/kg)	Adjusted 1-g SAR (W/kg)	Cal. Lab 1-g SAR (W/kg)	1-g SAR % Error	Power Drift (dB)
5.95	23.8	24.6	-3.25%	12.7	50.8	52.4	-3.05%	0.09

4.2 Measurement Uncertainty for System Validation

Source of Uncertainty	Value(dB)	Probability Distribution	Divisor	c_i	$u_i(y)$	$(u_i(y))^2$
Measurement System						
Probe Calibration	5.50	n1	1	1	5.50	30.250
Axial Isotropy	4.70	r	1.732	0.7	2.71	7.364
Hemispherical Isotropy	9.60	r	1.732	0.7	5.54	30.722
Boundary Effect	1.00	r	1.732	1	0.58	0.333
Linearity	4.70	r	1.732	1	2.71	7.364
System Detection Limits	1.00	r	1.732	1	0.58	0.333
Readout Electronics	0.30	n1	1	1	0.30	0.090
Response Time	0.80	r	1.732	1	0.46	0.213
Integration Time	2.60	r	1.732	1	1.50	2.253
RF Ambient Noise	3.00	r	1.732	1	1.73	3.000
RF Ambient Reflections	3.00	r	1.732	1	1.73	3.000
Probe Positioner	0.40	r	1.732	1	0.23	0.053
Probe Positioning	2.90	r	1.732	1	1.67	2.803
Max. SAR Eval.	1.00	r	1.732	1	0.58	0.333
Dipole / Generator / Power Meter Related						
Dipole positioning	2.90	n1	1	1	2.90	8.410
Dipole Calibration Uncertainty	0.68	r	1.732	1	0.39	0.154
Power Meter 1 Uncertainty (+20C to +25C)	0.13	n1	1	2	0.13	0.017
Power Meter 2 Uncertainty (+20C to +25C)	0.04	n1	1	3	0.04	0.002
Sig Gen VSWR Mismatch Error	1.80	n1	1	5	1.80	3.240
Sig Gen Resolution Error	0.01	n1	1	6	0.01	0.000
Sig Gen Level Error	0.90	n1	1	1	0.90	0.810
Phantom and Setup						
Phantom Uncertainty	4.00	r	1.732	1	2.31	5.334
Liquid Conductivity (target)	5.00	r	1.732	0.43	2.89	8.334
Liquid Conductivity (meas.)	2.50	n1	1	0.43	2.50	6.250
Liquid Permittivity (target)	5.00	r	1.732	0.49	2.89	8.334
Liquid Permittivity (meas.)	2.50	n1	1	0.49	2.50	6.250
Combined Standard Uncertainty		N1	1	1	11.63	135.247
Expanded Uncertainty		Normal k=	2		**23.26**	

4.3 Tissue Simulating Liquid Description and Validation

The dielectric parameters were verified to be within 5% of the target values prior to assessment. The dielectric parameters (ε_r, σ) are shown in Table 4. A recipe for the tissue simulating fluid used is shown in Table 5.

Table 4: Dielectric Parameter Validations

Date	Temperature (C)	Tissue Type	Frequency (MHz)	ε' Target	σ Target	ε' Measured	σ Measured	ε'' Calculated	Dielectric % Deviation	Conductivity % Deviation
3/28/2023	22.8	2450MHz HSL	2450	39.2	1.8	38.3	1.78	13.06	2.19	1.11
3/31/2023	21.5	2450MHz HSL	2450	39.2	1.8	38.2	1.81	13.28	2.47	0.56

Table 5: Tissue Simulating Fluid Recipe

Composition of Ingredients for Liquid Tissue Phantoms (450MHz to 2450 MHz data only)												
Ingredient (% by weight)	f (MHz)											
	450		835		915		1900		2450		5500	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56	54.9	70.45	62.7	68.64	65.53	78.67
Salt (NaCl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.36	0.5			
Sugar	56.32	46.78	56	45	56.5	41.76						
HEC	0.98	0.52	1	1	1	1.21						
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27						
Triton X-100									36.8		17.235	10.665
DGBE							44.92	29.18		31.37		
DGHE											17.235	10.665
Dielectric Constant	43.42	58	42.54	56.1	42	56.8	39.9	53.3	39.8	52.7		
Conductivity (S/m)	0.85	0.83	0.91	0.95	1	1.07	1.42	1.52	1.88	1.95		

Tissue Simulating Liquid for 5GHz, MBBL3500-5800V5 Manufactured by SPEAG (proprietary mixture)

Ingredients	(% by weight)
Water	78
Mineral oil	11
Emulsifiers	9
Additives and Salt	2

5 Evaluation Procedures

Prior to any testing, the appropriate fluid was used to fill the phantom to a depth of 15 cm ±0.2cm. The fluid parameters were verified and the dipole validation was performed as described in the previous sections.

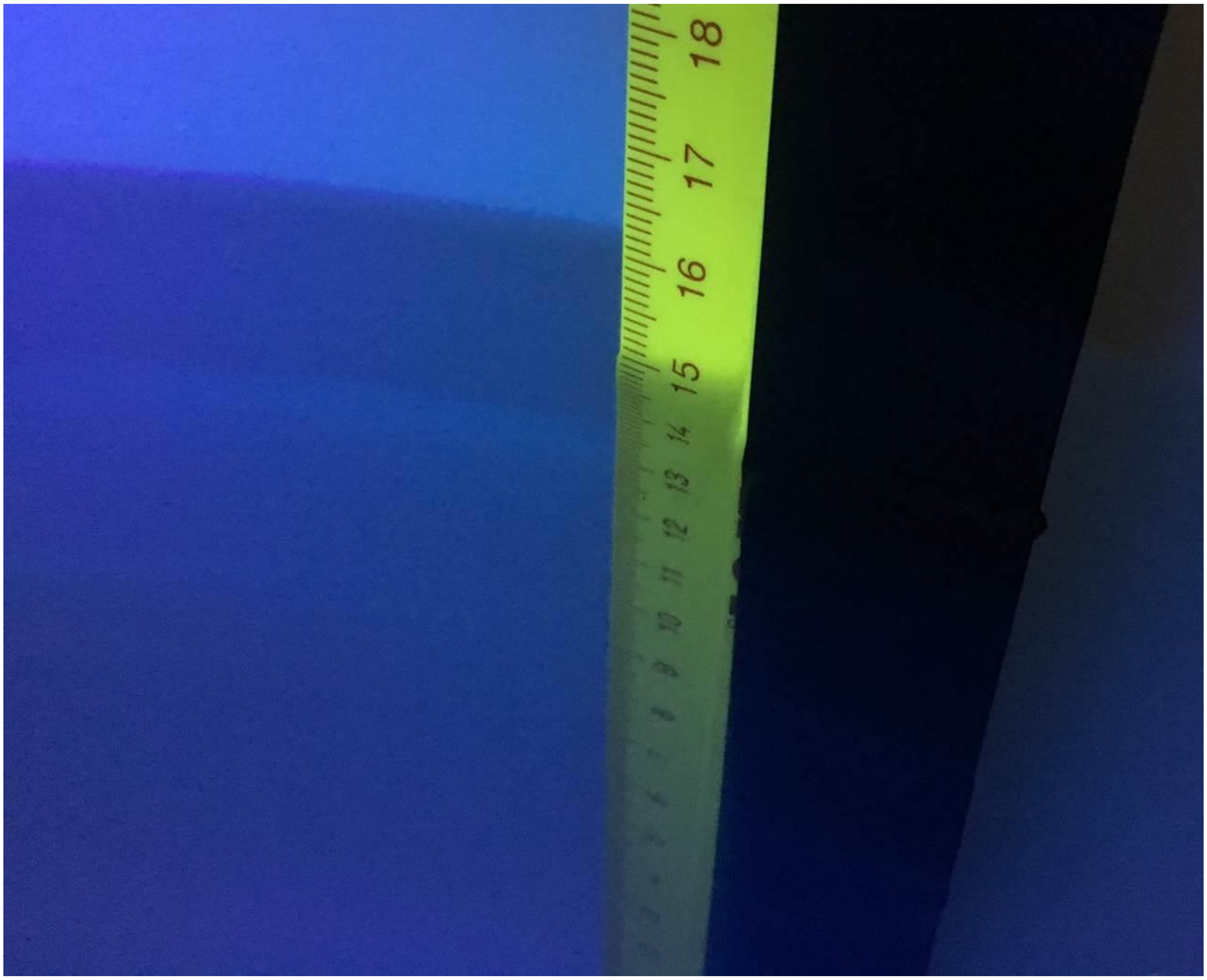


Figure 3: Fluid Depth 15cm

5.1 Test Positions:

The Device was positioned against the SAM phantom using the exact procedure described in IEEE Std 1528:2013, IEC62209-2:2010, IEC/IEEE 62209-1528, and the Office of Engineering and Technology KDB 447498.

5.2 Reference Power Measurement:

The measurement probe was positioned at a fixed location above the reference point. A power measurement was made with the probe above this reference position so it could used for the assessing the power drift later in the test procedure.

5.3 Area Scan:

A coarse area scan was performed in order to find the approximate location of the peak SAR value. This scan was performed with the measurement probe at a constant height in the simulating fluid. A two dimensional spline interpolation algorithm was then used to determine the peaks and gradients within the scanned area. The area scan resolution conformed to the requirements of KDB 865664 as shown in Table 6.

5.4 Zoom Scan:

A zoom scan was performed around the approximate location of the peak SAR as determined from the area scan. On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure. The zoom scan resolution conformed to the requirements of KDB 865664 as shown in Table 6.

Table 6: SAR Area and Zoom Scan Resolutions

<table>
<tr><th colspan="3"></th><th>≤ 3 GHz</th><th>> 3 GHz</th></tr>
<tr><td colspan="3">Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface</td><td>5 ± 1 mm</td><td>½·δ·ln(2) ± 0.5 mm</td></tr>
<tr><td colspan="3">Maximum probe angle from probe axis to phantom surface normal at the measurement location</td><td>30° ± 1°</td><td>20° ± 1°</td></tr>
<tr><td colspan="3" rowspan="2">Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}</td><td>≤ 2 GHz: ≤ 15 mm
2 – 3 GHz: ≤ 12 mm</td><td>3 – 4 GHz: ≤ 12 mm
4 – 6 GHz: ≤ 10 mm</td></tr>
<tr><td colspan="2">When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.</td></tr>
<tr><td colspan="3">Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}</td><td>≤ 2 GHz: ≤ 8 mm
2 – 3 GHz: ≤ 5 mm*</td><td>3 – 4 GHz: ≤ 5 mm*
4 – 6 GHz: ≤ 4 mm*</td></tr>
<tr><td rowspan="3">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2">uniform grid: $\Delta z_{Zoom}(n)$</td><td>≤ 5 mm</td><td>3 – 4 GHz: ≤ 4 mm
4 – 5 GHz: ≤ 3 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td rowspan="2">graded grid</td><td>$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface</td><td>≤ 4 mm</td><td>3 – 4 GHz: ≤ 3 mm
4 – 5 GHz: ≤ 2.5 mm
5 – 6 GHz: ≤ 2 mm</td></tr>
<tr><td>$\Delta z_{Zoom}(n>1)$: between subsequent points</td><td colspan="2">≤ 1.5·$\Delta z_{Zoom}(n-1)$</td></tr>
<tr><td>Minimum zoom scan volume</td><td colspan="2">x, y, z</td><td>≥ 30 mm</td><td>3 – 4 GHz: ≥ 28 mm
4 – 5 GHz: ≥ 25 mm
5 – 6 GHz: ≥ 22 mm</td></tr>
<tr><td colspan="5">Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.
* When zoom scan is required and the <u>reported</u> SAR from the area scan based 1-g SAR estimation procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.</td></tr>
</table>

5.5 Interpolation, Extrapolation and Detection of Maxima:

The probe is calibrated at the center of the dipole sensors which is located 1 to 2.7 mm away from the probe tip. During measurements, the probe stops shortly above the phantom surface, depending on the probe and the surface detecting system. Both distances are included as parameters in the probe configuration file. The software always knows exactly how far away the measured point is from the surface. As the probe cannot directly measure at the surface, the values between the deepest measured point and the surface must be extrapolated.

In DASY5, the choice of the coordinate system defining the location of the measurement points has no influence on the uncertainty of the interpolation, Maxima Search and extrapolation routines. The interpolation, extrapolation and maximum search routines are all based on the modified Quadratic Shepard's method.

Thereby, the interpolation scheme combines a least-square fitted function method and a weighted average method which are the two basic types of computational interpolation and approximation. The DASY5 routines construct a once-continuously differentiable function that interpolates the measurement values as follows:

- For each measurement point a trivariate (3-D) / bivariate (2-D) quadratic is computed. It interpolates the measurement values at the data point and forms a least-square fit to neighboring measurement values.
- The spatial location of the quadratic with respect to the measurement values is attenuated by an inverse distance weighting. This is performed since the calculated quadratic will fit measurement values at nearby points more accurate than at points located further away.
- After the quadratics are calculated for at all measurement points, the interpolating function is calculated as a weighted average of the quadratics.

There are two control parameters that govern the behavior of the interpolation method. One specifies the number of measurement points to be used in computing the least-square fits for the local quadratics. These measurement points are the ones nearest the input point for which the quadratic is being computed. The second parameter specifies the number of measurement points that will be used in calculating the weights for the quadratics to produce the final function. The input data points used there are the ones nearest the point at which the interpolation is desired. Appropriate defaults are chosen for each of the control parameters.

The trivariate quadratics that have been previously computed for the 3-D interpolation and whose input data are at the closest distance from the phantom surface, are used in order to extrapolate the fields to the surface of the phantom.

In order to determine all the field maxima in 2-D (Area Scan) and 3-D (Zoom Scan), the measurement grid is refined by a default factor of 10 and the interpolation function is used to evaluate all field values between corresponding measurement points. Subsequently, a linear search is applied to find all the candidate maxima. In a last step, non-physical maxima are removed and only those maxima which are within 2 dB of the global maximum value are retained.

5.6 Averaging and Determination of Spatial Peak SAR

The interpolated data is used to average the SAR over the 1g and 10g cubes by spatially discretizing the entire measured volume. The resolution of this spatial grid used to calculate the averaged SAR is 1mm or about 42875 interpolated points. The resulting volumes are defined as cubical volumes containing the appropriate tissue parameters that are centered at the location. The location is defined as the center of the incremental volume. The spatial-peak SAR must be evaluated in cubical volumes containing a mass that is within 5% of the required mass. The cubical volume centered at each location, as defined above, should be expanded in all directions until the desired value for the mass is reached, with no surface boundaries of the averaging volume extending beyond the outermost surface of the considered region. In addition, the cubical volume should not consist of more than 10% of air. If these conditions are not satisfied then the center of the averaging volume is moved to the next location. Otherwise, the exact size of the final sampling cube is found using an inverse polynomial approximation algorithm, leading to results with improved accuracy. If one boundary of the averaging volume reaches the boundary of the measured volume during its expansion, it will not be evaluated at all. Reference is kept of all locations used and those not used for averaging the SAR. All average SAR values are finally assigned to the centered location in each valid averaging volume.
All locations included in an averaging volume are marked to indicate that they have been used at least once. If a location has been marked as used, but has never been assigned to the center of a cube, the highest averaged SAR value of all other cubical volumes which have used this location for averaging is assigned to this location. Only those locations that are not part of any valid averaging volume should be marked as unused. For the case of an unused location, a new averaging volume must be constructed which will have the unused location centered at one surface of the cube. The remaining five surfaces are expanded evenly in all directions until the required mass is enclosed, regardless of the amount of included air. Of the six possible cubes with one surface centered on the unused location, the smallest cube is used, which still contains the required mass.
If the final cube containing the highest averaged SAR touches the surface of the measured volume, an appropriate warning is issued within the post processing engine.

5.7 Power Drift Measurement:

The probe was positioned at precisely the same reference point and the reference power measurement was repeated. The difference between the initial reference power and the final one is referred to as the power drift. This value should not exceed 5%. The power drift measurement was used to assess the output power stability of the test sample throughout the SAR scan.

5.8 RF Ambient Activity:

During the entire SAR evaluation, the RF ambient activity was monitored using a spectrum analyzer with an antenna connected to it. The spectrum analyzer was tuned to the frequency of measurement and with one trace set to max hold mode. In this way, it was possible to determine if at any point during the SAR measurement there was an interfering ambient signal. If an ambient signal was detected, then the SAR measurement was repeated.

6 Criteria

The following ANSI/IEEE C95.1 – 1992 limits for SAR apply to portable devices operating in the General Population/Uncontrolled Exposure environment. Uncontrolled environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

Exposure Type (General Population/Uncontrolled Exposure environment)	**SAR Limit (W/kg or mW/g)**
Average over the whole body	0.08
Spatial Peak (1g)	1.60
Spatial Peak for hands, wrists, feet and ankles (10g)	4.00

7 Test Configuration

The BT Earbuds were designed to be used against the head, in either the left or right ear. Therefore, each earbud was successively placed against the ear position of the respective SAM head phantom.

The device was evaluated according to the specific requirements found in the following KDBs and Standards:

- FCC KDB 447498 D04 v01, General RF Exposure Guidance
- FCC KDB 865664 D01 v01r04, SAR Measurement Requirements for 100MHz to 6GHz
- RSS-102 Issue 5, Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)
- IEC/IEEE 62209-1528

8 Test Results

The worst case 1g SAR value for head exposure was less than the 1.6W/kg limit.

9 SAR Data:

The results on the following page(s) were obtained when the device was transmitting at maximum output power. The worst case plots, which reveal information about the location of the maximum SAR with respect to the device, are referenced are shown in APPENDIX B – Worst Case SAR Plot. The measured conducted output power was compared to the power declared by the manufacturer and used for scaling the measured SAR values.

Table 7: SAR Results (Left Earbud)

Mode	Power Setting	Channel	Frequency (MHz)	Peak (dBm)	Maximum (dBm)	Location	Measured 1-g SAR (W/kg)	Reported 1-g SAR (W/kg)	Measured 10-g SAR (W/kg)	Reported 10-g SAR (W/kg)	Power Drift (dB)
DH5	7	0	2402	12.03	13.50	reduced					
		38	2440	11.36	13.50	reduced					
		78	2480	12.21	13.50	+Y	0.258	0.347	0.109	0.147	-0.05
3-DH5	7	0	2402	11.82	13.50	reduced					
		38	2440	11.20	13.50	reduced					
		78	2480	12.01	13.50	+Y	0.258	0.364	0.109	0.154	-0.05
BLE 1M	6	0	2402	6.58	8.50	reduced					
		19	2440	6.48	8.50	reduced					
		39	2480	6.70	8.50	+Y	0.0783	0.119	0.0335	0.051	0.06
BLE 2M	6	0	2402	6.59	8.50	reduced					
		19	2440	6.49	8.50	reduced					
		39	2480	6.71	8.50	+Y	0.0643	0.097	0.0282	0.004	0.08
QHS-P2	7	0	2402	12.18	13.50	reduced					
		38	2440	11.34	13.50	reduced					
		78	2480	12.26	13.50	+Y	0.286	0.381	0.121	0.161	0.00
		78	2480	12.26	13.50	-Z	0.02993	0.040	0.0108	0.014	0.15
QHS-P6	7	0	2402	12.20	13.50	reduced					
		38	2440	11.35	13.50	reduced					
		78	2480	12.26	13.50	+Y	0.165	0.220	0.0711	0.095	0.05

Table 8: SAR Results (Right Earbud)

Mode	Power Setting	Channel	Frequency (MHz)	Peak (dBm)	Maximum (dBm)	Location	Measured 1-g SAR (W/kg)	Reported 1-g SAR (W/kg)	Measured 10-g SAR (W/kg)	Reported 10-g SAR (W/kg)	Power Drift (dB)
DH5	7	0	2402	12.03	13.50	reduced					
		38	2440	13.47	13.50	+Y	0.204	0.205	0.0882	0.089	0.01
		78	2480	12.21	13.50	reduced					
3-DH5	7	0	2402	11.83	13.50	reduced					
		38	2440	13.28	13.50	+Y	0.0865	0.091	0.0378	0.040	0.11
		78	2480	12.03	13.50	reduced					
BLE 1M	6	0	2402	7.23	8.50	reduced					
		19	2440	8.32	8.50	+Y	0.0611	0.064	0.0272	0.028	0.08
		39	2480	6.84	8.50	reduced					
BLE 2M	6	0	2402	7.25	8.50	reduced					
		19	2440	8.31	8.50	+Y	0.0482	0.050	0.0215	0.022	0.07
		39	2480	6.86	8.50	reduced					
QHS-P2	7	0	2402	11.94	13.50	reduced					
		38	2440	13.45	13.50	+Y	0.136	0.138	0.059	0.060	0.02
		78	2480	12.28	13.50	reduced					
QHS-P6	7	0	2402	11.93	13.50	reduced					
		38	2440	13.44	13.50	+Y	0.208	0.211	0.0908	0.092	0.06
		78	2480	12.29	13.50	reduced					

Test Personnel:	Brian Lackey	Test Date:	3/28/2023 – 3/31/2023
Supervising/Reviewing Engineer: (Where Applicable)	NA	Tissue Depth:	15cm
Signal Setup:	Test Commands	Ambient Temperature:	22.4C
Power Method:	Fully Charged Battery	Relative Humidity:	48.6%
Pretest Dipole Verification:	Yes	Atmospheric Pressure:	989.2mbar

Deviations, Additions, or Exclusions:

1) Per KDB 447468 D04v01 §3.2.1 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 SAR ≤ 0.8 W/kg for 1-g, or SAR ≤ 2.0 W/kg for 10-g, when the transmission band span is ≤ 100 MHz

10 APPENDIX A – System Validation Summary

Per FCC KDB 865664, a tabulated summary of the system validation status including the validation date(s), measurement frequencies, SAR probes and tissue dielectric parameters have been included in the summary table below. The validation was performed with reference dipoles using the required tissue equivalent media for system validation according to KDB 865664. Each probe calibration point was validated at a frequency within the valid frequency range of the probe calibration point. All measurements were performed using probes calibrated for CW signals. Modulations in the table above represent test configurations for which the SAR system has been validated. The SAR system was also validated with modulated signals per KDB 865664.

Table 9: SAR System Validation Summary

				Probe Calibration Point		Dielectric Properties		CW Validation			Modulation Validation		
Frequency (MHz)	Date	Probe (SN#)	Probe (Model #)	Frequency (MHz)	Fluid Type	σ	ϵ_r	Sensitivity	Probe Linearity	Probe Isotropy	Mod. Type	Duty Factor	PAR
2450	2/7/2023	3516	EX3DV3	2450	Body	50.65	2.02	Pass	Pass	Pass	OFDM	N/A	Pass
5200	2/7/2023	3516	EX3DV3	5200	Body	48.71	5.54	Pass	Pass	Pass	OFDM	N/A	Pass
5500	2/7/2023	3516	EX3DV3	5500	Body	47.68	6.29	Pass	Pass	Pass	OFDM	N/A	Pass
5800	2/7/2023	3516	EX3DV3	5800	Body	48.71	5.54	Pass	Pass	Pass	OFDM	N/A	Pass

				Probe Calibration Point		Dielectric Properties		CW Validation			Modulation Validation		
Frequency (MHz)	Date	Probe (SN#)	Probe (Model #)	Frequency (MHz)	Fluid Type	σ	ϵ_r	Sensitivity	Probe Linearity	Probe Isotropy	Mod. Type	Duty Factor	PAR
835	2/7/2023	3516	EX3DV3	835	Body	54.2	0.98	Pass	Pass	Pass	GMSK	Pass	N/A
900	2/7/2023	3516	EX3DV3	900	Body	54	1.02	Pass	Pass	Pass	GMSK	Pass	N/A
1750	2/7/2023	3516	EX3DV3	1800	Body	52.9	1.41	Pass	Pass	Pass	GMSK	Pass	N/A
1900	2/7/2023	3516	EX3DV3	1900	Body	52.7	1.48	Pass	Pass	Pass	GMSK	Pass	N/A

11 APPENDIX B – Worst Case SAR Plot

Date/Time: 3/29/2023 11:02:17 AM

Test Laboratory: Intertek
File Name: Left Earbud.da53:0

Left Earbud

Procedure Notes:

DUT: Left Earbud; Serial: 084803M3051D018A1

Communication System: UID 0, QHS-P2; Communication System Band: 2.4Ghz ISM; Frequency: 2480 MHz;Duty Cycle: 1:1

Medium parameters used: f = 2480 MHz; σ = 1.815 S/m; ε_r = 38.229; ρ = 1000 kg/m^3

Phantom section: Left Section

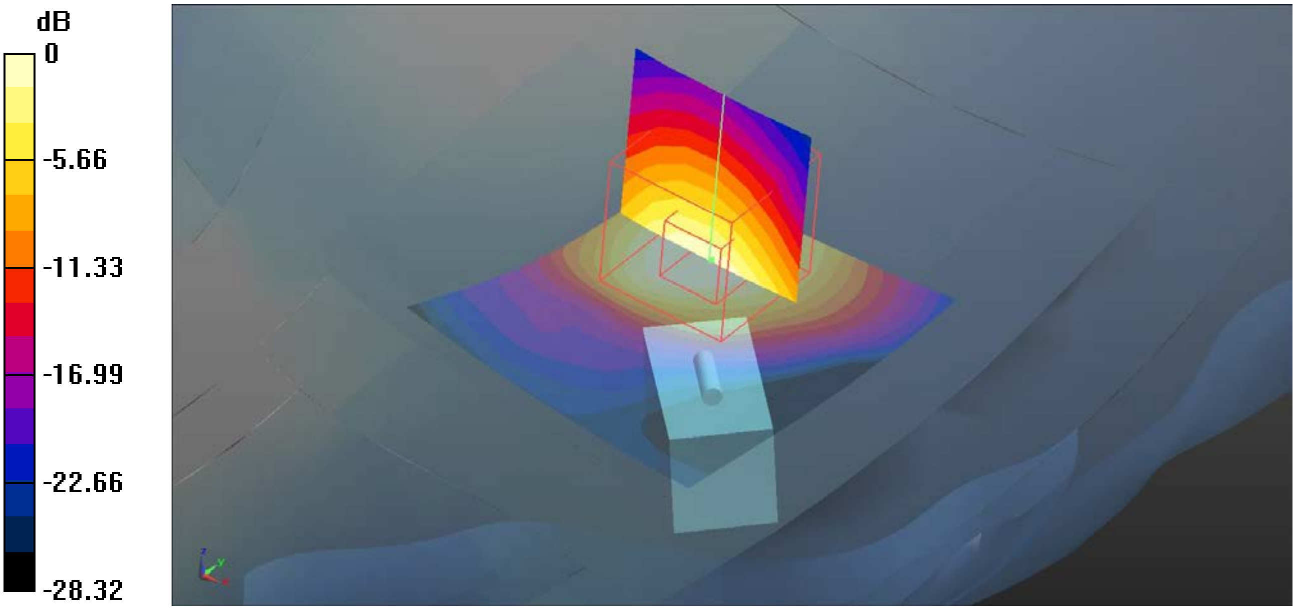
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY5 Configuration:

- Probe: EX3DV3 - SN3516; ConvF(8.62, 8.62, 8.62) @ 2480 MHz;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn358; Calibrated: 11/10/2022
- Phantom: SAM 2 with CRP v5.0; Type: QD000P40CD; Serial: TP:1663
- DASY52 52.10.4(1535);

Configuration/Outside Face 2/Area Scan (41x51x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 0.348 W/kg

Configuration/Outside Face 2/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 12.20 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 0.592 W/kg
SAR(1 g) = 0.280 W/kg; SAR(10 g) = 0.117 W/kg (SAR corrected for target medium)
Smallest distance from peaks to all points 3 dB below = 8.9 mm
Ratio of SAR at M2 to SAR at M1 = 49.1%
Maximum value of SAR (measured) = 0.317 W/kg



0 dB = 0.317 W/kg = -4.99 dBW/kg

12 APPENDIX C – Dipole Validation Plots

Date/Time: 3/28/2023 8:35:11 AM

Test Laboratory: Intertek
File Name: 2023-03-28 D2450V2 SAM Twin 2450MHz HSL.da53:0

12.1.1 2023-03-28 D2450V2 SAM Twin 2450MHz HSL

Procedure Notes:
DUT: D2450V2 - SN718; Serial: SN718
Communication System: UID 0, CW (0); Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2450 MHz; σ = 1.781 S/m; ε_r = 38.341; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)
DASY5 Configuration:

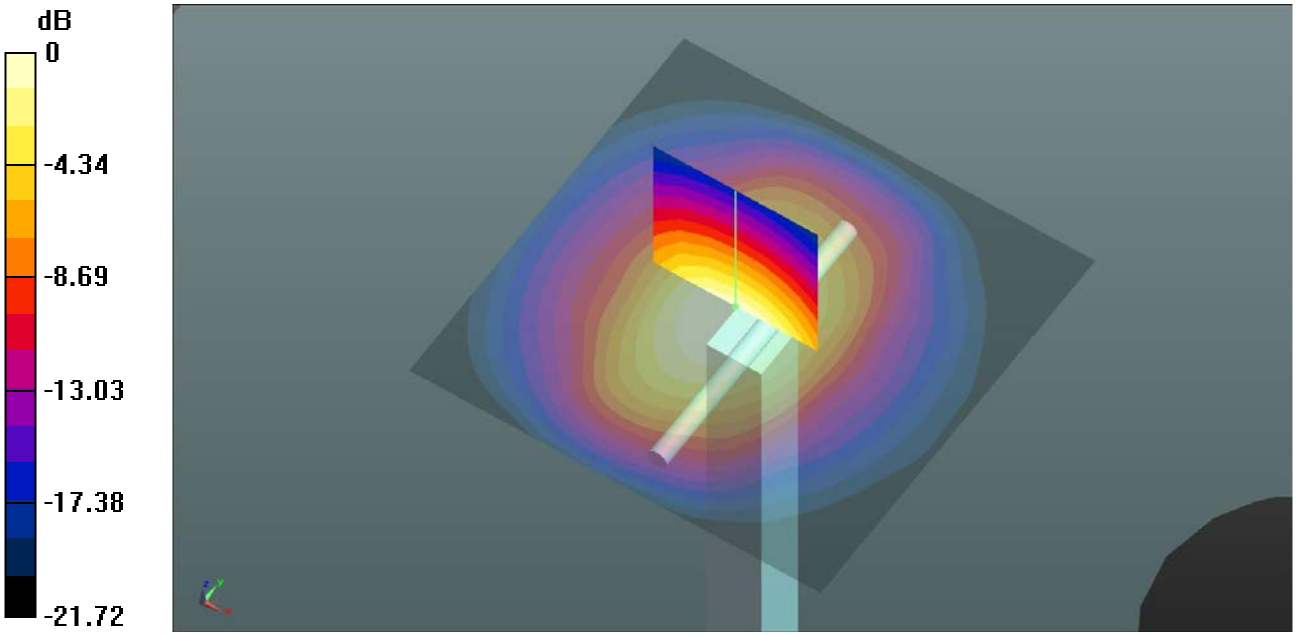
- Probe: EX3DV3 - SN3516; ConvF(8.62, 8.62, 8.62) @ 2450 MHz;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn358; Calibrated: 11/10/2022
- Phantom: SAM 2 with CRP v5.0; Type: QD000P40CD; Serial: TP:1663
- DASY52 52.10.4(1535);

Configuration/Unnamed procedure/Area Scan (51x51x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (interpolated) = 16.0 W/kg

Configuration/Unnamed procedure/Volume Scan (7x7x7): Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 87.84 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 26.1 W/kg
SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.95 W/kg (SAR corrected for target medium)
Total Absorbed Power = 0.0960 W

Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 14.4 W/kg



0 dB = 14.4 W/kg = 11.58 dBW/kg

13 APPENDIX D – Setup Photos

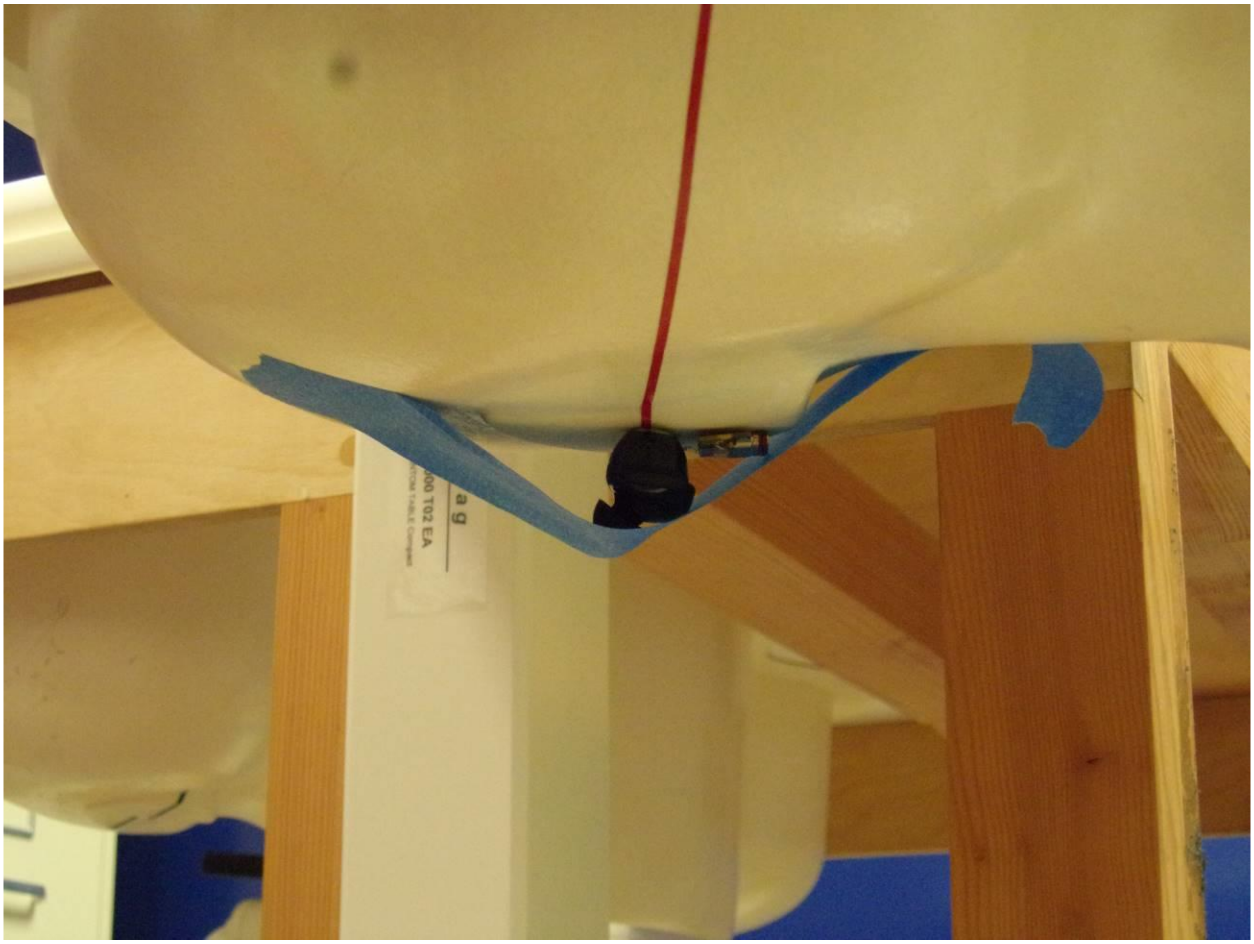


Figure 4 Right Earbud, +Y Direction

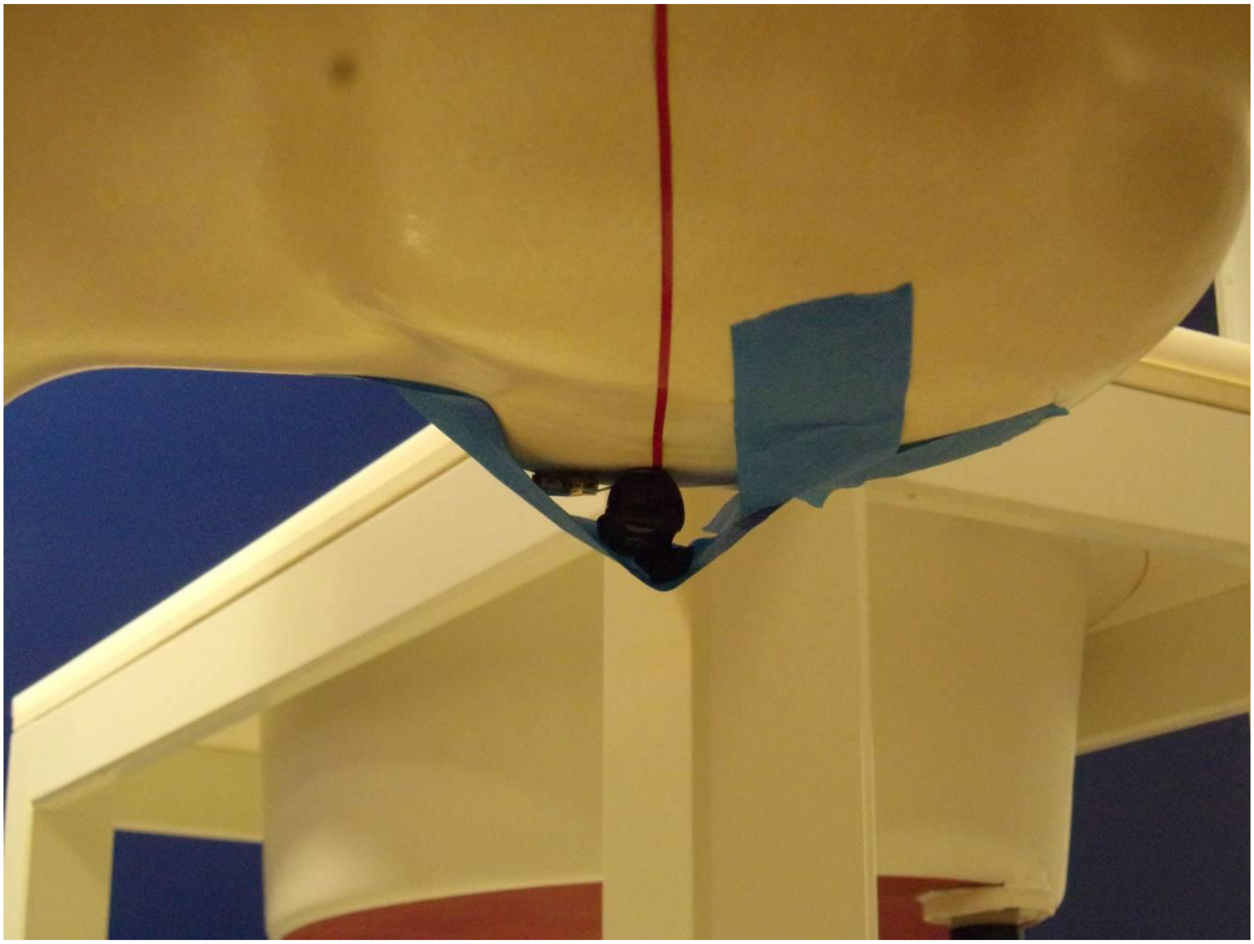


Figure 5 Left Earbud, +Y Direction

14 Revision History

Revision Level	Date	Report Number	Prepared By	Reviewed By	Notes
0	4/26/2023	105400225LEX-001	BL	JTS	Original Issue

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

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

Accreditation No.: SCS 0108

Client **Intertek**

Certificate No: D2450V2-718_Nov22

CALIBRATION CERTIFICATE

Object	D2450V2 - SN:718
Calibration procedure(s)	QA CAL-05.v11 Calibration Procedure for SAR Validation Sources between 0.7-3 GHz
Calibration date:	November 15, 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	04-Apr-22 (No. 217-03525/03524)	Apr-23
Power sensor NRP-Z91	SN: 103244	04-Apr-22 (No. 217-03524)	Apr-23
Power sensor NRP-Z91	SN: 103245	04-Apr-22 (No. 217-03525)	Apr-23
Reference 20 dB Attenuator	SN: BH9394 (20k)	04-Apr-22 (No. 217-03527)	Apr-23
Type-N mismatch combination	SN: 310982 / 06327	04-Apr-22 (No. 217-03528)	Apr-23
Reference Probe EX3DV4	SN: 7349	31-Dec-21 (No. EX3-7349_Dec21)	Dec-22
DAE4	SN: 601	31-Aug-22 (No. DAE4-601_Aug22)	Aug-23

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
Power sensor HP 8481A	SN: MY41093315	07-Oct-15 (in house check Oct-22)	In house check: Oct-24
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-22)	In house check: Oct-24
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-22)	In house check: Oct-24

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Sven Kühn	Technical Manager	

Issued: November 16, 2022

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S **Schweizerischer Kalibrierdienst**
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Accreditation No.: SCS 0108

Glossary:

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

Calibration is Performed According to the Following Standards:

a) 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"

Additional Documentation:

c) DASY 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 source is mounted in a touch configuration below the center marking of the flat phantom.
- *Return Loss:* This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. 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	DASY52	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	2450 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	39.2	1.80 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	38.4 ± 6 %	1.87 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	13.4 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**52.4 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	6.23 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**24.6 W/kg ± 16.5 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Body TSL parameters	22.0 °C	52.7	1.95 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	51.7 ± 6 %	2.01 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm^3 (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	12.7 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**49.8 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Body TSL	condition	
SAR measured	250 mW input power	5.95 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**23.6 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	53.5 Ω + 4.6 jΩ
Return Loss	- 25.0 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	50.0 Ω + 6.4 jΩ
Return Loss	- 23.9 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.146 ns

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

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

Additional EUT Data

Manufactured by	SPEAG

DASY5 Validation Report for Head TSL

Date: 15.11.2022

Test Laboratory: SPEAG, Zurich, Switzerland

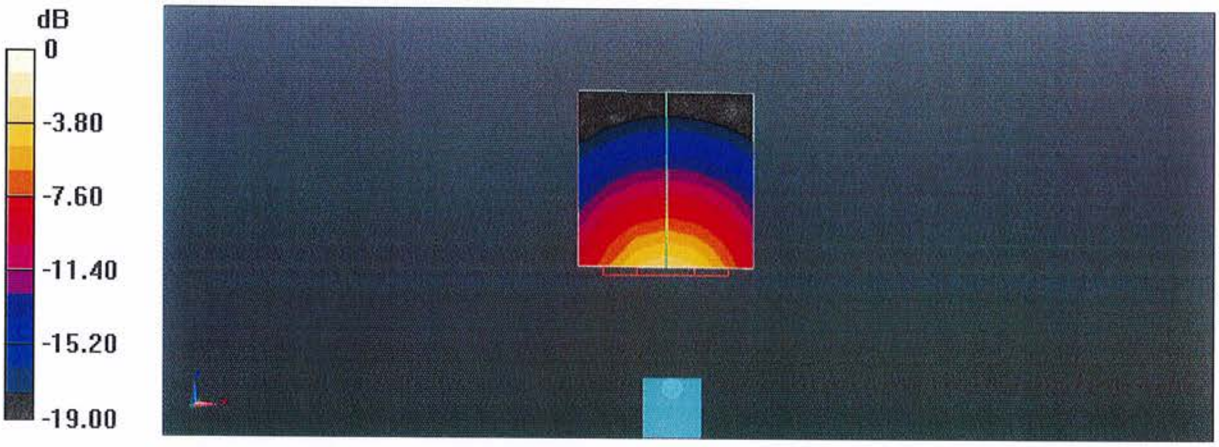
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:718

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.87 S/m; ε_r = 38.4; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

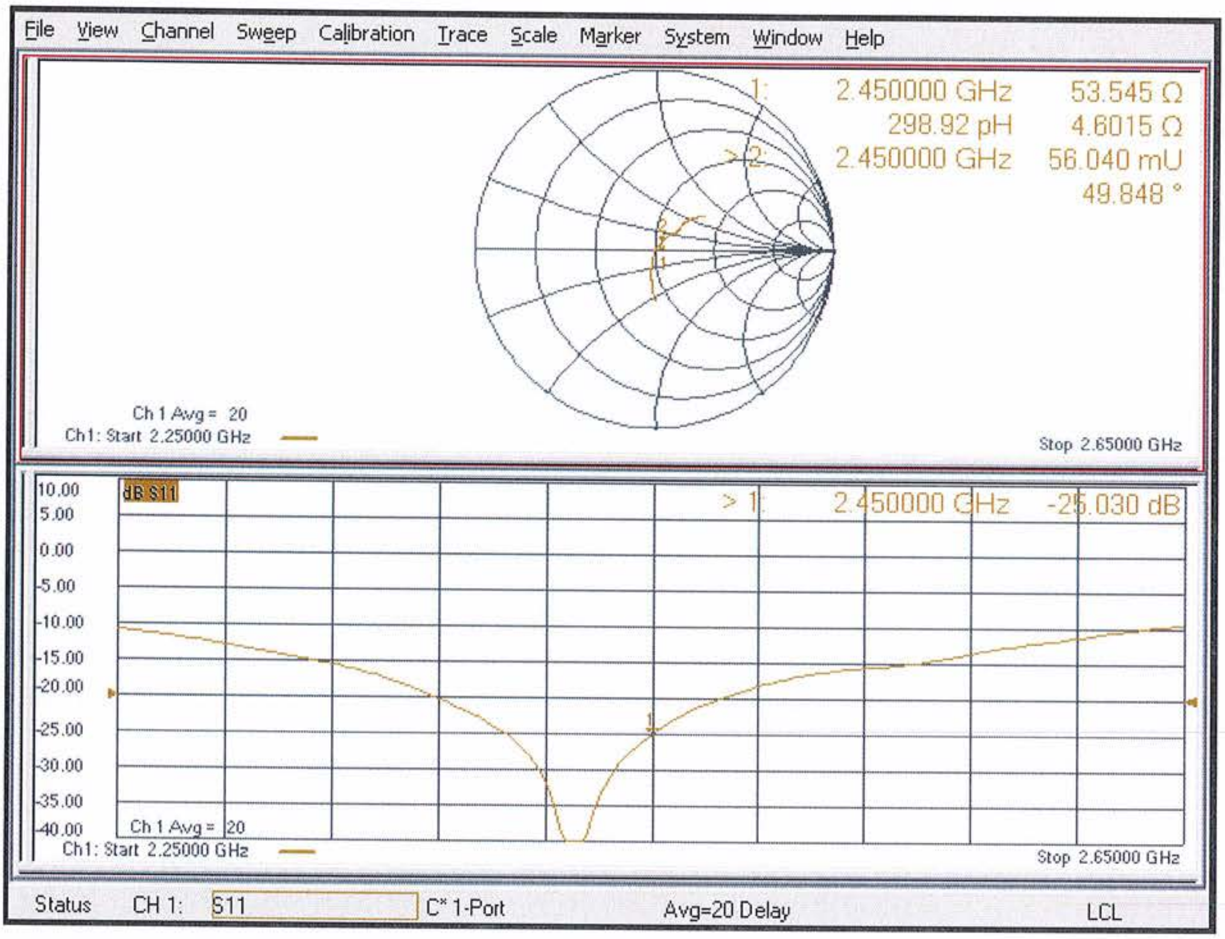
- Probe: EX3DV4 - SN7349; ConvF(7.96, 7.96, 7.96) @ 2450 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 31.08.2022
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

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 = 116.2 V/m; Power Drift = -0.01 dB
Peak SAR (extrapolated) = 26.3 W/kg
SAR(1 g) = 13.4 W/kg; SAR(10 g) = 6.23 W/kg
Smallest distance from peaks to all points 3 dB below = 9 mm
Ratio of SAR at M2 to SAR at M1 = 50.9%
Maximum value of SAR (measured) = 22.0 W/kg



0 dB = 22.0 W/kg = 13.42 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 15.11.2022

Test Laboratory: SPEAG, Zurich, Switzerland

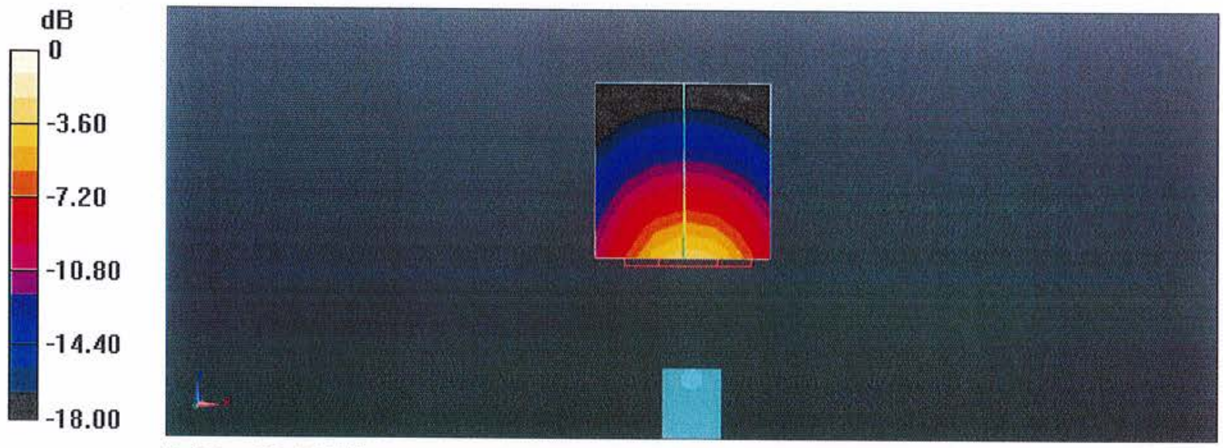
DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2 - SN:718

Communication System: UID 0 - CW; Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 2.01 S/m; ε_r = 51.7; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

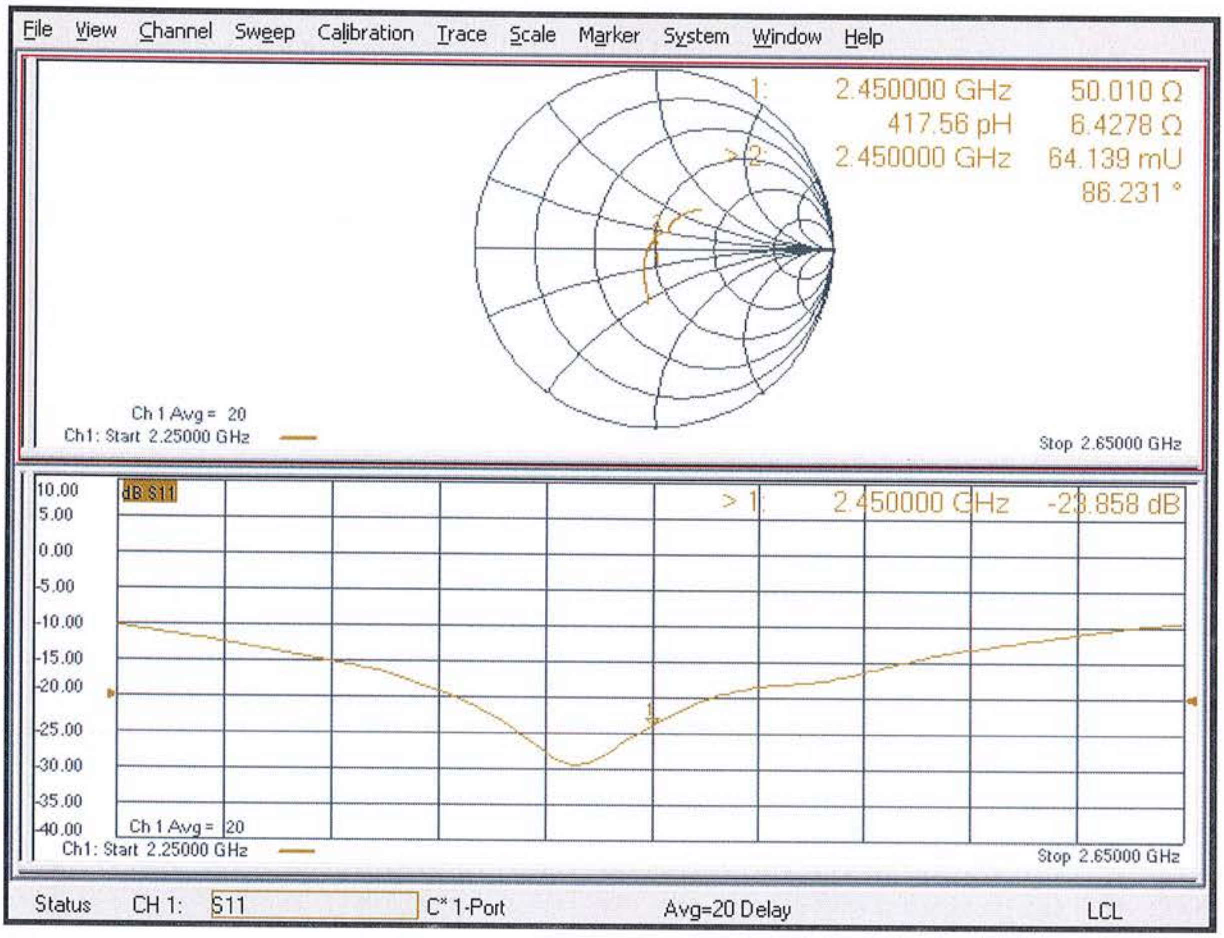
- Probe: EX3DV4 - SN7349; ConvF(8.12, 8.12, 8.12) @ 2450 MHz; Calibrated: 31.12.2021
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 31.08.2022
- Phantom: Flat Phantom 5.0 (back); Type: QD 000 P50 AA; Serial: 1002
- DASY52 52.10.4(1535); SEMCAD X 14.6.14(7501)

Dipole Calibration for Body Tissue/Pin=250 mW, d=10mm 2/Zoom Scan (7x7x7)/Cube 0:
Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 108.0 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 24.0 W/kg
SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.95 W/kg
Smallest distance from peaks to all points 3 dB below = 8.5 mm
Ratio of SAR at M2 to SAR at M1 = 53.5%
Maximum value of SAR (measured) = 20.4 W/kg



0 dB = 20.4 W/kg = 13.10 dBW/kg

Impedance Measurement Plot for Body TSL



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S Schweizerischer Kalibrierdienst
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Accreditation No.: **SCS 0108**

Client **Intertek**

Certificate No: **DAE4-358_Nov22**

CALIBRATION CERTIFICATE

Object	DAE4 - SD 000 D04 BM - SN: 358
Calibration procedure(s)	QA CAL-06.v30 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	November 10, 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
Keithley Multimeter Type 2001	SN: 0810278	29-Aug-22 (No:34389)	Aug-23
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Auto DAE Calibration Unit	SE UWS 053 AA 1001	24-Jan-22 (in house check)	In house check: Jan-23
Calibrator Box V2.1	SE UMS 006 AA 1002	24-Jan-22 (in house check)	In house check: Jan-23

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

Issued: November 10, 2022

Glossary

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

Methods Applied and Interpretation of Parameters

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

DC Voltage Measurement

A/D - Converter Resolution nominal

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

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

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

Calibration Factors	X	Y	Z
High Range	404.138 ± 0.02% (k=2)	403.787 ± 0.02% (k=2)	403.648 ± 0.02% (k=2)
Low Range	3.93983 ± 1.50% (k=2)	3.96790 ± 1.50% (k=2)	3.99107 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	326.0 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	199994.17	-1.81	-0.00
Channel X	+ Input	20006.08	3.62	0.02
Channel X	- Input	-19997.33	4.38	-0.02
Channel Y	+ Input	199995.05	-1.28	-0.00
Channel Y	+ Input	20003.30	1.05	0.01
Channel Y	- Input	-20000.22	1.47	-0.01
Channel Z	+ Input	199995.44	-0.57	-0.00
Channel Z	+ Input	20001.98	-0.22	-0.00
Channel Z	- Input	-20001.74	0.18	-0.00

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2001.49	0.02	0.00
Channel X	+ Input	203.06	1.17	0.58
Channel X	- Input	-197.60	0.45	-0.23
Channel Y	+ Input	2001.25	-0.13	-0.01
Channel Y	+ Input	201.96	0.37	0.19
Channel Y	- Input	-198.77	-0.52	0.26
Channel Z	+ Input	2002.40	1.03	0.05
Channel Z	+ Input	200.72	-0.81	-0.40
Channel Z	- Input	-199.25	-0.87	0.44

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	8.50	6.81
	- 200	-5.38	-7.33
Channel Y	200	-4.26	-4.30
	- 200	3.43	3.29
Channel Z	200	11.09	11.21
	- 200	-13.41	-13.75

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	-	-3.02	-2.02
Channel Y	200	7.59	-	-2.05
Channel Z	200	6.68	5.57	-

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	16028	15226
Channel Y	16133	16458
Channel Z	15834	14981

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	1.40	0.39	2.20	0.38
Channel Y	-0.08	-1.28	0.83	0.36
Channel Z	0.50	-0.67	1.79	0.37

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

3516

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Accreditation No.: **SCS 0108**

Client Intertek

Certificate No EX-3516_Nov22

CALIBRATION CERTIFICATE

Object	EX3DV3 - SN:3516
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	November 17, 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	04-Apr-22 (No. 217-03525/03524)	Apr-23
Power sensor NRP-Z91	SN: 103244	04-Apr-22 (No. 217-03524)	Apr-23
OCP DAK-3.5 (weighted)	SN: 1249	20-Oct-22 (OCP-DAK3.5-1249_Oct22)	Oct-23
OCP DAK-12	SN: 1016	20-Oct-22 (OCP-DAK12-1016_Oct22)	Oct-23
Reference 20 dB Attenuator	SN: CC2552 (20x)	04-Apr-22 (No. 217-03527)	Apr-23
DAE4	SN: 660	10-Oct-22 (No. DAE4-660_Oct22)	Oct-23
Reference Probe ES3DV2	SN: 3013	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-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	

Issued: November 18, 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., $\vartheta = 0$ 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:

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 $\vartheta = 0$ ($f \leq 900$ 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. 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 $f \leq 800$ 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 *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).

Parameters of Probe: EX3DV3 - SN:3516

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc ($k = 2$)
Norm ($\mu V/(V/m)^2$) [A]	0.82	0.72	0.60	±10.1%
DCP (mV) [B]	103.0	103.5	105.0	±4.7%

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB$\sqrt{\mu V}$	C	D dB	VR mV	Max dev.	Max Unc[E] $k = 2$
0	CW	X	0.00	0.00	1.00	0.00	167.6	±3.0%	±4.7%
		Y	0.00	0.00	1.00		161.6		
		Z	0.00	0.00	1.00		157.7		

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] Linearization parameter uncertainty for maximum specified field strength.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

Parameters of Probe: EX3DV3 - SN:3516

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle	-135.5°
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.

Parameters of Probe: EX3DV3 - SN:3516

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 ($k = 2$)
750	41.9	0.89	11.68	11.68	11.68	0.30	0.80	±12.0%
835	41.5	0.90	10.91	10.91	10.91	0.30	0.99	±12.0%
900	41.5	0.97	10.87	10.87	10.87	0.23	0.98	±12.0%
1750	40.1	1.37	9.36	9.36	9.36	0.38	0.86	±12.0%
1900	40.0	1.40	9.07	9.07	9.07	0.28	0.86	±12.0%
2450	39.2	1.80	8.62	8.62	8.62	0.25	0.90	±12.0%
2600	39.0	1.96	8.26	8.26	8.26	0.38	0.90	±12.0%
4950	36.3	4.40	6.00	6.00	6.00	0.40	1.80	±13.1%
5200	36.0	4.66	5.30	5.30	5.30	0.40	1.80	±13.1%
5300	35.9	4.76	5.14	5.14	5.14	0.40	1.80	±13.1%
5500	35.6	4.96	5.15	5.15	5.15	0.40	1.80	±13.1%
5600	35.5	5.07	4.94	4.94	4.94	0.40	1.80	±13.1%
5800	35.3	5.27	4.80	4.80	4.80	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.

Parameters of Probe: EX3DV3 - SN:3516

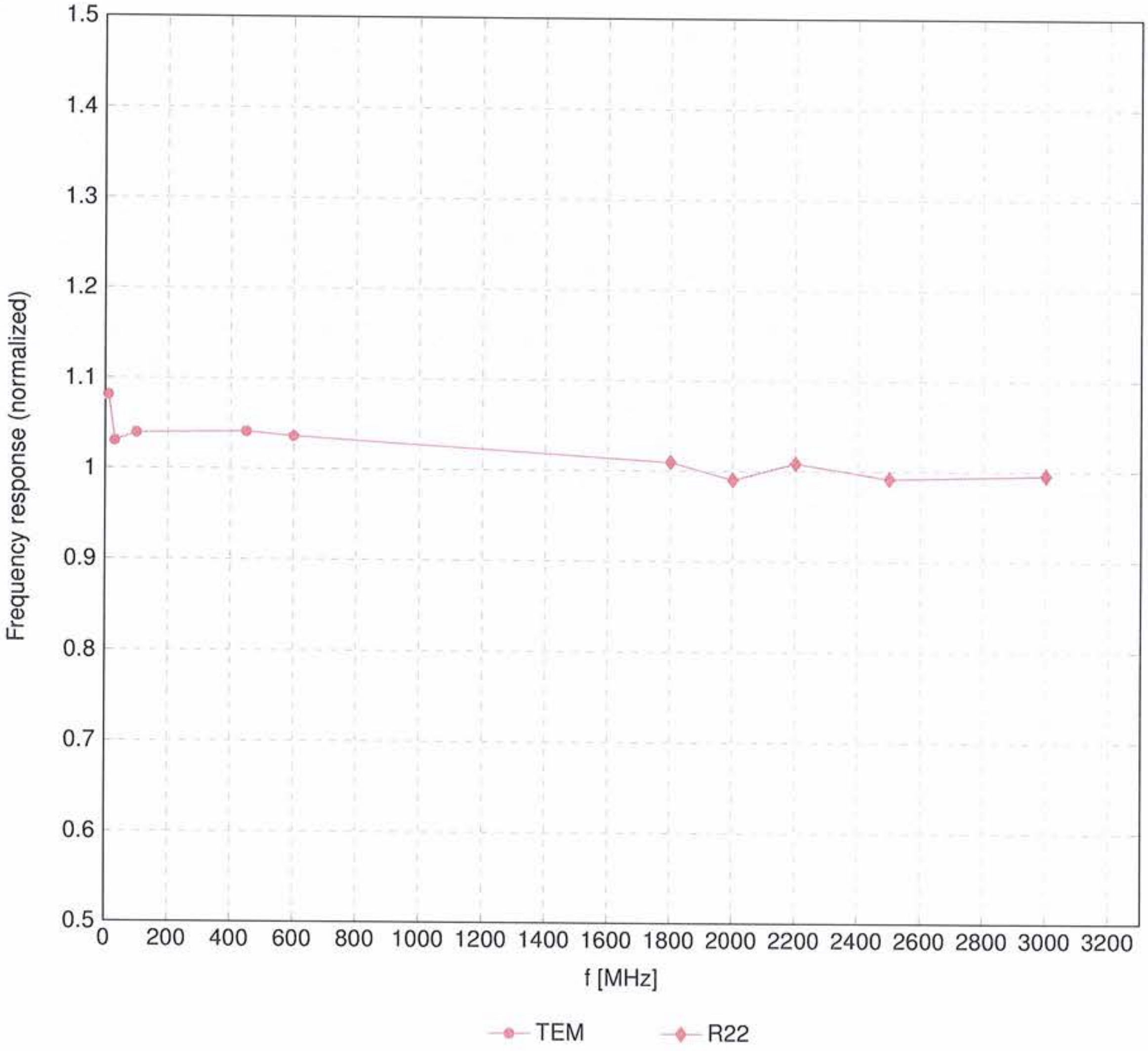
Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz)[C]	Relative Permittivity[F]	Conductivity[F] (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha[G]	Depth[G] (mm)	Unc ($k = 2$)
750	55.5	0.96	11.07	11.07	11.07	0.38	0.80	±12.0%
835	55.2	0.97	10.92	10.92	10.92	0.27	0.97	±12.0%
900	55.0	1.05	10.87	10.87	10.87	0.35	0.80	±12.0%
1750	53.4	1.49	9.26	9.26	9.26	0.27	0.86	±12.0%
1900	53.3	1.52	8.90	8.90	8.90	0.23	0.86	±12.0%
2450	52.7	1.95	8.31	8.31	8.31	0.32	0.90	±12.0%
2600	52.5	2.16	8.17	8.17	8.17	0.31	0.90	±12.0%
4950	49.4	5.01	5.40	5.40	5.40	0.50	1.90	±13.1%
5200	49.0	5.30	4.55	4.55	4.55	0.50	1.90	±13.1%
5300	48.9	5.42	4.45	4.45	4.45	0.50	1.90	±13.1%
5500	48.6	5.65	4.20	4.20	4.20	0.50	1.90	±13.1%
5600	48.5	5.77	4.03	4.03	4.03	0.50	1.90	±13.1%
5800	48.2	6.00	3.90	3.90	3.90	0.50	1.90	±13.1%

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

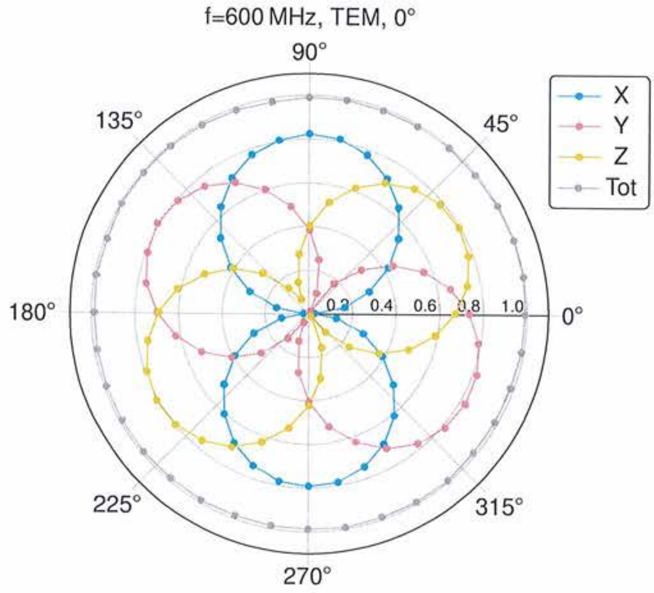
Frequency Response of E-Field

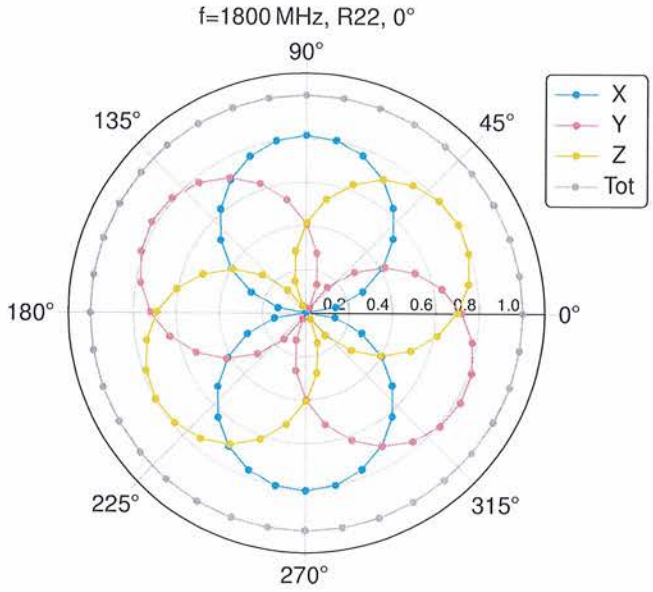
(TEM-Cell:ifi110 EXX, Waveguide:R22)

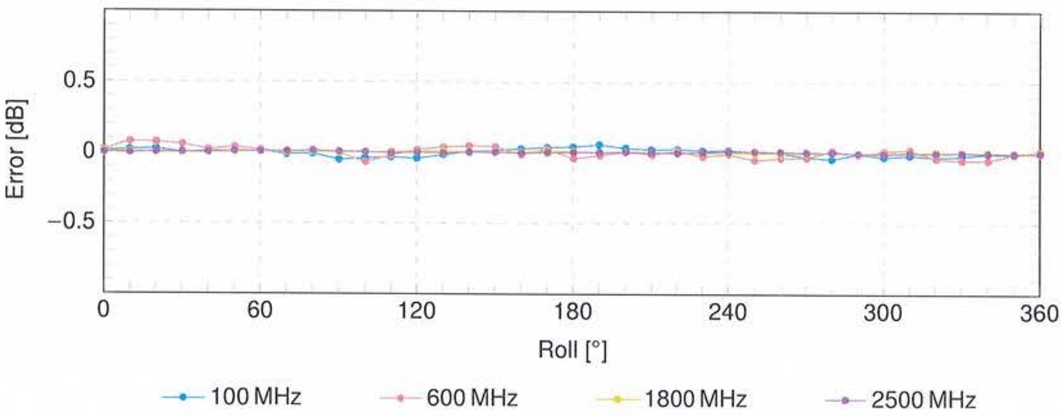


Uncertainty of Frequency Response of E-field: ±6.3% (k=2)

Receiving Pattern (ϕ), $\vartheta = 0°$



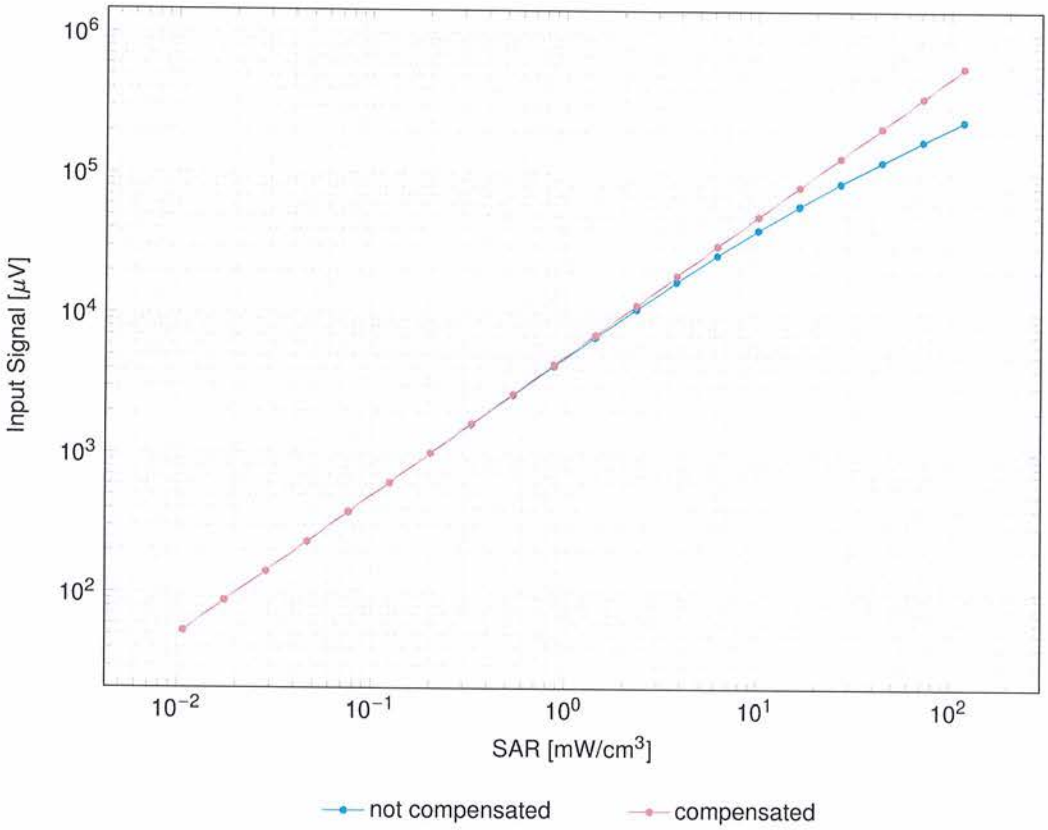


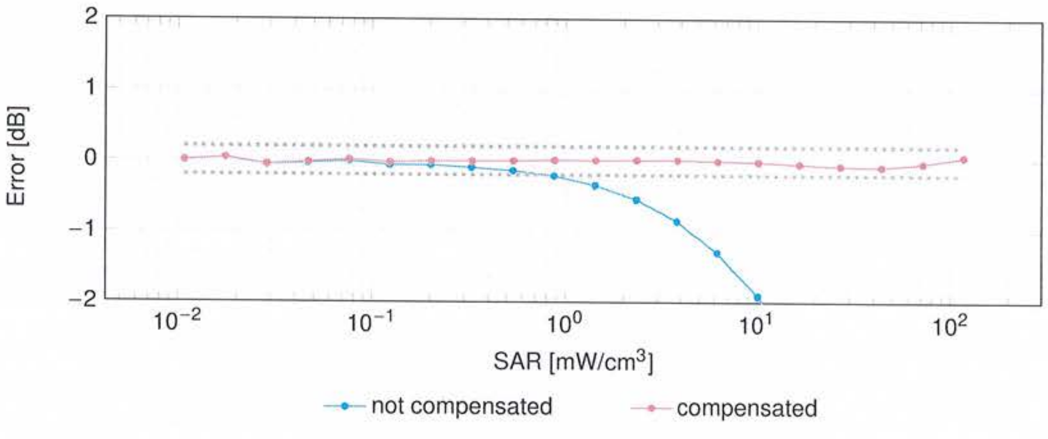


Uncertainty of Axial Isotropy Assessment: ±0.5% (k=2)

Dynamic Range f(SAR_{head})

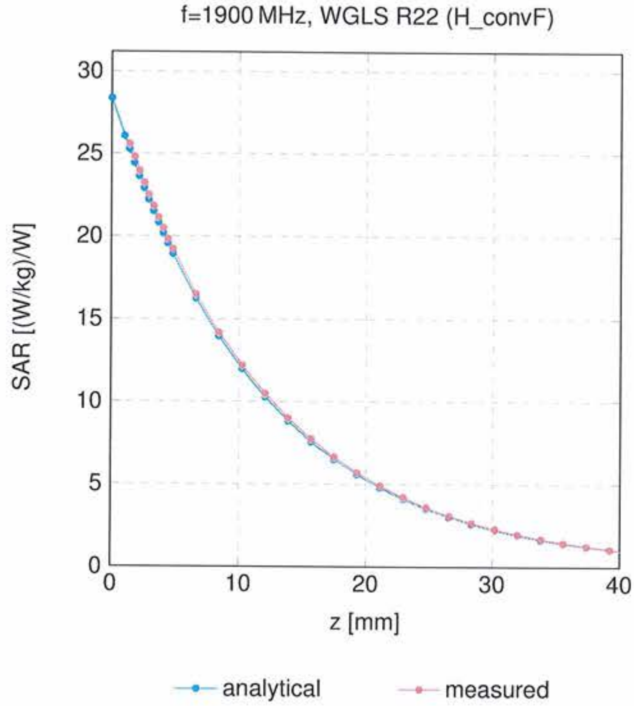
(TEM cell, f_{eval} = 1900 MHz)



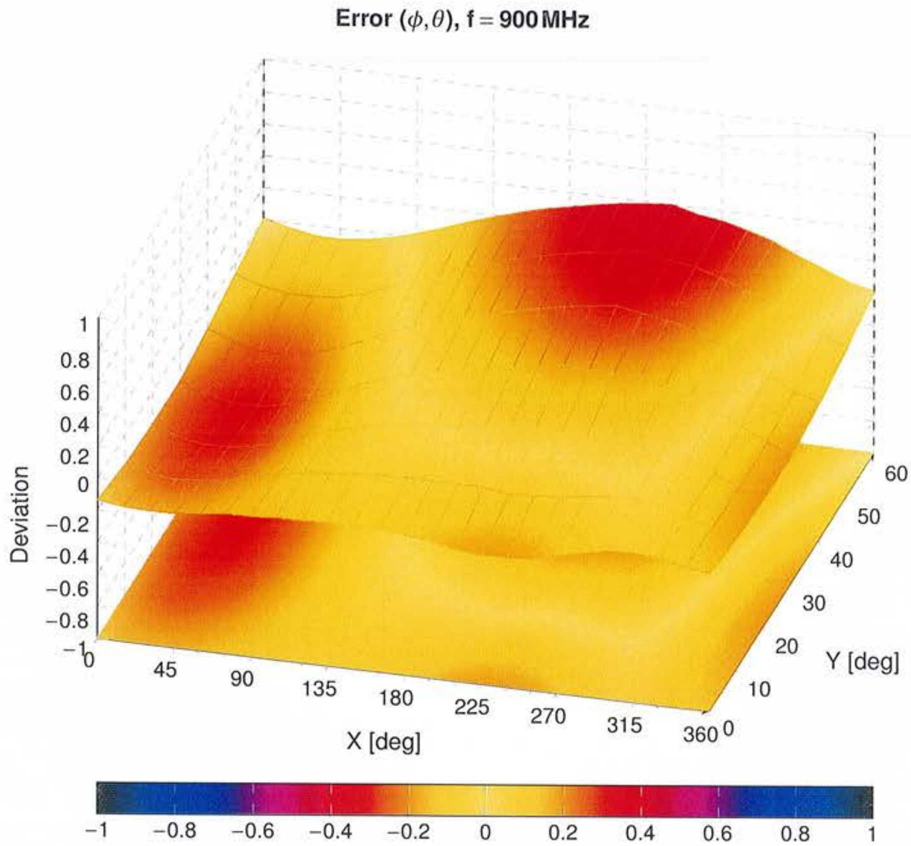


Uncertainty of Linearity Assessment: ±0.6% (k=2)

Conversion Factor Assessment



Deviation from Isotropy in Liquid



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