FCC SAR Test Report
(Class II Permissive Change)

Product Name ： 1TX 11ax (WiFi6E) BW160 + BT/BLE Combo Card

Model No. ： MT7902

Applicant ： MediaTek Inc.

Address ： No. 1, Dusing 1st Rd. Hsinchu Science Park, Hsinchu City, Taiwan

Date of Receipt ： 2022/11/26

Issued Date ： 2023/01/18

Report No. ： 22B0941R-SAUSV01S-A

Report Version ： V1.0

Test Report

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Report No.: 22B0941R-SAUSV01S-A

Product Name	:	1TX 11ax (WiFi6E) BW160 + BT/BLE Combo Card
Applicant	:	MediaTek Inc.
Address	:	No. 1, Dusing 1st Rd. Hsinchu Science Park, Hsinchu City, Taiwan
Manufacturer	:	MediaTek Inc.
Model No.	:	MT7902
Trade Name	:	MediaTek
FCC ID	:	RAS-MT7902
Applicable Standard	:	IEEE 1528-2013 KDB 447498 D01 v06 KDB 865664 D01 v01r04
Test Result	:	Max. SAR Measurement (1g) 2.4GHz: **0.747** W/kg 5 GHz: **1.084** W/kg 6 GHz: **0.544** W/kg Max. psPD Measurement 6 GHz: **6.294** W/m^2
Application Type	:	Certification

The above equipment has been tested by DEKRA, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's SAR characteristics under the conditions specified in this report.

Documented By : Ida Tung
(Project Specialist / Ida Tung)

Tested By : Luke Cheng
(Senior Engineer / Luke Cheng)

Approved By : San Lin
(Assistant Manager / San Lin)

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Revision History

Report No.	Version	Description	Issued Date
22B0941R-SAUSV01S-A	V1.0	Initial issue of report.	2023/01/18

1. General Information

1.1 EUT Description

Product Name	1TX 11ax (WiFi6E) BW160 + BT/BLE Combo Card			
Trade Name	MediaTek			
Model No.	MT7902			
FCC ID	RAS-MT7902			
Frequency Range	WLAN 2.4GHz: 2412-2472MHz WLAN 5GHz: 5180-5240MHz, 5260-5320, 5500-5720MHz, 5745-5825MHz, 5845-5885MHz WLAN 6GHz: 5955-7115MHz BT: 2402-2480MHz			
Type of Modulation	802.11b: DSSS 802.11a/g/n/ac/ax: OFDM, OFDMA GFSK(1Mbps) / π/4DQPSK(2Mbps) / 8DPSK(3Mbps)			
Antenna Type	PIFA			
Device Category	Portable			
RF Exposure Environment	Uncontrolled			
Summary of test result – SAR				
Test configuration	DTS	NII	6XD	DSS(BT)
Reported 1g SAR (W/Kg)	0.747	1.084	0.544	0.211
Simultaneous 1g SAR (W/Kg)	DTS (Main + Aux)	NII (Main + Aux)	6XD (Main + Aux)	NII + DSS(BT)
	N/A	N/A	N/A	1.295
Summary of test result – Power Density				
Test configuration	6XD			
APD	3.440			
Reported PD (W/m^2)	6.294			

Note:

Host information			
Brand	Product Name	Model No.	Difference
ASUS	VivoBook/ASUS Laptop	M1405Y	All models are electrically identical, different model names are for marketing purpose.
		D1405Y	
		Y1405CY	
The representative test sample is M1405Y.			

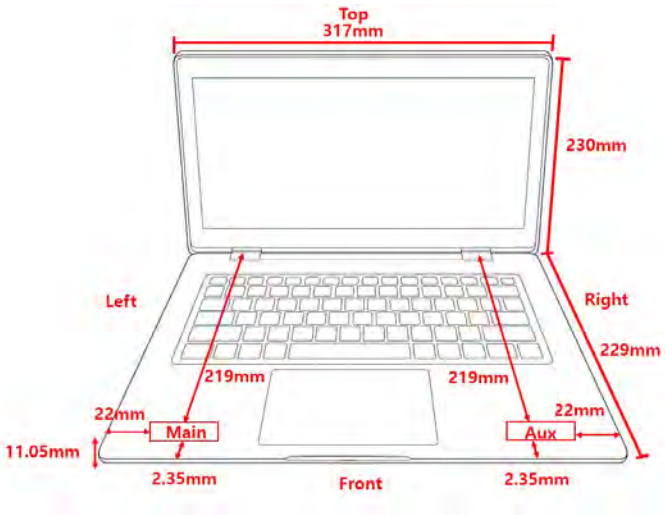
1.2 Antenna List

No.	Manufacturer	Part No.	ASUS Part No.	Antenna Type	Peak Gain
1	INPAQ	WA-P-LE-02-064 (Main)	14008-04890100 (Main)	PIFA	2.75 dBi for 2400 MHz 2.90 dBi for 5150~5250 MHz 3.25 dBi for 5250~5350 MHz 4.39 dBi for 5470~5725 MHz 4.57 dBi for 5725~5850 MHz 4.41 dBi for 5850~5925 MHz 4.41 dBi for 5925~6425 MHz 3.58 dBi for 6425~6525 MHz 4.53 dBi for 6525~6875 MHz 3.92 dBi for 6875~7125 MHz
		WA-P-LE-01-006 (Aux)	14008-04890000 (Aux)	PIFA	2.71 dBi for 2400 MHz 3.50 dBi for 5150~5250 MHz 3.49 dBi for 5250~5350 MHz 4.35 dBi for 5470~5725 MHz 4.63 dBi for 5725~5850 MHz 4.52 dBi for 5850~5925 MHz 4.31 dBi for 5925~6425 MHz 4.07 dBi for 6425~6525 MHz 4.55 dBi for 6525~6875 MHz 4.06 dBi for 6875~7125 MHz
2	Pulse	TZ20921 (Main)	14008-04890300 (Main)	PCB PIFA	2.55 dBi for 2400 MHz 2.78 dBi for 5150~5250 MHz 3.12 dBi for 5250~5350 MHz 4.11 dBi for 5470~5725 MHz 4.33 dBi for 5725~5850 MHz 4.12 dBi for 5850~5925 MHz 4.12 dBi for 5925~6425 MHz 1.31 dBi for 6425~6525 MHz 2.53 dBi for 6525~6875 MHz 2.53 dBi for 6875~7125 MHz
		TZ20924 (Aux)	14008-04890200 (Aux)	PCB PIFA	2.22 dBi for 2400 MHz 1.22 dBi for 5150~5250 MHz 1.71 dBi for 5250~5350 MHz 4.15 dBi for 5470~5725 MHz 4.15 dBi for 5725~5850 MHz 2.86 dBi for 5850~5925 MHz 2.62 dBi for 5925~6425 MHz 1.90 dBi for 6425~6525 MHz 1.98 dBi for 6525~6875 MHz 2.83 dBi for 6875~7125 MHz

Note: 1. The above EUT information by host manufacturer.
2. INPAQ antenna was tested and recorded in this report since it represents worst case gain.
3. There are the same antenna only difference in Manufacturer.

1.3 SAR Test Exclusion Calculation

According to KDB Publication 616217 D04, SAR evaluation is required for the bottom surface of the laptop keyboard.



1.4 Test Environment

Ambient conditions in the laboratory:

Test Date: 2022/11/15

Items	Required	Actual
Temperature (°C)	18-25	22.5 ±2
Humidity (%RH)	30-70	51 ±20

Test Date: 2022/11/16

Items	Required	Actual
Temperature (°C)	18-25	22.9 ±2
Humidity (%RH)	30-70	50 ±20

Test Date: 2022/12/27

Items	Required	Actual
Temperature (°C)	18-25	22.7 ±2
Humidity (%RH)	30-70	50 ±20

Test Date: 2022/12/28

Items	Required	Actual
Temperature (°C)	18-25	23 ±2
Humidity (%RH)	30-70	50 ±20

USA	**:**	**FCC Registration Number: TW0033**
Canada	**:**	**CAB Identifier Number: TW3023 / Company Number: 26930**

Site Description	:	Accredited by TAF Accredited Number: 3023
Test Laboratory	:	DEKRA Testing and Certification Co., Ltd
Address	:	No. 26, Huaya 1st Rd., Guishan Dist., Taoyuan City 333411, Taiwan, R.O.C.
Phone number	:	886-3-275-7255
Fax number	:	886-3-327-8031
Email address	:	info.tw@dekra.com
Website	:	http://www.dekra.com.tw

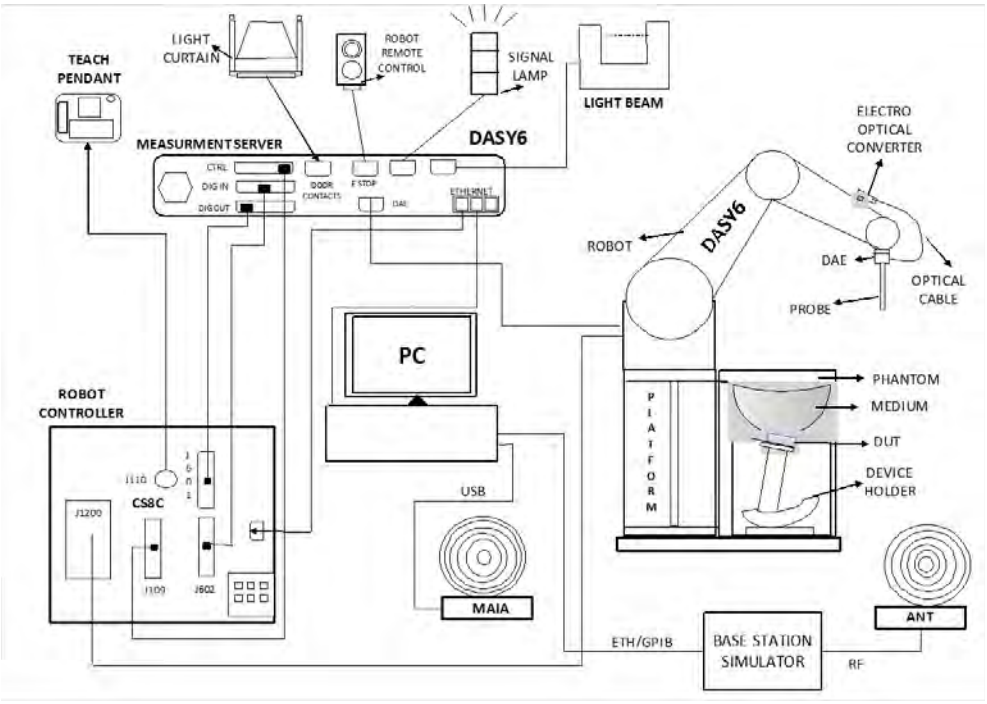
1.5 Measurement procedures

IEEE 1528-2013
47CFR § 2.1093
KDB 248227 D01 v02r02
KDB 447498 D01 v06
KDB 616217 D04 v01r02
KDB 865664 D01 v01r04
IEC TR 63170:2018
IEC/IEEE 62209-1528:2020

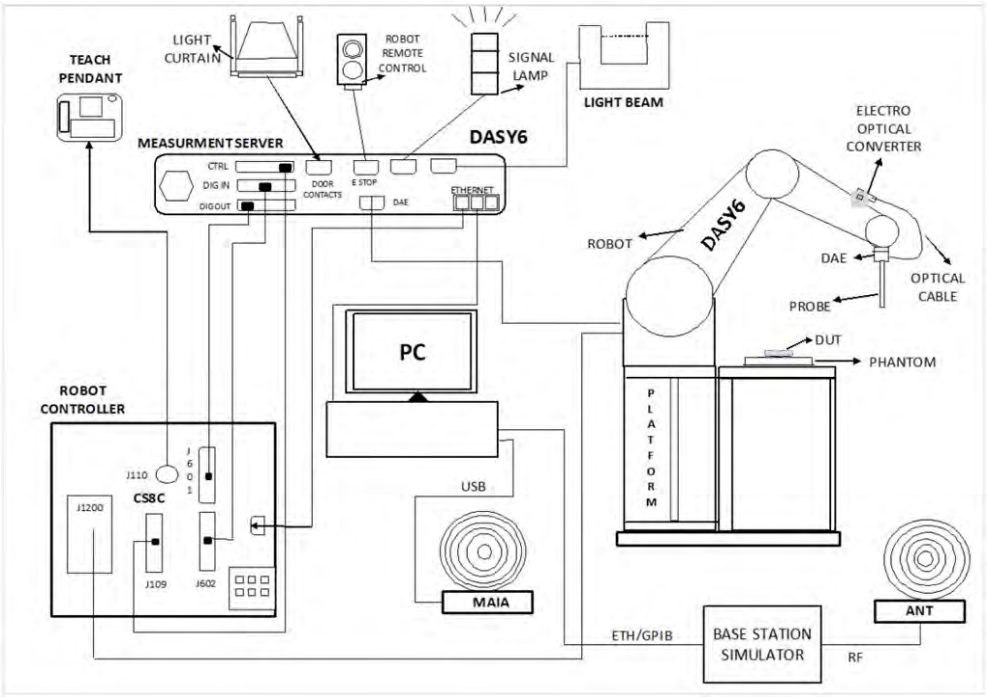
2. Measurement System

2.1 DASY System Description

SAR Configurations is shown below:



Power Density Configurations is shown below:



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

- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- 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 Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running Win7/8/10 and the DASY software.
- Remote control and 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.

2.1.1 Applications

Predefined procedures and evaluations for automated compliance testing with all worldwide standards, e.g., IEEE 1528, OET 65, IEC 62209-1, IEC 62209-2, EN 50360, EN 50383 and others.

2.1.2 Area Scans

Area scans are defined prior to the measurement process being executed with a user defined variable spacing between each measurement point (integral) allowing low uncertainty measurements to be conducted. Scans defined for FCC applications utilize a 10mm^2 step integral, with 1mm interpolation used to locate the peak SAR area used for zoom scan assessments.

When an Area Scan has measured all reachable points, it computes the field maxima found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE 1528-2013, EN 50361 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan).

2.1.3 Zoom Scan (Cube Scan Averaging)

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. A density of 1000 kg/m^3 is used to represent the head and body tissue density and not the phantom liquid density, in order to be consistent with the definition of the liquid dielectric properties, i.e. the side length of the 1 g cube is 10mm, with the side length of the 10 g cube 21,5mm.

The zoom scan integer steps can be user defined so as to reduce uncertainty, but normal practice for typical test applications (including FCC) utilize a physical step of 5x5x7 (8mmx8mmx5mm) providing a volume of 32mm in the X & Y axis, and 30mm in the Z axis.

2.1.4 Uncertainty of Inter-/Extrapolation and Averaging

In order to evaluate the uncertainty of the interpolation, extrapolation and averaged SAR calculation algorithms of the Postprocessor, DASY5 allows the generation of measurement grids which are artificially predefined by analytically based test functions. Therefore, the grids of area scans and zoom scans can be filled with uncertainty test data, according to the SAR benchmark functions of IEEE 1528.The three analytical functions shown in equations as below are used to describe the possible range of the expected SAR distributions for the tested handsets. The field gradients are covered by the spatially flat distribution f1, the spatially steep distribution f3 and f2 accounts for H-field cancellation on the phantom/tissue surface.

$$f_1(x,y,z) = Ae^{-\frac{z}{2a}}\cos^2\left(\frac{\pi}{2}\frac{\sqrt{x'^2+y'^2}}{5a}\right)$$

$$f_2(x,y,z) = Ae^{-\frac{z}{a}}\frac{a^2}{a^2+x'^2}\left(3-e^{-\frac{2z}{a}}\right)\cos^2\left(\frac{\pi}{2}\frac{y'}{3a}\right)$$

$$f_3(x,y,z) = A\frac{a^2}{\frac{a^2}{4}+x'^2+y'^2}\left(e^{-\frac{2z}{a}}+\frac{a^2}{2(a+2z)^2}\right)$$

2.2 DASY Probe

The SAR measurement is conducted with the dosimetric probe manufactured by SPEAG. The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency.

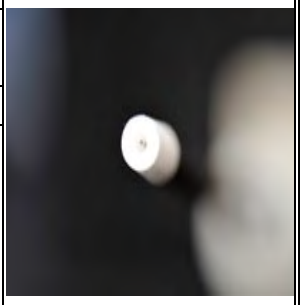
SPEAG conducts the probe calibration in compliance with international and national standards (e.g. IEEE 1528, EN 62209-1, IEC 62209, etc.) under ISO 17025.

2.2.1 Isotropic E-Field Probe Specification

Model	EX3DV4	
Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Frequency	4 MHz to 10 GHz Linearity: ± 0.2 dB (30 MHz to 10 GHz)	
Directivity	± 0.1 dB in TSL (rotation around probe axis) ± 0.3 dB in TSL (rotation normal to probe axis)	
Dynamic Range	10 µW/g to 100 mW/g Linearity: ± 0.2 dB (noise: typically < 1 µW/g)	
Dimensions	Overall length: 337 mm (tip: 20 mm) Tip diameter: 2.5 mm (body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm	
Application	High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields); the only probe that enables compliance testing for frequencies up to 6 GHz with precision of better than 30%	

2.2.2 E-Field mm-Wave Probe Specification

Model	EUmmWVx
Construction	Two dipoles optimally arranged to obtain pseudo-vector information Minimum three measurements/point, 120º rotated around probe axis Sensors (0.8 mm length) printed on glass substrate protected by high density foam
Frequency	750 MHz to 110 GHz
Dynamic Range	< 20 V/m to 10000 V/m with PRE-10 (min < 20 V/m to 2000 V/m)
Position Precision	< 0.2 mm
Dimensions	Overall length: 337 mm (tip: 20 mm) Tip diameter: encapsulation 8 mm (internal sensor < 1mm) Distance from probe tip to dipole centers: < 2 mm Sensor displacement to probe's calibration point: < 0.3 mm
Application	E-field measurements of 5G devices and other mm-wave transmitters operating above 10GHz in < 2 mm distance from device (free-space) Power density, H-field, and far-field analysis using total field reconstruction



2.3 DATA Acquisition Electronics (DAE) and Measurement Server

The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit.

Transmission to the 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 input impedance of the DAE4 is 200M Ohm; the inputs are symmetrical and floating. Common mode rejection is above 80dB.

2.4 Robot

The DASY system uses the high precision robots TX90 XL type out of the newer series from Stäubli SA (France). For the 6-axis controller DASY system, the CS8C robot controller version from Stäubli is used.

The XL robot series have many features that are important for our application:

- High precision (repeatability 0.02 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)
- 6-axis controller

2.5 Device Holder

The DASY device holder is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear reference points). The rotation center for both scales is the ear reference point (EPR).

Thus the device needs no repositioning when changing the angles.

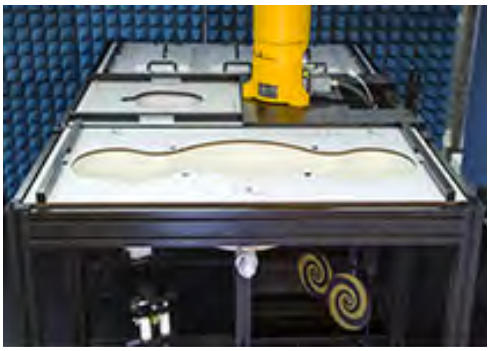
The DASY device holder has been made out of low-loss POM material having the following dielectric parameters: relative permittivity εr =3 and loss tangent δ = 0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence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

2.6 Phantom

2.6.1 SAM Twin Phantom

The SAM twin phantom is a fiberglass shell phantom with 2mm shell thickness (except the ear region where shell thickness increases to 6mm). It has three measurement areas:

- Left head
- Right head
- Flat phantom



The device holder positions are adjusted to the standard measurement positions in the three sections. A cover is provided to tap the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. On the phantom top, three reference markers are provided to identify the phantom position with respect to the robot.

2.6.2 mmWave Phantom

The mmWave Phantom approximates free-space conditions, allowing to evaluate not only the antenna side of the device but also the front (screen) side or any opposite-radiating side of wireless devices operating above 10 GHz without distorting the RF field. It consists of a 40 mm thick Rohacell plate used as a test bed, which has a loss tangent ($\tan \delta$) ≤ 0.05 and a relative permittivity (ε_r) ≤ 1.2.
High-performance RF absorbers are placed below the foam.

3. Tissue Simulating Liquid

3.1 The composition of the tissue simulating liquid

Description: Aqueous solution with surfactants and inhibitors
Declarable, or hazardous components:

CAS: 107-21-1 EINECS: 203-473-3 Reg.nr.: 01-2119456816-28-0000	**Ethanediol** STOT RE 2, H373; Acute Tox. 4, H302	< 5.2%
CAS: 68608-26-4 EINECS: 271-781-5 Reg.nr.: 01-2119527859-22-0000	**Sodium petroleum sulfonate** Eye Irrit. 2, H319	< 2.9%
CAS: 107-41-5 EINECS: 203-489-0 Reg.nr.: 01-2119539582-35-0000	**Hexylene Glycol / 2-Methyl-pentane-2,4-diol** Skin Irrit. 2, H315; Eye Irrit. 2, H319	< 2.9%
CAS: 68920-66-1 NLP: 500-236-9 Reg.nr.: 01-2119489407-26-0000	**Alkoxylated alcohol, > C_{16}** Aquatic Chronic 2, H411; Skin Irrit. 2, H315; Eye Irrit. 2, H319	< 2.0%

Note. Speag provided.

3.2 Tissue Calibration Result

The dielectric parameters of the liquids were verified prior to the SAR evaluation using Dielectric Probe Kit and Vector Network Analyzer.

Date	Tissue Type	Frequency (MHz)	Relative Permittivity (εr)			Conductivity (σ)			Tissue Temp. (°C)
			Measured	Target	Delta (%)	Measured	Target	Delta (%)	
2022/11/16	Head	2412	39.43	39.28	0.38	1.76	1.77	-0.56	21.2
		2437	39.33	39.23	0.25	1.79	1.79	0.00	
		2441	39.32	39.22	0.25	1.80	1.79	0.56	
		2450	39.28	39.20	0.20	1.82	1.80	1.11	
		2462	39.24	39.18	0.15	1.83	1.81	1.10	
2022/11/15	Head	5210	36.33	35.99	0.94	4.60	4.67	-1.50	21.7
		5250	36.22	35.95	0.75	4.66	4.71	-1.06	
		5290	36.10	35.91	0.53	4.71	4.75	-0.84	
		5530	35.44	35.61	-0.48	5.04	5.00	0.80	
		5600	35.25	35.50	-0.70	5.13	5.07	1.18	
		5610	35.22	35.49	-0.76	5.14	5.08	1.18	
		5690	35.01	35.41	-1.13	5.25	5.16	1.74	
		5775	34.77	35.33	-1.59	5.36	5.25	2.10	
		5800	34.70	35.30	-1.70	5.39	5.27	2.28	
		5855	34.55	35.25	-1.99	5.46	5.33	2.44	
2022/12/27	Head	6500	34.72	34.50	0.64	6.16	6.07	1.48	21.9
		6025	35.09	35.07	0.06	5.61	5.51	1.81	
		6185	34.96	34.88	0.23	5.82	5.70	2.11	
		6505	34.72	34.49	0.67	6.17	6.08	1.48	
		6825	34.47	34.11	1.06	6.54	6.45	1.40	
		6985	34.35	33.92	1.27	6.72	6.63	1.36	

3.3 Tissue Dielectric Parameters for Head and Body Phantoms

The head tissue dielectric parameters recommended by the IEC/IEEE 62209-1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head tissue parameters that have not been specified are interpolated according to the head parameters specified in IEC/IEEE 62209-1528.

Target Frequency	Head	
(MHz)	ε_r	σ (S/m)
450	43.5	0.87
750	41.9	0.89
835	41.5	0.90
900	41.5	0.97
1450	40.5	1.20
1640	40.2	1.31
1750	40.1	1.37
1800 – 2000	40.0	1.40
2450	39.2	1.80
3000	38.5	2.40
5000	36.2	4.45
5200	36.0	4.66
5400	35.8	4.86
5600	35.3	5.27
5800	35.3	5.27
6000	35.1	5.48
6500	34.5	6.07
7000	33.9	6.65
7500	33.3	7.24

(ε_r = relative permittivity, σ = conductivity and ρ = 1000 kg/m^3)

4. Measurement Procedure

4.1 System Check

4.1.1 Dipoles

The SAR dipoles are optimized symmetrical dipole with λ/4 balun matched to a Flat phantom section filled with tissue simulating liquids. 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. They are available for the variety of frequencies between 300MHz and 10 GHz. The provided tripod is used to hold the dipole below the phantom. As the distance between the dipole center and the TSL is critical, a spacer is placed between the dipole and the phantom. The spacing distance is frequency dependent.

4.1.2 Verification Source

The verification sources apply to system check or verification at specific mmWave frequencies. The sources comprisehorn-antennas and very stable signal generators.

4.1.3 SAR System Check Result

Comparing to the original SAR value provided by SPEAG, the verification data should be within its specification of 10 %.

Below table shows the target SAR and measured SAR after normalized to 1W input power. The table below indicates the system performance check can meet the variation criterion and the plots can be referred to Appendix A of this report.

Date	Frequency (MHz)	Input Power (mW)	Measured 1g SAR (W/kg)	Targeted 1g SAR (W/kg)	Normalized 1g SAR (W/kg)	Delta 1g (%)	Measured 10g SAR (W/kg)	Targeted 10g SAR (W/kg)	Normalized 10g SAR (W/kg)	Delta 10g (%)	Tissue Temp. (°C)
2022/11/16	2450	250	12.70	53.10	50.8	-4.33	5.77	24.80	23.08	-6.94	21.2
2022/11/15	5250	100	8.01	81.60	80.1	-1.84	2.23	23.20	22.3	-3.88	21.7
2022/11/15	5600	100	8.62	85.90	86.2	0.35	2.45	24.20	24.5	1.24	21.7
2022/11/15	5800	100	8.39	82.00	83.9	2.32	2.35	22.80	23.5	3.07	21.7
2022/12/27	6500	100	29.80	293.00	298	1.71	5.64	53.80	56.4	4.83	21.9

4.1.4 Power Density System Check Result

The system performance check verifies that the system operates within its specifications.

The system check is successful if the difference between the normalized measured local power density and the numerically validated target value is within the reported expanded uncertainty of the measurement system.

The recommended settings for measurement of verification sources are listed in the following:

Frequency (GHz)	Grid step	Grid extent X/Y (mm)	Measurement points
10	0.25 (λ/4)	120 / 120	18 x 18

According to the DASY specification in the user's manual and SPEAG's recommendation, the deviation threshold of ±0.66 dB represents the expanded standard uncertainty for system performance check. The system check is successful if the measured results are within ±0.66 dB tolerances to the target value shown in the calibration certificate of the verification source.

Date	Frequency (GHz)	Distance (mm)	Input Power (mW)	Measured Avg PD 4 cm^2 (W/m^2)	Targeted Avg PD 4 cm^2 (W/m^2)	Deviation (dB)
2022/12/28	10	10	124	149.3	146.00	0.10

Note: The Measured Avg PD was the average of psPDn+, psPDtot+ and psPDmod+, which refers to the demonstration from calibration certificate.

4.2 SAR Measurement Procedure

The DASY calculates SAR using the following equation,

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

σ: represents the simulated tissue conductivity

ρ: represents the tissue density

The EUT is set to transmit at the required power in line with product specification, at each frequency relating to the LOW, MID, and HIGH channel settings.

Pre-scans are made on the device to establish the location for the transmitting antenna, using a large area scan in either air or tissue simulation fluid.

The EUT is placed against the Universal Phantom where the maximum area scan dimensions are larger than the physical size of the resonating antenna. When the scan size is not large enough to cover the peak SAR distribution, it is modified by either extending the area scan size in both the X and Y directions, or the device is shifted within the predefined area.

The area scan is then run to establish the peak SAR location (interpolated resolution set at $1mm^2$)which is then used to orient the center of the zoom scan. The zoom scan is then executed and the 1g and 10g averages are derived from the zoom scan volume (interpolated resolution set at $1mm^3$).

4.3 Power Density Measurement Procedure

The power density for an electromagnetic field represents the rate of energy transfer per unit area. The local power density (i.e. Poynting vector) at a given spatial point is deduced from electromagnetic fields by the following formula:

$$S = \frac{1}{2}\mathrm{Re}\{E \times H^*\} \cdot \vec{n}$$

Where: E is the complex electric field peak phasor and H is the complex conjugate magnetic field peak phasor.

The spatial-average power density distribution on the evaluation surface is determined per the IEC TR 63170. The spatial area, A is specified by the applicable exposure limit or regulatory requirements. The circular shape was used.

$$S_{av} = \frac{1}{2A}\Re\left(\int E \times H^* \cdot \hat{n} dA\right)$$

5. RF Exposure Limits

SAR assessments have been made in line with the requirements of IEEE-1528, FCC Supplement C, and comply with ANSI/IEEE C95.1-1992 “Uncontrolled Environments” limits. These limits apply to a location which is deemed as “Uncontrolled Environment” which can be described as a situation where the general public may be exposed to an RF source with no prior knowledge or control over their exposure.

Limits for General Population/Uncontrolled Exposure (W/kg)

Type Exposure	**Uncontrolled Environment Limit**
Spatial Peak SAR (1g cube tissue for brain or body)	**1.60 W/kg**
Spatial Average SAR (whole body)	**0.08 W/kg**
Spatial Peak SAR (10g for hands, feet, ankles and wrist)	**4.00 W/kg**
Power density[1]	**1.0 mW/cm^2**

Note: 1 mW/cm^2 = 10 W/m^2

6. Test Equipment List

Instrument	Manufacturer	Model No.	Serial No.	Last Calibration	Next Calibration
Reference Dipole 2450MHz	Speag	D2450V2	1053	2021/02/10	2024/02/09
Reference Dipole 5GHz	Speag	D5GHzV2	1041	2020/05/25	2023/05/24
Reference Dipole 6.5GHz	Speag	D6.5GHzV2	1021	2021/02/09	2024/02/08
Verification Source Antenna 10GHz	Speag	5G Verification Source 10GHz	2006	2022/05/02	2023/05/01
Device Holder	Speag	N/A	N/A	N/A	N/A
Data Acquisition Electronic	Speag	DAE4	1207	2021/11/22	2022/11/21
Data Acquisition Electronic	Speag	DAE4	1651	2022/02/24	2023/02/23
E-Field Probe	Speag	EX3DV4	3698	2021/11/24	2022/11/23
E-Field Probe	Speag	EX3DV4	7631	2022/01/24	2023/01/23
mmWave E-field Probe	Speag	EUmmWV4	9546	2022/04/27	2023/04/26
SAR Software	Speag	DASY52	V52.10.0.1446	N/A	N/A
SAR Software	Speag	cDASY6	V16.2.0.1425	N/A	N/A
Power Amplifier	Mini-Circuit	ZVE-8G+	447202211	N/A	N/A
Power Amplifier	Mini-Circuit	ZVA-02303HP+	20211217-1	N/A	N/A
Directional Coupler	Agilent	87300C	MY44300353	N/A	N/A[1]
Attenuator	Woken	WATT-218FS-10	N/A	N/A	N/A[1]
Attenuator	Mini-Circuit	BW-S20W2+	N/A	N/A	N/A[1]
Vector Network Analyzer	Agilent	E5071C	MY46108013	2022/02/25	2023/02/24
Signal Generator	Anritsu	MG3694A	041902	2022/08/30	2023/08/29
Power Meter	Anritsu	ML2487A	6K00001447	2022/10/31	2023/10/30
Power Sensor	Anritsu	MA2411B	1339194	2022/10/31	2023/10/30

Note: 1. System Check, the path loss measured by the network analyzer, includes the signal generator, amplifier, cable, attenuator and directional coupler.

Note:

Per KDB 865664 D01 requirements for dipole calibration, the following are recommended FCC procedures for SAR dipole calibration.

1. After a dipole is damaged and properly repaired to meet required specifications

2. When the measured SAR deviates from the calibrated SAR value by more than 10% due to changes in physical, mechanical, electrical or other relevant dipole conditions;

3. When the most recent return-loss, measured at least annually, deviates by more than 20% from the previous measurement (i.e. 0.2 of the dB value) or not meeting the required -20 dB return-loss specification

	Frequency	Tissue	Return loss	Limit	Date
Calibration	2450	Head	-24.2dB	Within 20%	2021.02.10
Measurement	2450	Head	-24.69dB		2022.02.14

	Frequency	Tissue	Return loss	Limit	Verified Date
Calibration	5250	Head	-26.86dB	Within 20%	2020.05.25
Measurement	5250	Head	-24.16dB		2021.05.18
Measurement	5250	Head	-25.46dB		2022.05.17

	Frequency	Tissue	Return loss	Limit	Verified Date
Calibration	5600	Head	-24.43dB	Within 20%	2020.05.25
Measurement	5600	Head	-27.05dB		2021.05.18
Measurement	5600	Head	-24.46dB		2022.05.17

	Frequency	Tissue	Return loss	Limit	Verified Date
Calibration	5800	Head	-26.80dB	Within 20%	2020.05.25
Measurement	5800	Head	-25.64dB		2021.05.18
Measurement	5800	Head	-24.88dB		2022.05.17

	Frequency	Tissue	Return loss	Limit	Verified Date
Calibration	6500	Head	-34.07dB	Within 20%	2021.02.09
Measurement	6500	Head	-31.54dB		2022.02.09

4. When the most recent measurement of the real or imaginary parts of the impedance, measured at least annually, deviates by more than 5 Ω from the previous measurement

	Frequency	Tissue	Impedance	Limit	Verified Date
Calibration	2450	Head	52.7	Within 5Ω	2021.02.10
Measurement	2450	Head	53.26		2022.02.14

	Frequency	Tissue	Return loss	Limit	Verified Date
Calibration	5250	Head	49.04	Within 5Ω	2020.05.25
Measurement	5250	Head	45.54		2021.05.18
Measurement	5250	Head	50.45		2022.05.17

	Frequency	Tissue	Return loss	Limit	Verified Date
Calibration	5600	Head	56.26	Within 5Ω	2020.05.25
Measurement	5600	Head	52.24		2021.05.18
Measurement	5600	Head	55.41		2022.05.17

	Frequency	Tissue	Return loss	Limit	Verified Date
Calibration	5800	Head	54.28	Within 5Ω	2020.05.25
Measurement	5800	Head	49.85		2021.05.18
Measurement	5800	Head	56.96		2022.05.17

	Frequency	Tissue	Return loss	Limit	Verified Date
Calibration	6500	Head	51.01	Within 5Ω	2021.02.09
Measurement	6500	Head	51.08		2022.02.09

7. Measurement Uncertainty

Measurement uncertainty for 30 MHz to 3 GHz								
Error Description	Uncert. 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%	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 Effects	±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.	±4.0%	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%	R	√3	1	1	±0.0%	±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 (meas.)	±2.5%	R	√3	0.78	0.71	±1.1%	±1.0%	∞
Liquid Permittivity (meas.)	±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 Std. Uncertainty						±11.2%	±11.1%	361
Expanded STD Uncertainty						±22.3%	±22.2%	

Measurement uncertainty for 3GHz to 6 GHz								
Error Description	Uncert. 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 Effects	±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%	R	√3	1	1	±0.0%	±0.0%	
Phantom and Setup								
Phantom Uncertainty	±6.6%	R	√3	1	1	±3.8%	±3.8%	∞
SAR correction	±1.9%	R	√3	1	1	±1.1%	±0.9%	∞
Liquid Conductivity (meas.)	±2.5%	R	√3	1	0.84	±1.1%	±1.0%	∞
Liquid Permittivity (meas.)	±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 Std. Uncertainty						±12.3%	±12.2%	748
Expanded STD Uncertainty						±24.6%	±24.5%	

Measurement uncertainty for 6 GHz to 10 GHz							
Error Description	Uncert. value	Prob. Dist.	Div.	(ci) 1g	(ci) 10g	Std. Unc. (1g)	Std. Unc. (10g)
Measurement System Errors							
Probe Calibration	±18.6%	N	2	1	1	±9.3%	±9.3%
Probe Calibration Drift	±1.7%	R	√3	1	1	±1.0%	±1.0%
Probe Linearity	±4.7%	R	√3	1	1	±2.7%	±2.7%
Broadband Signal	±2.8%	R	√3	1	1	±1.6%	±1.6%
Probe Isotropy	±7.6%	R	√3	1	1	±4.4%	±4.4%
Data Acquisition	±0.3%	N	1	1	1	±0.3%	±0.3%
RF Ambient	±1.8%	N	1	1	1	±1.8%	±1.8%
Probe Positioning	±0.005 mm	N	1	0.50	0.50	±0.25%	±0.25%
Data Processing	±3.5%	N	1	1	1	±3.5%	±3.5%
Phantom and Device Errors							
Conductivity (meas.)	±2.5%	N	1	0.78	0.71	±2.0%	±1.8%
Conductivity (temp.)	±2.4%	R	√3	0.78	0.71	±1.1%	±1.0%
Phantom Permittivity	±14.0%	R	√3	0.5	0.5	±4.0%	±4.0%
Distance DUT - TSL	±2.0%	N	1	2	2	±4.0%	±4.0%
Device Positioning	±1.0%	N	1	1	1	±1.0%	±1.0%
Device Holder	±3.6%	N	1	1	1	±3.6%	±3.6%
DUT Modulation	±2.4%	R	√3	1	1	±1.4%	±1.4%
Time-average SAR	±1.7%	R	√3	1	1	±1.0%	±1.0%
DUT drift	±2.5%	N	1	1	1	±2.5%	±2.5%
Val Antenna Unc.	±0.0%	N	1	1	1	±0%	±0%
Unc. Input Power	±0.0%	N	1	1	1	±0%	±0%
Correction to the SAR results							
Deviation to Target	±1.9%	N	1	1	0.84	±1.9%	±1.6%
SAR scaling	±0%	R	√3	1	1	±0%	±0%
Combined Uncertainty						±14.0%	±13.9%
Expanded Uncertainty						±28.0%	±27.9%

Measurement uncertainty for Power Density						
Error Description	Uncert. Value (±dB)	Prob. Dist.	Div.	(ci)	Std. Unc. (±dB)	(vi) Veff
Uncertainty terms dependent on the measurement system						
Calibration	0.49	N	1	1	0.49	∞
Probe correction	0	R	√3	1	0	∞
Frequency response (BW ≤ 1 GHz)	0.20	R	√3	1	0.12	∞
Sensor cross coupling	0	R	√3	1	0	∞
Isotropy	0.50	R	√3	1	0.29	∞
Linearity	0.20	R	√3	1	0.12	∞
Probe scattering	0	R	√3	1	0	∞
Probe positioning offset	0.30	R	√3	1	0.17	∞
Probe positioning repeatability	0.04	R	√3	1	0.02	∞
Sensor mechanical offset	0	R	√3	1	0	∞
Probe spatial resolution	0	R	√3	1	0	∞
Field impedance dependance	0	R	√3	1	0	∞
Amplitude and phase drift	0	R	√3	1	0	∞
Amplitude and phase noise	0.04	R	√3	1	0.02	∞
Measurement area truncation	0	R	√3	1	0	∞
Data acquisition	0.03	N	1	1	0.03	∞
Sampling	0	R	√3	1	0	∞
Field reconstruction	2	R	√3	1	1.15	∞
FTE/MEO	0	R	√3	1	0	∞
Power density scaling	-	R	√3	1	-	∞
Spatial averaging	0.10	R	√3	1	0.06	∞
System detection limit	0.04	R	√3	1	0.02	∞
Uncertainty terms dependent on the DUT and environmental factors						
Probe coupling with DUT	0	R	√3	1	0	∞
Modulation response	0.40	R	√3	1	0.23	∞
Integration time	0	R	√3	1	0	∞
Response time	0	R	√3	1	0	∞
Device holder influence	0.10	R	√3	1	0.06	∞
DUT alignment	0	R	√3	1	0	∞
RF ambient conditions	0.04	R	√3	1	0.02	∞
Ambient reflections	0.04	R	√3	1	0.02	∞
Immunity / secondary reception	0	R	√3	1	0	∞
Drift of the DUT	0.21	R	√3	1	0.12	∞
Combined Standard Uncertainty					1.33	∞
Expanded Standard Uncertainty (95%)					2.67	

8. Conducted Power Measurement (Including tolerance allowed for production unit)

WLAN 2.4G									
	Frequency	Mode	BW	SISO-Main			SISO-Aux		
				CH	AV Power	AV Target	CH	AV Power	AV Target
DSSS/OFDM mode specified maximum output power at an antenna port	WLAN 2.4GHz	b	20	1	16.04	16.5	1	16.41	16.5
				6	16.42	16.5	6	16.46	16.5
				11	16.36	16.5	11	16.31	16.5
				12	16.12	16.5	12	16.30	16.5
				13	15.55	16	13	15.99	16
		g	20	1	16.26	16.5	1	16.22	16.5
				6	16.32	16.5	6	16.33	16.5
				11	16.41	16.5	11	16.37	16.5
				12	15.26	15.5	12	15.23	15.5
				13	10.58	11	13	10.60	11
		n (HT)	20	1	16.23	16.5	1	16.05	16.5
				6	16.32	16.5	6	16.19	16.5
				11	16.37	16.5	11	16.29	16.5
				12	15.74	16	12	15.68	16
				13	13.40	13.5	13	13.33	13.5
			40	3	16.41	16.5	3	16.33	16.5
				6	16.34	16.5	6	16.36	16.5
				9	15.91	16.5	9	16.33	16.5
				10	15.42	15.5	10	15.41	15.5
				11	11.71	12	11	11.64	12
		ax (HE)	20	1	15.98	16.5	1	16.43	16.5
				6	15.96	16.5	6	15.92	16.5
				11	16.11	16.5	11	16.04	16.5
				12	15.51	16	12	15.95	16
				13	13.24	13.5	13	13.17	13.5
			40	3	16.28	16.5	3	16.21	16.5
				6	16.33	16.5	6	16.25	16.5
				9	16.35	16.5	9	16.26	16.5
				10	15.36	15.5	10	15.32	15.5
				11	11.63	12	11	11.61	12

WLAN 5G

OFDM mode specified maximum output power at an antenna port

Frequency	Mode	BW	SISO-Main			SISO-Aux		
			CH	AV Power	AV Target	CH	AV Power	AV Target
U-NII-1 (5150~5250MHz)	a	20	36	14.17	14.5	36	14.03	14.5
			40	14.14	14.5	40	14.07	14.5
			44	13.91	14.5	44	14.35	14.5
			48	13.97	14.5	48	14.36	14.5
	n (HT)	20	36	14.09	14.5	36	13.92	14.5
			40	14.07	14.5	40	13.93	14.5
			44	14.41	14.5	44	14.25	14.5
			48	14.28	14.5	48	14.19	14.5
		40	38	14.30	14.5	38	14.18	14.5
			46	14.37	14.5	46	14.24	14.5
	ac(VHT)	80	42	13.97	14.5	42	14.32	14.5
	ax (HE)	20	36	13.97	14.5	36	14.35	14.5
			40	14.01	14.5	40	14.37	14.5
			44	14.02	14.5	44	13.90	14.5
			48	14.12	14.5	48	13.99	14.5
		40	38	14.19	14.5	38	14.13	14.5
			46	14.27	14.5	46	14.18	14.5
		80	42	14.27	14.5	42	14.37	14.5
U-NII-2C (5470~5725MHz)	a	20	100	14.26	14.5	100	14.22	14.5
			112	14.08	14.5	112	13.99	14.5
			116	14.13	14.5	116	14.16	14.5
			128	14.00	14.5	128	13.94	14.5
			132	14.28	14.5	132	14.26	14.5
	n (HT)	20	100	14.16	14.5	100	14.17	14.5
			112	13.97	14.5	112	13.96	14.5
			116	14.11	14.5	116	14.03	14.5
			128	14.41	14.5	128	14.37	14.5
			132	14.28	14.5	132	14.18	14.5
		40	102	14.38	14.5	102	14.30	14.5
			110	13.93	14.5	110	13.93	14.5
			118	14.14	14.5	118	14.05	14.5
			126	14.42	14.5	126	14.31	14.5
			134	14.13	14.5	134	14.01	14.5
	ac (VHT)	20	144	14.06	14.5	144	13.96	14.5
		40	142	13.96	14.5	142	13.92	14.5
		80	138	14.01	14.5	138	13.99	14.5
			106	14.37	14.5	106	14.36	14.5
			122	14.02	14.5	122	14.35	14.5
		160	114	14.13	14.5	114	14.19	14.5
	ax (HE)	20	100	14.11	14.5	100	14.06	14.5
			112	14.21	14.5	112	14.17	14.5
			116	14.42	14.5	116	14.30	14.5
			128	14.19	14.5	128	13.95	14.5
			132	13.91	14.5	132	14.21	14.5
			144	14.27	14.5	144	14.19	14.5
		40	102	14.40	14.5	102	14.31	14.5
			110	14.41	14.5	110	14.37	14.5
			118	14.07	14.5	118	14.06	14.5
			126	14.38	14.5	126	14.31	14.5
			134	14.16	14.5	134	14.05	14.5
			142	13.95	14.5	142	14.35	14.5
		80	106	14.37	14.5	106	13.93	14.5
			122	14.13	14.5	122	14.18	14.5
		160	114	14.33	14.5	114	14.19	14.5

Frequency	Mode	BW	SISO-Main			SISO-Aux		
			CH	AV Power	AV Target	CH	AV Power	AV Target
U-NII-2A (5250~5350MHz)	a	20	52	14.22	14.5	52	14.08	14.5
			56	14.26	14.5	56	14.11	14.5
			60	13.94	14.5	60	14.37	14.5
			64	14.42	14.5	64	14.36	14.5
	n (HT)	20	52	14.14	14.5	52	13.98	14.5
			56	14.06	14.5	56	14.03	14.5
			60	14.39	14.5	60	14.32	14.5
			64	14.37	14.5	64	14.37	14.5
		40	54	14.18	14.5	54	14.03	14.5
			62	14.01	14.5	62	13.94	14.5
	ac (VHT)	80	58	14.43	14.5	58	14.38	14.5
		160	50	14.32	14.5	50	14.17	14.5
	ax (HE)	20	52	14.37	14.5	52	14.23	14.5
			56	14.41	14.5	56	14.18	14.5
			60	14.31	14.5	60	14.24	14.5
			64	14.36	14.5	64	14.25	14.5
		40	54	14.03	14.5	54	13.92	14.5
			62	14.05	14.5	62	13.91	14.5
		80	58	14.07	14.5	58	14.07	14.5
		160	50	14.39	14.5	50	14.17	14.5
U-NII-3 (5725~5850MHz)	a	20	149	13.96	14.5	149	14.31	14.5
			157	14.21	14.5	157	14.11	14.5
			165	13.93	14.5	165	14.31	14.5
	n (HT)	20	149	14.34	14.5	149	14.27	14.5
			157	14.02	14.5	157	13.97	14.5
			165	14.34	14.5	165	14.26	14.5
		40	151	13.95	14.5	151	14.37	14.5
			159	14.06	14.5	159	13.90	14.5
	ac(VHT)	80	155	14.29	14.5	155	14.23	14.5
	ax (HE)	20	149	14.30	14.5	149	14.07	14.5
			157	14.33	14.5	157	14.06	14.5
			165	14.29	14.5	165	14.03	14.5
		40	151	14.42	14.5	151	14.33	14.5
			159	13.94	14.5	159	13.89	14.5
		80	138	14.25	14.5	138	14.23	14.5
			155	14.03	14.5	155	14.04	14.5
U-NII-4 (5850~5925MHz)	a	20	169	14.19	14.5	169	14.04	14.5
			173	14.17	14.5	173	14.03	14.5
			177	14.16	14.5	177	14.09	14.5
	n (HT)	20	169	14.01	14.5	169	14.01	14.5
			173	14.03	14.5	173	13.95	14.5
			177	14.02	14.5	177	14.02	14.5
		40	167	14.04	14.5	167	13.97	14.5
			175	14.12	14.5	175	14.03	14.5
	ac(VHT)	80	171	14.34	14.5	171	14.33	14.5
		160	163	14.37	14.5	163	14.37	14.5
	ax (HE)	20	169	14.34	14.5	169	14.04	14.5
			173	14.37	14.5	173	14.01	14.5
			177	14.33	14.5	177	14.08	14.5
		40	167	13.99	14.5	167	13.93	14.5
			175	14.01	14.5	175	13.91	14.5
		80	171	14.01	14.5	171	14.07	14.5
		160	163	14.03	14.5	163	14.37	14.5

WLAN 6G

OFDM mode specified maximum output power at an antenna port

Frequency	Mode	BW	SISO-Main			SISO-Aux		
			CH	AV Power	AV Target	CH	AV Power	AV Target
U-NII-5 (5925~6425MHz)	ax (HE)	20	1	6.67	7.0	1	6.67	7
			45	6.81	7.0	45	6.41	7
			93	6.49	7.0	93	6.11	7
		40	3	9.52	10.0	3	9.29	10
			43	9.54	10.0	43	9.21	10
			91	9.62	10.0	91	9.57	10
		80	7	12.87	13.0	7	12.87	13
			39	12.90	13.0	39	12.82	13
			87	12.82	13.0	87	12.74	13
		160	15	13.14	13.5	15	12.94	13.5
			47	12.81	13.5	47	12.71	13.5
			79	12.82	13.5	79	12.62	13.5
U-NII-6 (6425~6525MHz)	ax (HE)	20	97	6.92	7.0	97	6.51	7
			105	6.51	7.5	105	6.67	7.5
			113	6.64	7.5	113	6.82	7.5
		40	99	9.84	10.5	99	9.62	10.5
			107	9.77	10.5	107	9.63	10.5
		80	103	12.94	13.0	103	12.77	13
		160	111	13.28	13.5	111	13.02	13.5

Frequency	Mode	BW	SISO-Main			SISO-Aux		
			CH	AV Power	AV Target	CH	AV Power	AV Target
U-NII-7 (6525~6875MHz)	ax (HE)	20	117	6.54	7.0	117	6.78	7
			149	6.71	7.0	149	6.51	7
			181	6.58	7.0	181	6.65	7
		40	115	9.72	10.0	115	9.45	10
			147	9.35	10.0	147	9.67	10
			179	9.44	10.0	179	9.41	10
		80	119	12.98	13.0	119	12.76	13
			135	12.51	13.0	135	12.79	13
			151	12.61	13.0	151	12.78	13
			167	12.85	13.0	167	12.65	13
			183	13.01	13.5	183	13.05	13.5
		160	143	14.02	14.5	143	13.98	14.5
			175	14.23	14.5	175	14.39	14.5
U-NII-8 (6875~7125MHz)	ax (HE)	20	185	7.49	8.0	185	7.47	8
			209	7.19	8.0	209	7.48	8
			233	7.71	8.0	233	7.41	8
		40	187	9.92	10.5	187	9.11	10.5
			227	10.17	10.5	227	10.14	10.5
		80	199	13.26	14.0	199	13.46	14
			215	13.48	14.0	215	13.34	14
		160	207	14.15	14.5	207	14.03	14.5

BT									
Bluetooth mode maximum output power	Frequency	Mode	Modulation	SISO-Main			SISO-Aux		
				CH	AV Power	AV Target	CH	AV Power	AV Target
	BT 2.4GHz	BR	GFSK	0	12.85	13.5	0	13.01	13.5
				39	13.05	13.5	39	13.04	13.5
				78	12.71	13.5	78	12.76	13.5
		EDR	8DPSK	0	10.35	10.5	0	10.41	10.5
				39	10.41	10.5	39	10.47	10.5
				78	10.32	10.5	78	10.38	10.5
		BLE	GFSK	0	11.88	13.5	0	11.94	13.5
				19	11.91	13.5	19	11.97	13.5
				39	11.58	13.5	39	11.64	13.5

9. Test Results

9.1 SAR Test Results Summary

SAR MEASUREMENT								
Ambient Temperature (°C) : 22.5 ±2				Relative Humidity (%): 51%				
Liquid Temperature (°C) : 21.2 ±2				Depth of Liquid (cm): >15				
Test Position	Dist (mm)	Frequency		Conducted Power (dBm)		**SAR** 1g (W/Kg)		Plot No.
		Channel	MHz	Measurement	Tune-up Limit	Measurement	Tune-up Scaled	
Test Mode: 802.11b (MT7902) – INPAQ – Main								
Bottom	0	6	2437	16.42	16.5	0.161	0.164	
Edge(Front)	0	1	2412	16.04	16.5	0.591	0.657	
Edge(Front)	0	6	2437	16.42	16.5	0.733	**0.747**	1
Edge(Front)	0	11	2462	16.36	16.5	0.694	0.717	
Test Mode: 802.11b (MT7902) – INPAQ – Aux								
Bottom	0	6	2437	16.46	16.5	0.558	0.563	
Edge(Front)	0	6	2437	16.46	16.5	0.220	0.222	
Test Mode: BT-1M (MT7902) – INPAQ – Main								
Edge(Front)	0	39	2441	13.05	13.5	0.190	0.211	2
Test Mode: BT-1M (MT7902) – INPAQ – Aux								
Bottom	0	39	2441	13.04	13.5	0.104	0.116	
Note: 1. When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR is not required. 2. When the reported SAR of the highest measured maximum output power channel for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.								

SAR MEASUREMENT								
Ambient Temperature (°C) : 22.9 ±2				Relative Humidity (%): 50%				
Liquid Temperature (°C) : 21.7 ±2				Depth of Liquid (cm): >15				
Test Position	Dist (mm)	Frequency		Conducted Power (dBm)		**SAR** 1g (W/Kg)		Plot No.
		Channel	MHz	Measurement	Tune-up Limit	Measurement	Tune-up Scaled	
Test Mode: 802.11ac80M (MT7902) – INPAQ – Main								
Bottom	0	58	5290	14.43	14.5	0.316	0.321	
Bottom	0	106	5530	14.37	14.5	0.209	0.215	
Bottom	0	155	5775	14.29	14.5	0.273	0.287	
Bottom	0	171	5855	14.34	14.5	0.258	0.268	
Edge(Front)	0	58	5290	14.43	14.5	0.533	0.542	
Edge(Front)	0	106	5530	14.37	14.5	0.783	0.807	
Edge(Front)	0	122	5610	14.02	14.5	0.786	0.878	3
Edge(Front)	0	138	5690	14.01	14.5	0.767	0.859	
Edge(Front)	0	155	5775	14.29	14.5	0.712	0.747	4
Edge(Front)	0	171	5855	14.34	14.5	0.743	0.771	5
Test Mode: 802.11ac80M (MT7902) – INPAQ – Aux								
Bottom	0	58	5290	14.38	14.5	0.225	0.231	
Bottom	0	106	5530	14.36	14.5	0.184	0.190	
Bottom	0	155	5775	14.23	14.5	0.199	0.212	
Bottom	0	171	5855	14.33	14.5	0.221	0.230	
Edge(Front)	0	42	5210	14.32	14.5	1.040	**1.084**	6
Edge(Front)	0	58	5290	14.38	14.5	0.942	0.968	
Edge(Front)	0	106	5530	14.36	14.5	0.793	0.819	
Edge(Front)	0	122	5610	14.35	14.5	0.795	0.823	
Edge(Front)	0	138	5690	13.99	14.5	0.694	0.780	
Edge(Front)	0	155	5775	14.23	14.5	0.678	0.721	
Edge(Front)	0	171	5855	14.33	14.5	0.700	0.728	
Test Mode: 802.11ac80M (MT7902) – Pulse – Aux								
Edge(Front)	0	42	5210	14.48	14.5	1.020	1.025	

Note: 1. When multiple transmission modes have the same specified maximum output power, largest channel bandwidth, lowest order modulation and lowest data rate, the lowest order 802.11 mode is selected

2. When the reported SAR of the highest measured maximum output power channel for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required in that exposure configuration.

3. When the reported SAR of the highest measured maximum U-NII-2A for the exposure configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band.

SAR MEASUREMENT										PD MEASUREMENT						
Ambient Temperature (°C): 22.7 ±2 Relative Humidity (%): 50%																
Liquid Temperature (°C): 21.9 ±2 Depth of Liquid (cm): >15																
Test Position	Dist (mm)	Frequency		Conducted Power (dBm)		SAR 1g (W/Kg)		Measured APD (W/m^2)	Plot No.	Grid Step [λ]	Scaling Factor for Measure Uncertainty	Normal psPD (W/m^2)	Scaled Normal psPD (W/m^2)	Total psPD (W/m^2)	Scaled Total psPD (W/m^2)	Plot No.
		Ch	MHz	Meas	Tune-Up	Meas	Scaled									
Test Mode: 802.11ax160M (MT7902) – INPAQ – Main																
Edge(Front)	0	15	6025	13.14	13.5	0.328	0.356	2.270		0.0625	1.55	2.050	3.835	2.660	4.977	
Edge(Front)	0	47	6185	12.81	13.5	0.222	0.260	1.590		-	-	-	-	-	-	
Edge(Front)	0	111	6505	13.28	13.5	0.291	0.306	2.000		0.0625	1.55	2.190	3.967	2.900	5.253	
Bottom	0	175	6825	14.23	14.5	0.141	0.150	1.110		-	-	-	-	-	-	
Edge(Front)	0	175	6825	14.23	14.5	0.282	0.300	2.040		-	-	-	-	-	-	
Edge(Front)	0	207	6985	14.15	14.5	0.224	0.243	1.760		-	-	-	-	-	-	
Test Mode: 802.11ax160M (MT7902) – INPAQ – Aux																
Edge(Front)	0	15	6025	12.94	13.5	0.224	0.255	1.370		-	-	-	-	-	-	
Edge(Front)	0	47	6185	12.71	13.5	0.236	0.283	1.600		0.0625	1.55	2.000	4.131	2.390	4.937	
Edge(Front)	0	111	6505	13.02	13.5	0.252	0.281	1.370		-	-	-	-	-	-	
Bottom	0	175	6825	14.39	14.5	0.159	0.163	1.170		-	-	-	-	-	-	
Edge(Front)	0	175	6825	14.39	14.5	0.530	**0.544**	3.440	7	0.0625	1.55	2.310	4.080	3.260	5.758	
Edge(Front)	0	207	6985	14.03	14.5	0.402	0.448	2.650		0.0625	1.55	2.680	5.143	3.280	**6.294**	8
Note: Per WLAN 6GHz interim test procedure in Oct. 2020 TCBs Workshop notes. At least 5 channels for BW 160MHz should be tested.																

9.2 Simultaneous Transmission

Simultaneous Transmission Configurations	
1	WLAN 5GHz + BT
2	WLAN 6GHz + BT

9.2.1 Simultaneous transmission of test exclusion considerations

WLAN 5GHz + BT					
Mode	WLAN SAR (W/kg)	BT SAR (W/kg)	Simultaneous Transmission (W/kg)	Antenna pair in mm	Peak location separation ratio
Edge(Front)	1.084	0.211	1.295	N/A	N/A

WLAN 6GHz + BT					
Mode	WLAN SAR (W/kg)	BT SAR (W/kg)	Simultaneous Transmission (W/kg)	Antenna pair in mm	Peak location separation ratio
Edge(Front)	0.544	0.211	0.755	N/A	N/A

Note: The sum of value is less than 1.6W/Kg or the ratio is determined by $(SAR1 + SAR2)^{1.5}/Ri$, rounded to two decimal digits, and must be ≤ 0.04 for all antenna pairs in the configuration to qualify for SAR test exclusion.

10. SAR measurement variability

1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.
2) When the original highest measured SAR is ≥ 0.80 W/kg, repeat that measurement once.
3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

Frequency		**SAR** 1g (W/kg)						
Channel	MHz	Original	First Repeated		Second Repeated		Third Repeated	
			Value	Ratio	Value	Ratio	Value	Ratio
42	5210	1.040	0.953	1.091	N/A	N/A	N/A	N/A

Appendix

Appendix A. System Check Data

Appendix B. Measurement Data

Appendix C. Test Setup Photographs

Appendix D. Probe Calibration Data

Appendix E. Dipole & Source Calibration Data

Appendix F. Product Photos-Please refer to the file: 22B0941R-Product Photos

Appendix A. SAR System Check Data

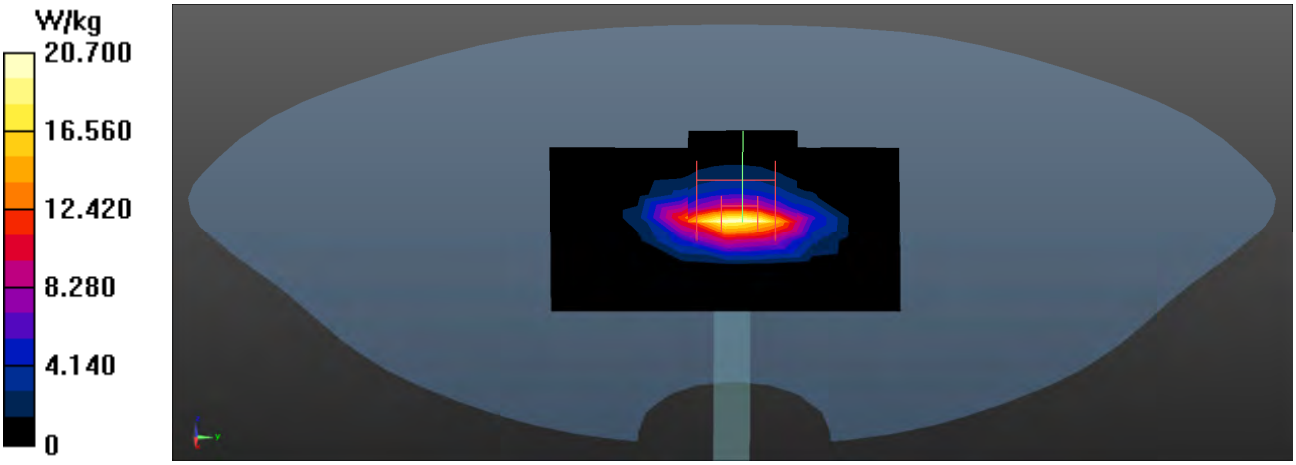
Test Laboratory: DEKRA Date: 2022/11/16

System Performance Check_2450MHz-Head
DUT: Dipole 2450 MHz; Type: D2450V2
Communication System: UID 10000, CW; Frequency: 2450 MHz;
Communication System PAR: 0 dB
Medium parameters used: f = 2450 MHz; σ = 1.82 S/m; ε_r = 39.28; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient Temperature (°C) : 22.5, Liquid Temperature (°C) : 21.2
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY5 Configuration:

- Probe: EX3DV4 - SN3698; ConvF(7.19, 7.19, 7.19); Calibrated: 2021/11/24;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1207; Calibrated: 2021/11/22
- Phantom: SAM with left table; Type: SAM;
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Configuration/2450MHz_Head/Area Scan (8x9x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (measured) = 20.7 W/kg

Configuration/2450MHz_Head/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 110.2 V/m; Power Drift = 0.17 dB
Peak SAR (extrapolated) = 25.1 W/kg
SAR(1 g) = 12.7 W/kg; SAR(10 g) = 5.77 W/kg
Maximum value of SAR (measured) = 22.0 W/kg



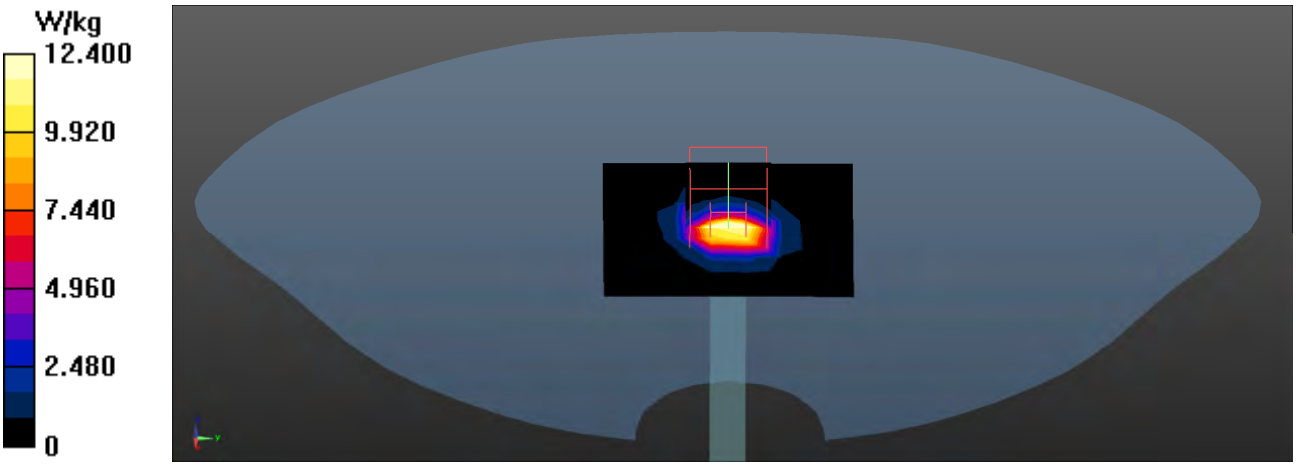
Test Laboratory: DEKRA Date: 2022/11/15

System Performance Check_5250MHz-Head
DUT: Dipole 5GHz; Type: D5GHzV2
Communication System: UID 0, CW; Frequency: 5250 MHz;
Communication System PAR: 0 dB
Medium parameters used: f = 5250 MHz; σ = 4.66 S/m; ε_r = 36.22; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient Temperature (°C) : 22.9, Liquid Temperature (°C) : 21.7
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY5 Configuration:

- Probe: EX3DV4 - SN3698; ConvF(4.7, 4.7, 4.7); Calibrated: 2021/11/24;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1207; Calibrated: 2021/11/22
- Phantom: SAM with right table; Type: SAM;
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Configuration/5250MHz_Head/Area Scan (8x8x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 12.4 W/kg

Configuration/5250MHz_Head/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 72.20 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 25.4 W/kg
SAR(1 g) = 8.01 W/kg; SAR(10 g) = 2.23 W/kg
Maximum value of SAR (measured) = 20.3 W/kg



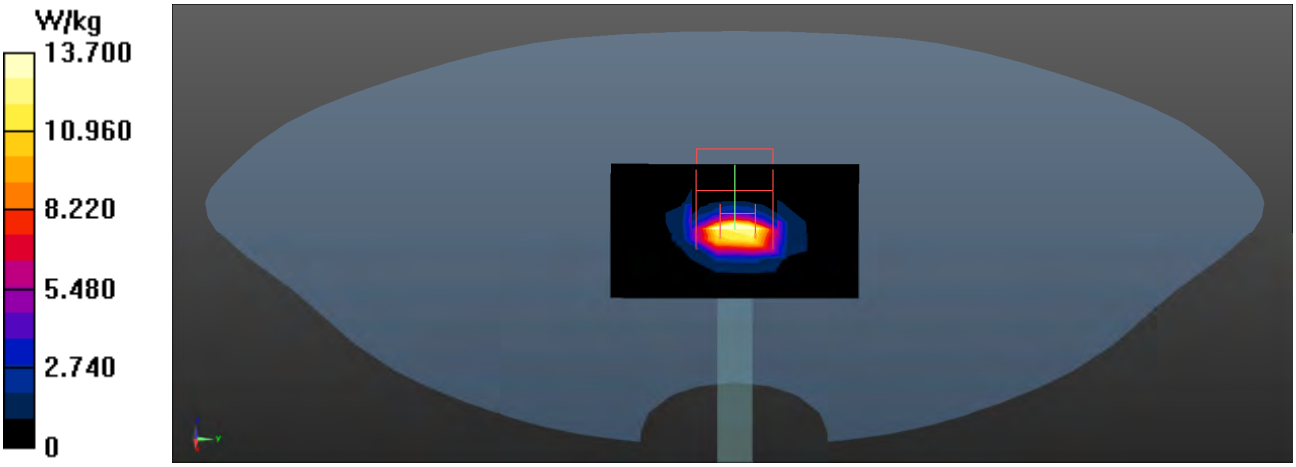
Test Laboratory: DEKRA Date: 2022/11/15

System Performance Check_5600MHz-Head
DUT: Dipole 5GHz; Type: D5GHzV2
Communication System: UID 0, CW; Frequency: 5600 MHz;
Communication System PAR: 0 dB
Medium parameters used: f = 5600 MHz; σ = 5.13 S/m; ε_r = 35.25; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient Temperature (°C) : 22.9, Liquid Temperature (°C) : 21.7
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY5 Configuration:

- Probe: EX3DV4 - SN3698; ConvF(4.35, 4.35, 4.35); Calibrated: 2021/11/24;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1207; Calibrated: 2021/11/22
- Phantom: SAM with right table; Type: SAM;
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Configuration/5600MHz_Head/Area Scan (8x8x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 13.7 W/kg

Configuration/5600MHz_Head/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 72.18 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 33.2 W/kg
SAR(1 g) = 8.62 W/kg; SAR(10 g) = 2.45 W/kg
Maximum value of SAR (measured) = 22.6 W/kg



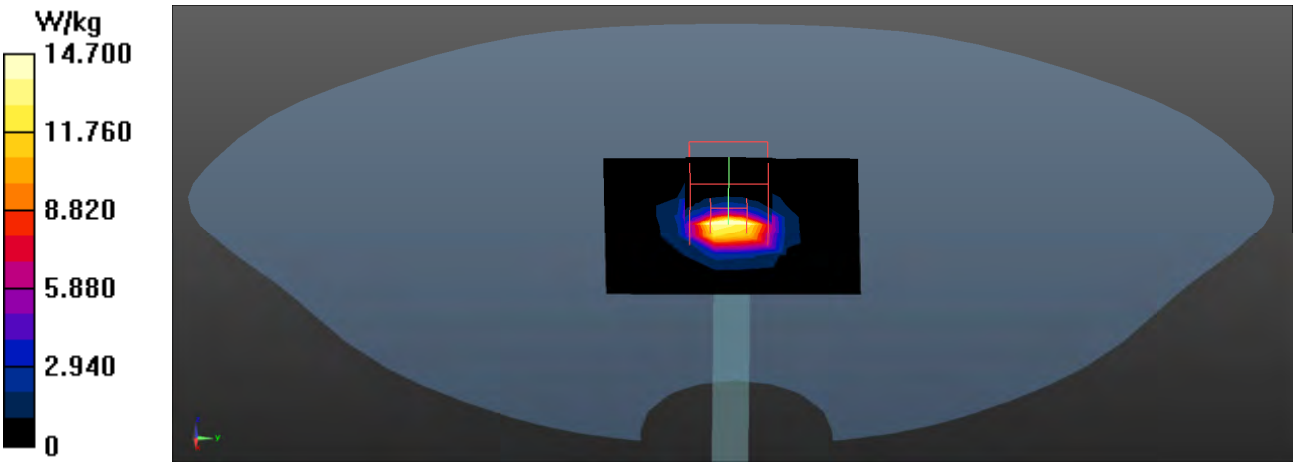
Test Laboratory: DEKRA Date: 2022/11/15

System Performance Check_5800MHz-Head
DUT: Dipole 5GHz; Type: D5GHzV2
Communication System: UID 0, CW; Frequency: 5800 MHz;
Communication System PAR: 0 dB
Medium parameters used: f = 5800 MHz; σ = 5.39 S/m; ε_r = 34.7; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient Temperature (°C) : 22.9, Liquid Temperature (°C) : 21.7
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY5 Configuration:

- Probe: EX3DV4 - SN3698; ConvF(4.58, 4.58, 4.58); Calibrated: 2021/11/24;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1207; Calibrated: 2021/11/22
- Phantom: SAM with right table; Type: SAM;
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Configuration/5800MHz_Head/Area Scan (8x8x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 14.7 W/kg

Configuration/5800MHz_Head/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 70.95 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 34.8 W/kg
SAR(1 g) = 8.39 W/kg; SAR(10 g) = 2.35 W/kg
Maximum value of SAR (measured) = 22.9 W/kg



Test Laboratory: DEKRA Date: 2022-12-27

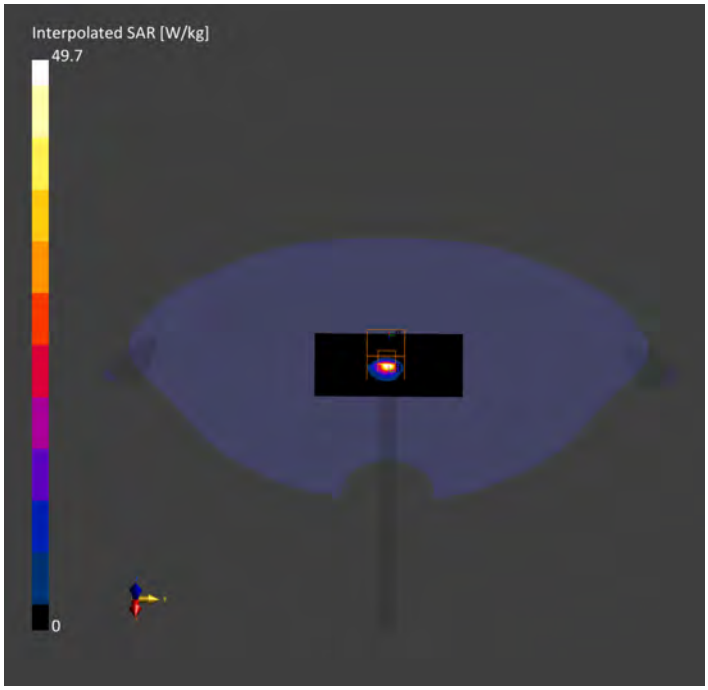
System Performance Check_6500MHz-Head

Communication System: UID 0--, ; Frequency: 6500.0 MHz
Medium parameters used: f = 6500.0 MHz; Conductivity = 6.16 S/m; Permittivity = 34.72
Phantom section: Flat
Ambient Temperature (°C) : 22.7, Liquid Temperature (°C) : 21.9
DASY6 Configuration:

- Probe: EX3DV4 - SN7631; ConvF(5.6, 5.6, 5.6); Calibrated: 2022-01-24
- Sensor-Surface: 1.4 mm
- Electronics: DAE4 Sn1651; Calibrated: 2022-02-24
- Phantom: Twin-SAM V8.0 (30deg probe tilt)
- Measurement SW: cDASY6 V16.2.0.1425

Area Scan (51.0 mm x 85.0 mm): Measurement grid: 8.5 mm x 8.5 mm
SAR(1 g) = 25.7 W/kg; SAR(10 g) = 5.09 W/kg

Zoom Scan (22.0 mm x 22.0 mm x 22.0 mm): Measurement grid: 3.4 mm x 3.4 mm x 1.4 mm
Power Drift = -0.01 dB
SAR(1 g) = 29.8 W/kg; SAR(10 g) = 5.64 W/kg
psAPD (4.0cm2, sq) = 137 W/m2



System Performance Check_10GHz
Device under Test Properties

Model, Manufacturer	Dimensions [mm]
5G Verification Source 10 GHz	100.0 x 100.0 x 100.0

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz], Channel Number	Conversion Factor
5G Air	FRONT, 10.00	Validation band	CW,	10000.0, 10000	1.0

Hardware Setup

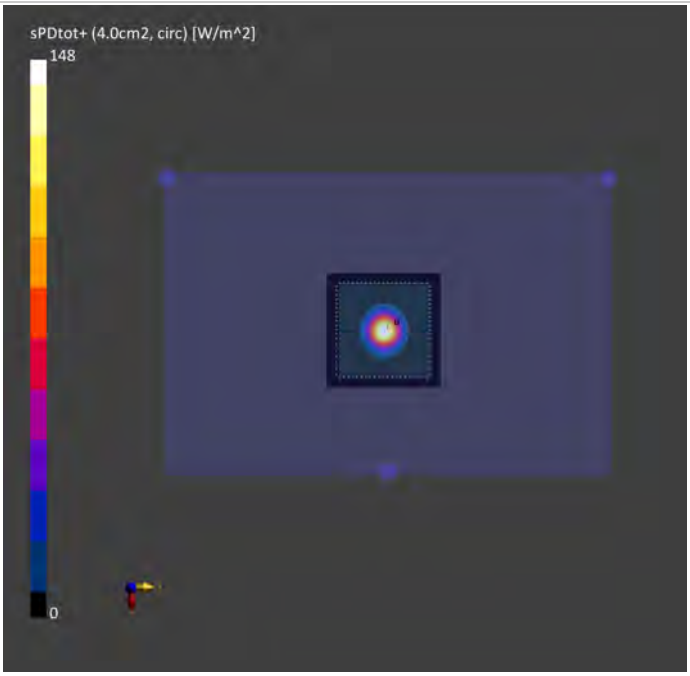
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave- 1068	Air---	EUmmWV4 - SN9546_F1-55GHz, 2022-04-27	DAE4 Sn1651, 2022-02-24

Scan Setup

	5G Scan
Grid Extents [mm]	120.0 x 120.0
Grid Steps [lambda]	0.25 x 0.25
Sensor Surface [mm]	10.0
MAIA	N/A

Measurement Results

	5G Scan
Date	2022-12-28
Avg. Area [cm^2]	4.00
psPDn+ [W/m^2]	147
psPDtot+ [W/m^2]	148
psPDmod+ [W/m^2]	153
E_{max} [V/m]	292
Power Drift [dB]	-0.02



Appendix B. Measurement Data

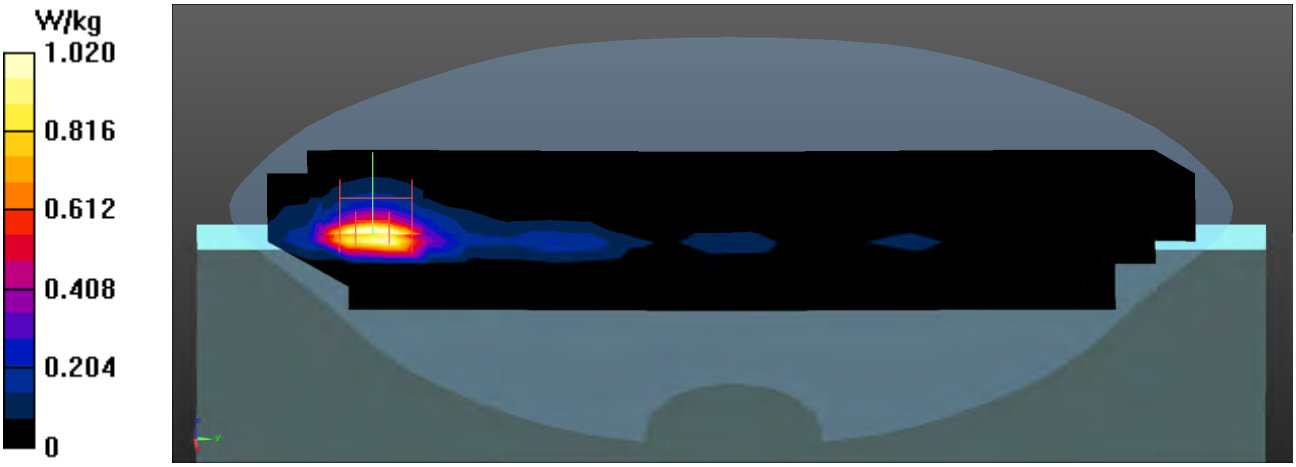
Test Laboratory: DEKRA Date: 2022/11/16

802.11b_6 Edge(Front) Main-INPAQ
DUT: VivoBook/ASUS Laptop; Type: M1405Y
Communication System: UID 0, WLAN 2.4G; Frequency: 2437 MHz;
Communication System PAR: 0 dB
Medium parameters used: f = 2437 MHz; σ = 1.79 S/m; ε_r = 39.33; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient Temperature (°C) : 22.5, Liquid Temperature (°C) : 21.2
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY5 Configuration:

- Probe: EX3DV4 - SN3698; ConvF(7.19, 7.19, 7.19); Calibrated: 2021/11/24;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1207; Calibrated: 2021/11/22
- Phantom: SAM with left table; Type: SAM;
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Configuration/Flat/Area Scan (8x26x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (measured) = 1.02 W/kg

Configuration/Flat/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 7.419 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 1.80 W/kg
SAR(1 g) = 0.733 W/kg; SAR(10 g) = 0.293 W/kg
Maximum value of SAR (measured) = 1.39 W/kg



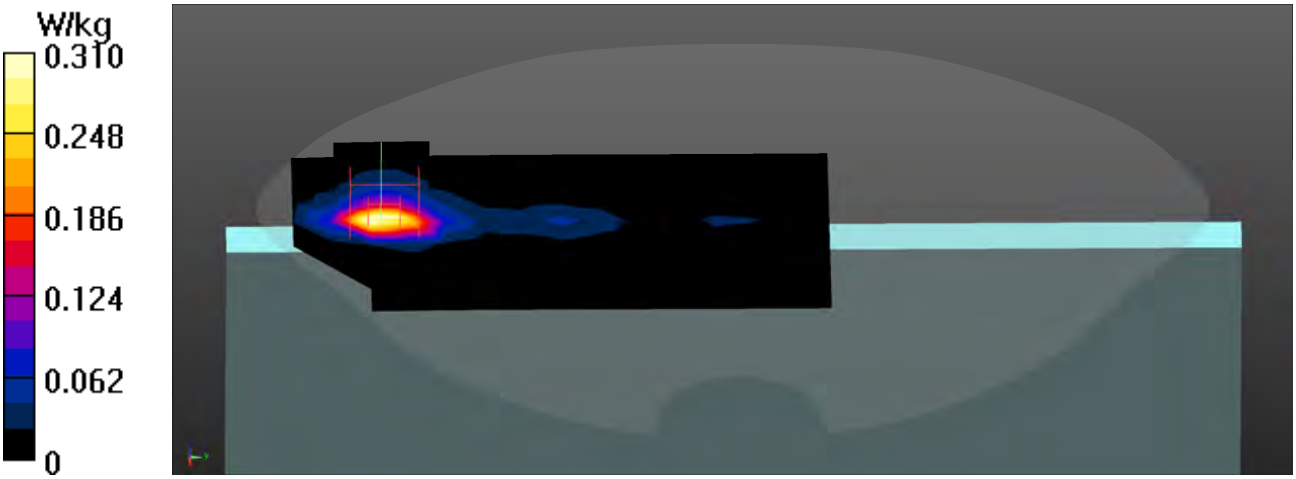
Test Laboratory: DEKRA Date: 2022/11/16

BT-1M_39 Edge(Front) Main-INPAQ
DUT: VivoBook/ASUS Laptop; Type: M1405Y
Communication System: UID 0, BT 1M&3M&BLE; Frequency: 2441 MHz;
Communication System PAR: 0 dB
Medium parameters used: f = 2441 MHz; σ = 1.8 S/m; ε_r = 39.32; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient Temperature (°C) : 22.5, Liquid Temperature (°C) : 21.2
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY5 Configuration:

- Probe: EX3DV4 - SN3698; ConvF(7.19, 7.19, 7.19); Calibrated: 2021/11/24;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1207; Calibrated: 2021/11/22
- Phantom: SAM with left table; Type: SAM;
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

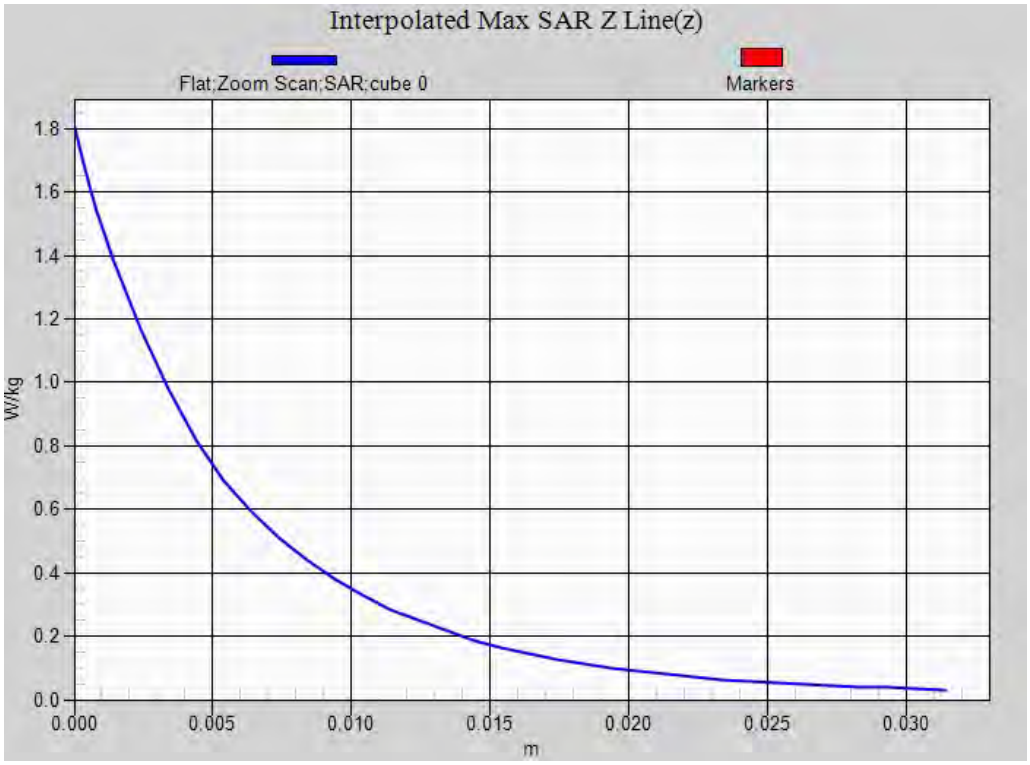
Configuration/Flat/Area Scan (8x16x1): Measurement grid: dx=12mm, dy=12mm
Maximum value of SAR (measured) = 0.310 W/kg

Configuration/Flat/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 14.49 V/m; Power Drift = -0.02 dB
Peak SAR (extrapolated) = 0.446 W/kg
SAR(1 g) = 0.190 W/kg; SAR(10 g) = 0.076 W/kg
Maximum value of SAR (measured) = 0.352 W/kg



802.11b EUT Edge(Front) (Main-INPAQ Antenna), Z-Axis plot

Channel: 6



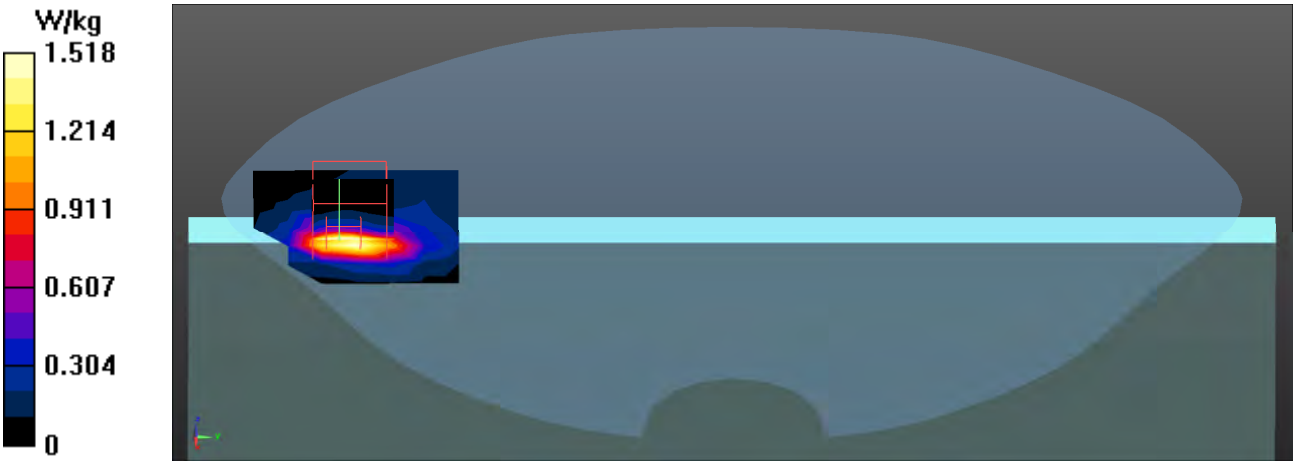
Test Laboratory: DEKRA Date: 2022/11/15

802.11ac80M_122-Edge(Front) Main-INPAQ
DUT: VivoBook/ASUS Laptop; Type: M1405Y
Communication System: UID 0, WLAN 5G; Frequency: 5610 MHz;
Communication System PAR: 0 dB
Medium parameters used: f = 5610 MHz; σ = 5.14 S/m; ε_r = 35.22; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient Temperature (°C) : 22.9, Liquid Temperature (°C) : 21.7
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY5 Configuration:

- Probe: EX3DV4 - SN3698; ConvF(4.35, 4.35, 4.35); Calibrated: 2021/11/24;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1207; Calibrated: 2021/11/22
- Phantom: SAM with right table; Type: SAM;
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Configuration/Flat/Area Scan (7x8x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 1.52 W/kg

Configuration/Flat/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 3.855 V/m; Power Drift = 0.06 dB
Peak SAR (extrapolated) = 3.53 W/kg
SAR(1 g) = 0.786 W/kg; SAR(10 g) = 0.274 W/kg
Maximum value of SAR (measured) = 1.98 W/kg



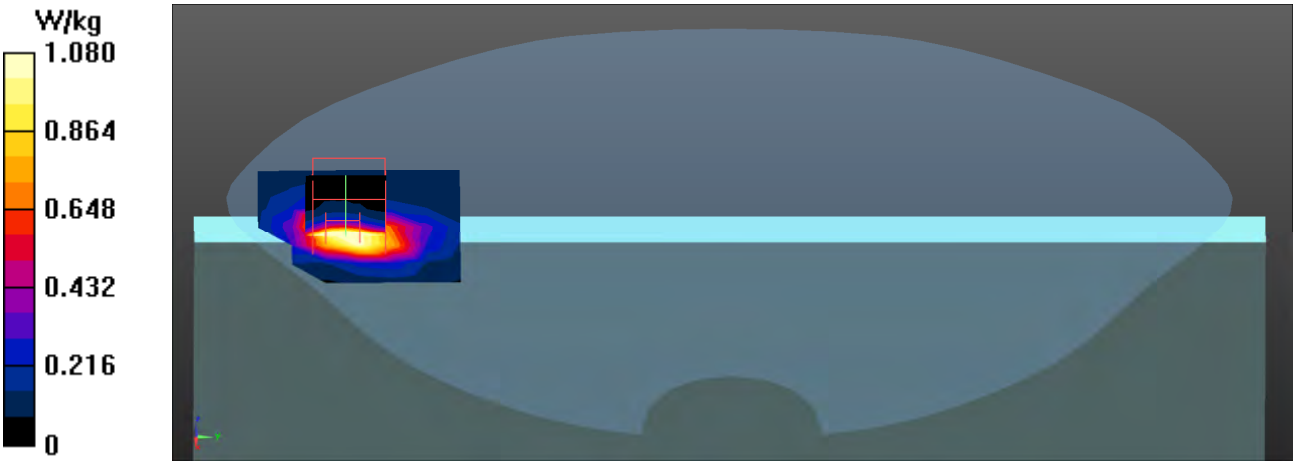
Test Laboratory: DEKRA Date: 2022/11/15

802.11ac80M_155-Edge(Front) Main-INPAQ
DUT: VivoBook/ASUS Laptop; Type: M1405Y
Communication System: UID 0, WLAN 5G; Frequency: 5775 MHz;
Communication System PAR: 0 dB
Medium parameters used: f = 5775 MHz; σ = 5.36 S/m; ε_r = 34.77; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient Temperature (°C) : 22.9, Liquid Temperature (°C) : 21.7
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY5 Configuration:

- Probe: EX3DV4 - SN3698; ConvF(4.58, 4.58, 4.58); Calibrated: 2021/11/24;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1207; Calibrated: 2021/11/22
- Phantom: SAM with right table; Type: SAM;
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Configuration/Flat/Area Scan (7x8x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 1.08 W/kg

Configuration/Flat/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 3.755 V/m; Power Drift = -0.06 dB
Peak SAR (extrapolated) = 3.36 W/kg
SAR(1 g) = 0.712 W/kg; SAR(10 g) = 0.245 W/kg
Maximum value of SAR (measured) = 1.83 W/kg



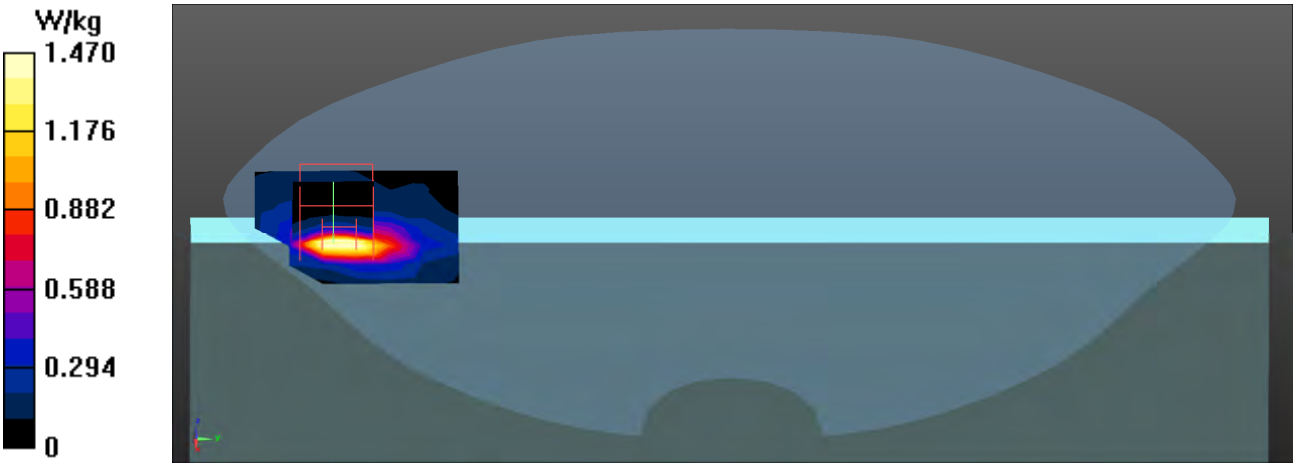
Test Laboratory: DEKRA Date: 2022/11/15

802.11ac80M_171-Edge(Front) Main-INPAQ
DUT: VivoBook/ASUS Laptop; Type: M1405Y
Communication System: UID 0, WLAN 5G; Frequency: 5855 MHz;
Communication System PAR: 0 dB
Medium parameters used: f = 5855 MHz; σ = 5.46 S/m; ε_r = 34.55; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient Temperature (°C) : 22.9, Liquid Temperature (°C) : 21.7
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY5 Configuration:

- Probe: EX3DV4 - SN3698; ConvF(4.58, 4.58, 4.58); Calibrated: 2021/11/24;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1207; Calibrated: 2021/11/22
- Phantom: SAM with right table; Type: SAM;
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Configuration/Flat/Area Scan (7x8x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 1.47 W/kg

Configuration/Flat/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 3.493 V/m; Power Drift = -0.17 dB
Peak SAR (extrapolated) = 3.56 W/kg
SAR(1 g) = 0.743 W/kg; SAR(10 g) = 0.251 W/kg
Maximum value of SAR (measured) = 1.92 W/kg



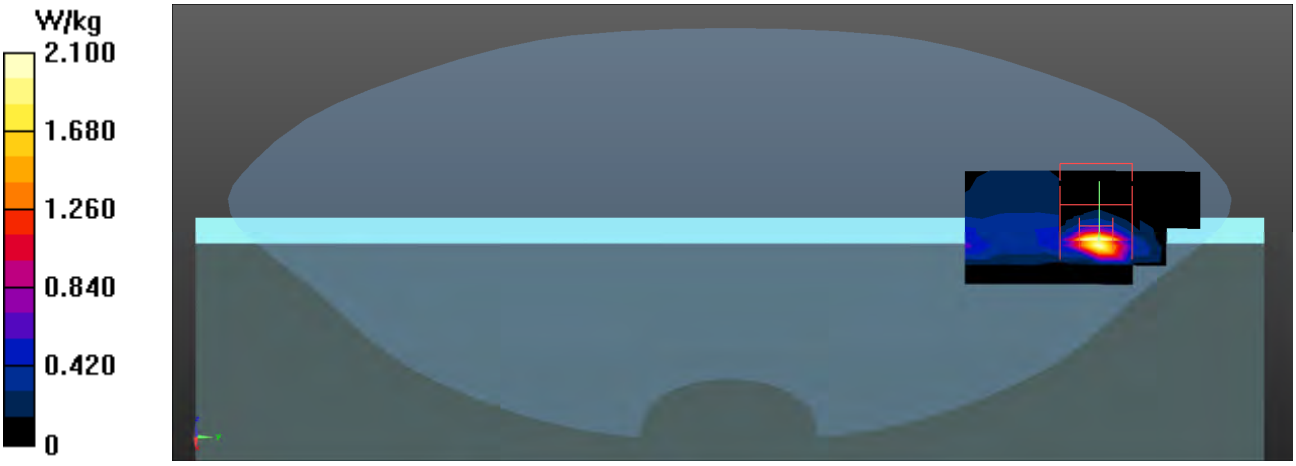
Test Laboratory: DEKRA Date: 2022/11/15

802.11ac80M_42-Edge(Front) Aux-INPAQ
DUT: VivoBook/ASUS Laptop; Type: M1405Y
Communication System: UID 0, WLAN 5G; Frequency: 5210 MHz;
Communication System PAR: 0 dB
Medium parameters used: f = 5210 MHz; σ = 4.6 S/m; ε_r = 36.33; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient Temperature (°C) : 22.9, Liquid Temperature (°C) : 21.7
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY5 Configuration:

- Probe: EX3DV4 - SN3698; ConvF(4.7, 4.7, 4.7); Calibrated: 2021/11/24;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1207; Calibrated: 2021/11/22
- Phantom: SAM with right table; Type: SAM;
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

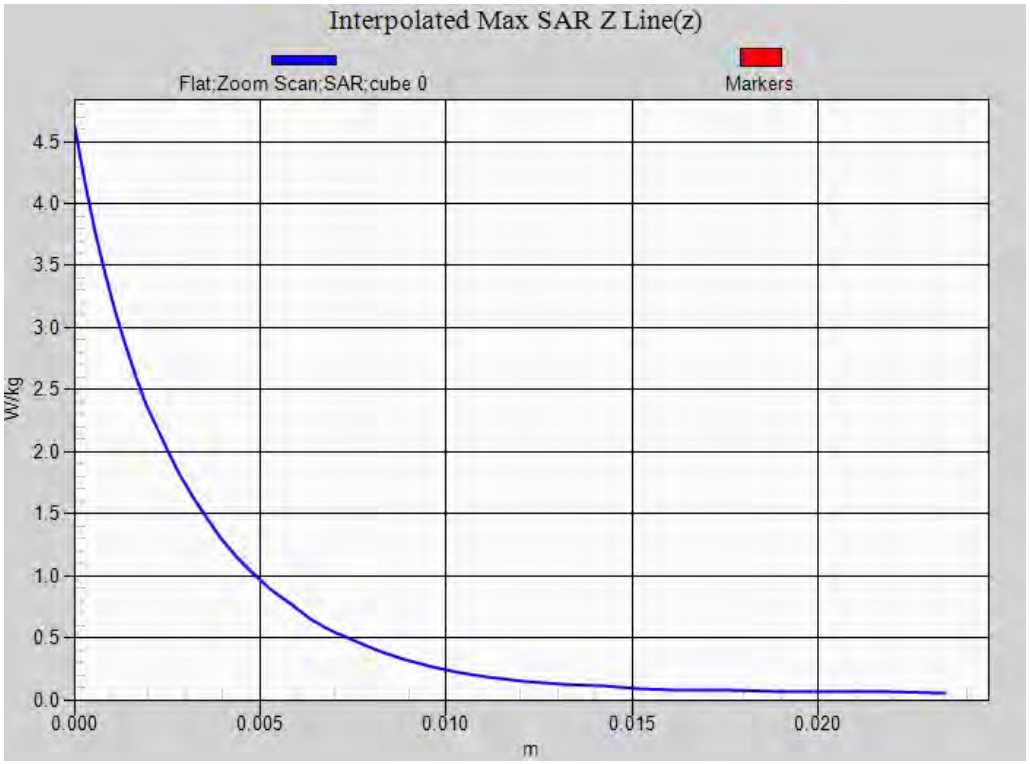
Configuration/Flat/Area Scan (7x8x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 2.10 W/kg

Configuration/Flat/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 5.327 V/m; Power Drift = -0.13 dB
Peak SAR (extrapolated) = 4.61 W/kg
SAR(1 g) = 1.04 W/kg; SAR(10 g) = 0.282 W/kg
Maximum value of SAR (measured) = 2.78 W/kg



802.11ac80 EUT Edge(Front) (Aux-INPAQ Antenna), Z-Axis plot

Channel: 42



Test Laboratory: DEKRA Date: 2022-12-27

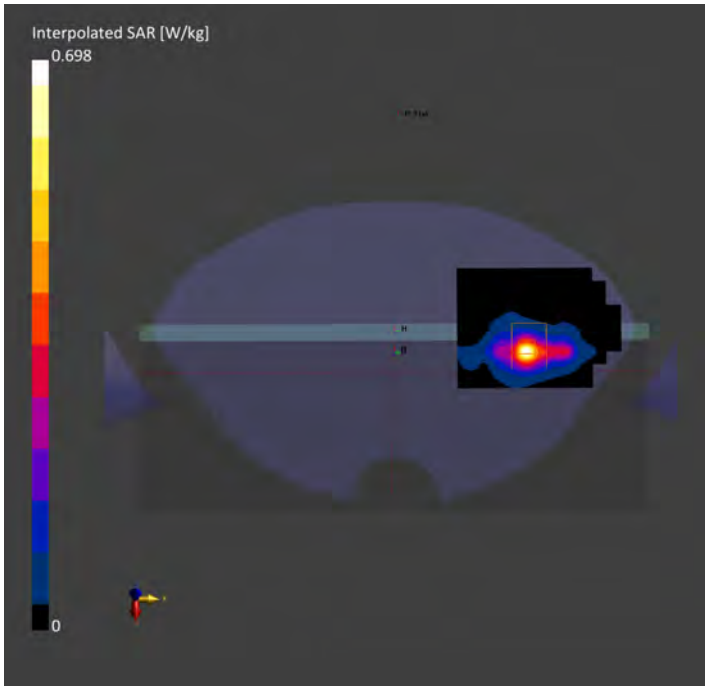
802.11ax160_HE0_175-Edge Aux-INPAQ

Communication System: UID 10755-AAC, WLAN; Frequency: 6825.0 MHz
Medium parameters used: f = 6825.0 MHz; Conductivity = 6.54 S/m; Permittivity = 34.47
Phantom section: Flat
Ambient Temperature (°C) : 22.7, Liquid Temperature (°C) : 21.9
DASY6 Configuration:

- Probe: EX3DV4 - SN7631; ConvF(5.6, 5.6, 5.6); Calibrated: 2022-01-24
- Sensor-Surface: 1.4 mm
- Electronics: DAE4 Sn1651; Calibrated: 2022-02-24
- Phantom: Twin-SAM V8.0 (30deg probe tilt)
- Measurement SW: cDASY6 V16.2.0.1425

Area Scan (85.0 mm x 102.0 mm): Measurement grid: 8.5 mm x 8.5 mm
SAR(1 g) = 0.483 W/kg; SAR(10 g) = 0.148 W/kg

Zoom Scan (22.0 mm x 22.0 mm x 22.0 mm): Measurement grid: 3.4 mm x 3.4 mm x 1.4 mm
Power Drift = -0.06 dB
SAR(1 g) = 0.530 W/kg; SAR(10 g) = 0.149 W/kg
psAPD (4.0cm2, sq) = 3.44 W/m2



802.11ax160_HE0_207-Edge Aux-INPAQ
Device under Test Properties

Model, Manufacturer	Dimensions [mm]
M1405Y	221.0 x 316.0 x 12.0

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz], Channel Number	Conversion Factor
5G Air	EDGE TOP, 2.00	U-NII-8	WLAN, 10755-AAC	6985.0, 207	1.0

Hardware Setup

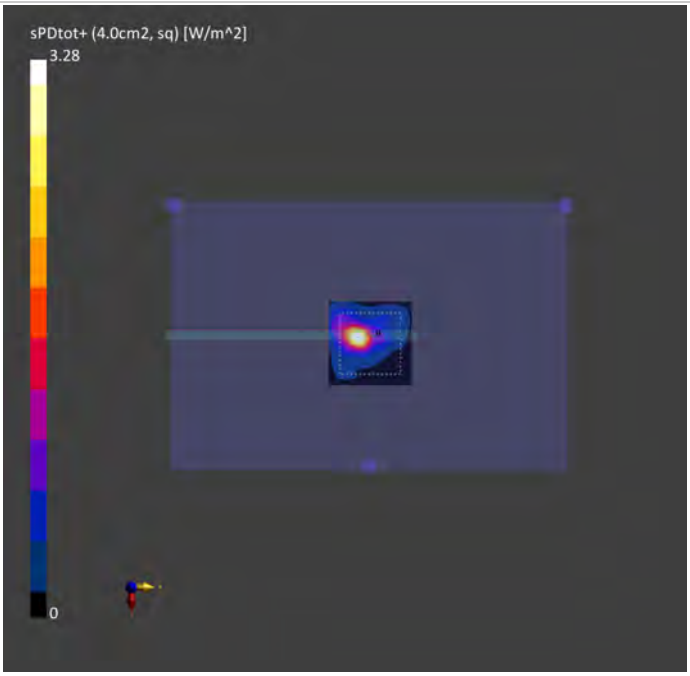
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave- 1068	Air	EUmmWV4 - SN9546_F1-55GHz, 2022-04-27	DAE4 Sn1651, 2022-02-24

Scan Setup

	5G Scan
Grid Extents [mm]	100.0 x 100.0
Grid Steps [lambda]	0.0625 x 0.0625
Sensor Surface [mm]	2.0
MAIA	N/A

Measurement Results

	5G Scan
Date	2022-12-28
Avg. Area [cm^2]	4.00
psPDn+ [W/m^2]	2.68
psPDtot+ [W/m^2]	3.28
psPDmod+ [W/m^2]	3.57
E_{max} [V/m]	49.9
Power Drift [dB]	0.06



SAR measurement variability

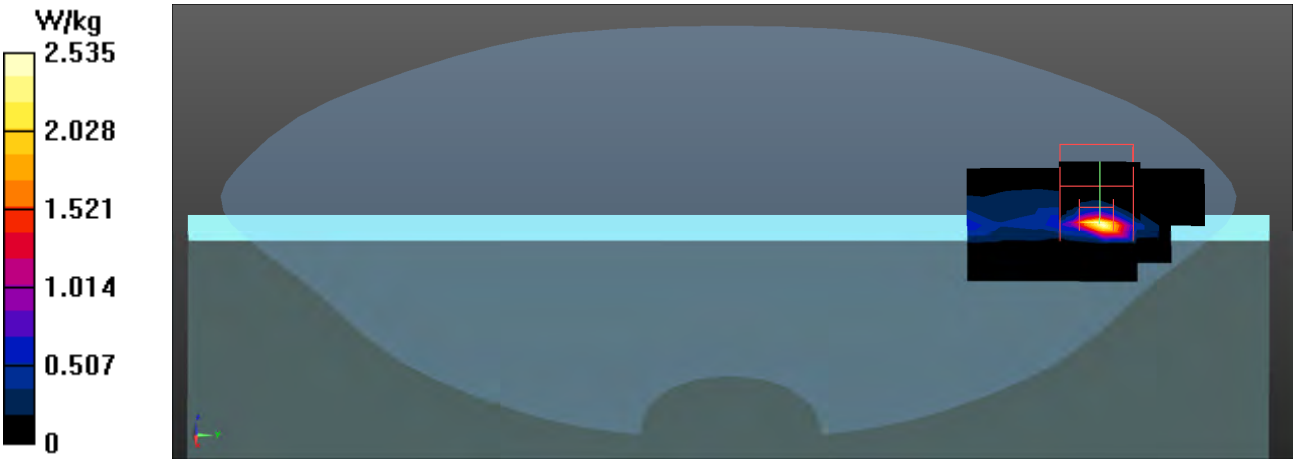
Test Laboratory: DEKRA Date: 2022/11/15

802.11ac80M_42-Edge(Front) Aux-INPAQ Verify
DUT: Notebook PC; Type: M1405Y
Communication System: UID 0, WLAN 5G; Frequency: 5210 MHz;
Communication System PAR: 0 dB
Medium parameters used: f = 5210 MHz; σ = 4.6 S/m; ε_r = 36.33; ρ = 1000 kg/m^3
Phantom section: Flat Section
Ambient Temperature (°C) : 22.9, Liquid Temperature (°C) : 21.7
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)
DASY5 Configuration:

- Probe: EX3DV4 - SN3698; ConvF(4.7, 4.7, 4.7); Calibrated: 2021/11/24;
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1207; Calibrated: 2021/11/22
- Phantom: SAM with right table; Type: SAM;
- Measurement SW: DASY52, Version 52.10 (0); SEMCAD X Version 14.6.10 (7417)

Configuration/Flat/Area Scan (7x8x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 2.54 W/kg

Configuration/Flat/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm
Reference Value = 6.166 V/m; Power Drift = 0.14 dB
Peak SAR (extrapolated) = 4.33 W/kg
SAR(1 g) = 0.953 W/kg; SAR(10 g) = 0.196 W/kg
Maximum value of SAR (measured) = 2.76 W/kg



Appendix D. Probe Calibration Data

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

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

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

Accreditation No.: SCS 0108

Client DEKRA (Auden)

Certificate No: EX3-3698_Nov21

CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:3698

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 24, 2021

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	09-Apr-21 (No. 217-03291/03292)	Apr-22
Power sensor NRP-Z91	SN: 103244	09-Apr-21 (No. 217-03291)	Apr-22
Power sensor NRP-Z91	SN: 103245	09-Apr-21 (No. 217-03292)	Apr-22
Reference 20 dB Attenuator	SN: CC2552 (20x)	09-Apr-21 (No. 217-03343)	Apr-22
DAE4	SN: 660	23-Dec-20 (No. DAE4-660_Dec20)	Dec-21
Reference Probe ES3DV2	SN: 3013	30-Dec-20 (No. ES3-3013_Dec20)	Dec-21
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-20)	In house check: Jun-22
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-22

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Niels Kuster	Quality Manager	

Issued: November 26, 2021

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 (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z*: *A, B, C, D* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ 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).

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3698

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.41	0.34	0.37	± 10.1 %
DCP (mV)[B]	105.0	101.0	105.0	

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Max dev.	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	147.1	±3.3 %	± 4.7 %
		Y	0.0	0.0	1.0		129.5		
		Z	0.0	0.0	1.0		141.3		

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

[A] The uncertainties of Norm X,Y,Z do not affect the E^2-field uncertainty inside TSL (see Page 5).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3698

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-137
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:3698

Calibration Parameter Determined in Head Tissue Simulating Media

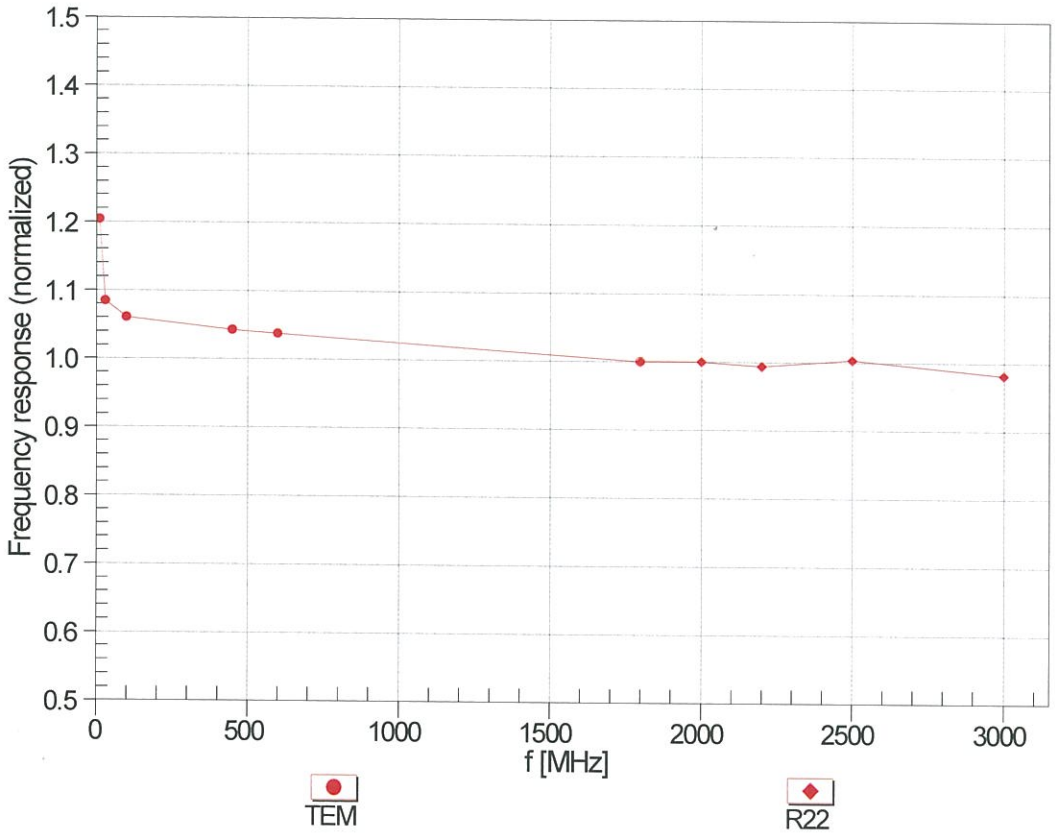
f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
450	43.5	0.87	9.73	9.73	9.73	0.16	1.30	± 13.3 %
750	41.9	0.89	9.10	9.10	9.10	0.46	0.80	± 12.0 %
835	41.5	0.90	8.90	8.90	8.90	0.38	0.96	± 12.0 %
900	41.5	0.97	8.81	8.81	8.81	0.47	0.80	± 12.0 %
1450	40.5	1.20	8.18	8.18	8.18	0.58	0.80	± 12.0 %
1640	40.2	1.31	8.08	8.08	8.08	0.30	0.86	± 12.0 %
1750	40.1	1.37	7.96	7.96	7.96	0.28	0.86	± 12.0 %
1950	40.0	1.40	7.60	7.60	7.60	0.39	0.86	± 12.0 %
2300	39.5	1.67	7.39	7.39	7.39	0.33	0.90	± 12.0 %
2450	39.2	1.80	7.19	7.19	7.19	0.27	0.90	± 12.0 %
2600	39.0	1.96	6.97	6.97	6.97	0.36	0.90	± 12.0 %
3300	38.2	2.71	6.65	6.65	6.65	0.30	1.35	± 13.1 %
3500	37.9	2.91	6.30	6.30	6.30	0.35	1.30	± 13.1 %
3700	37.7	3.12	6.15	6.15	6.15	0.35	1.30	± 13.1 %
5250	35.9	4.71	4.70	4.70	4.70	0.40	1.80	± 13.1 %
5600	35.5	5.07	4.35	4.35	4.35	0.40	1.80	± 13.1 %
5800	35.3	5.27	4.58	4.58	4.58	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.

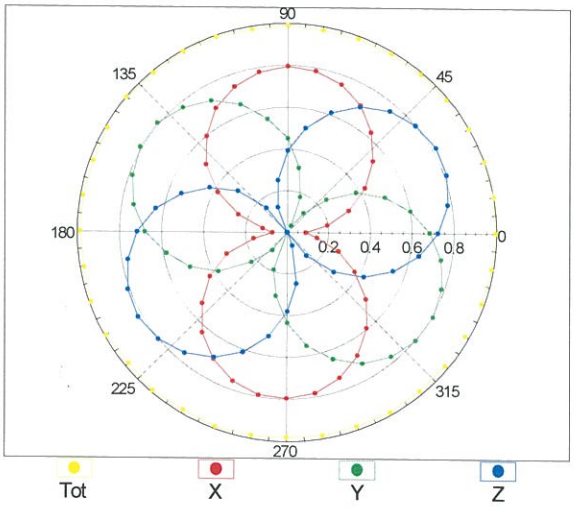
Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)



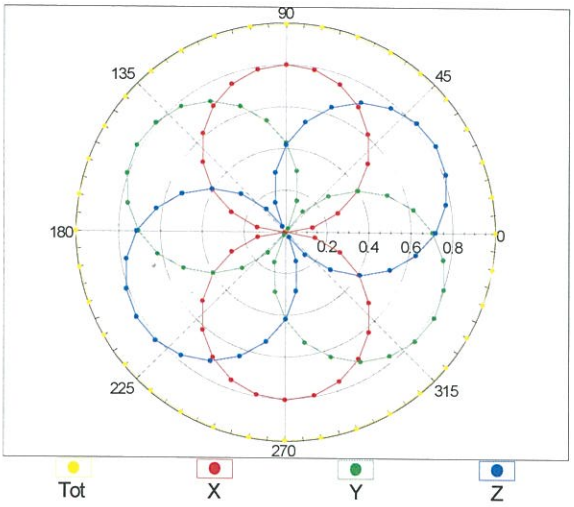
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

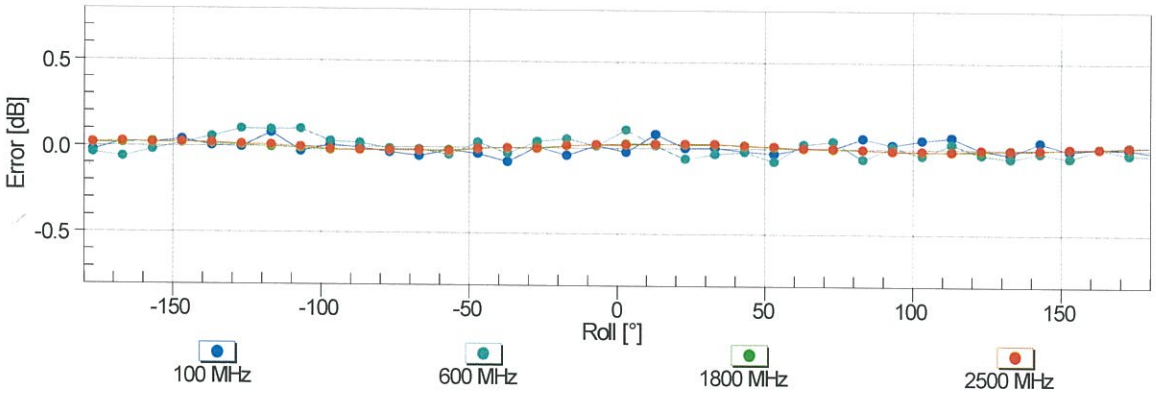
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



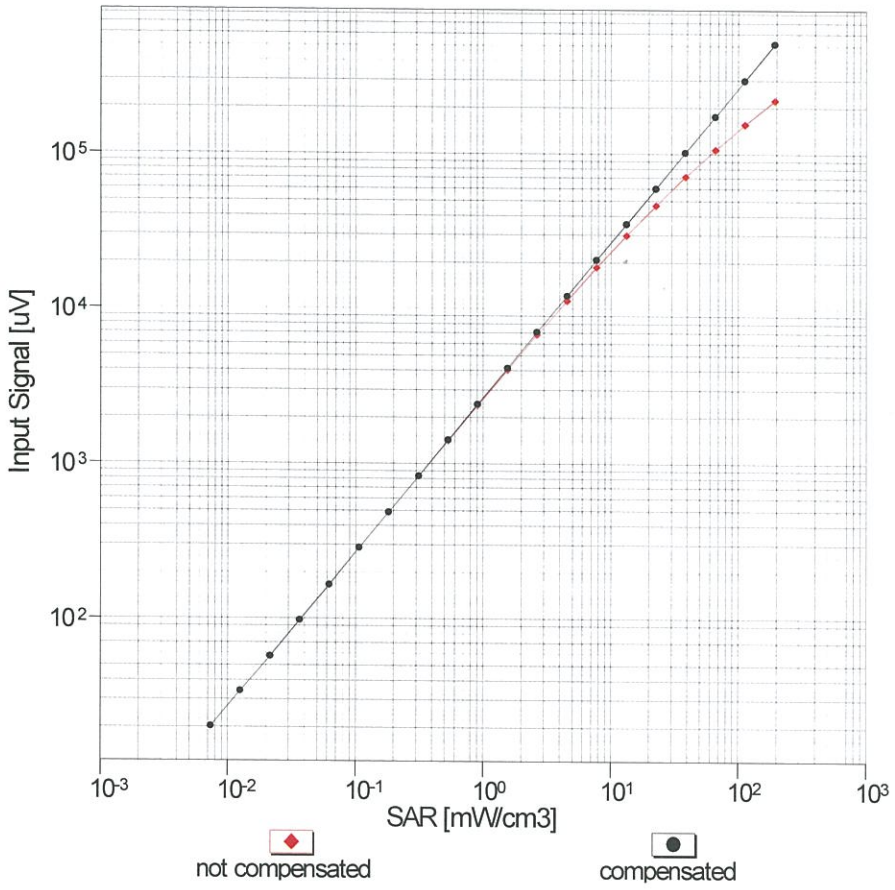
f=1800 MHz,R22

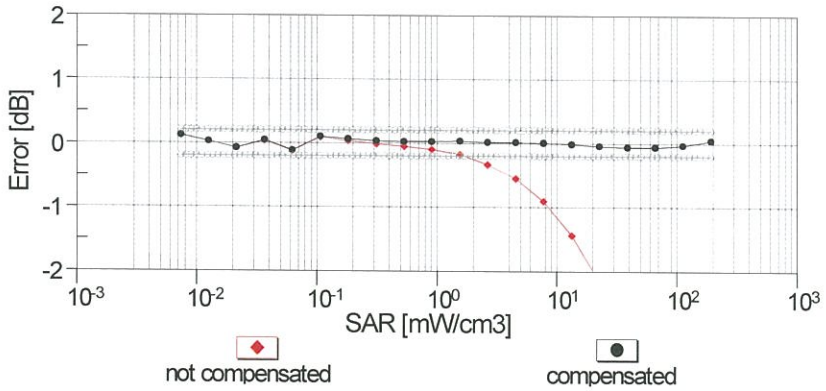




Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

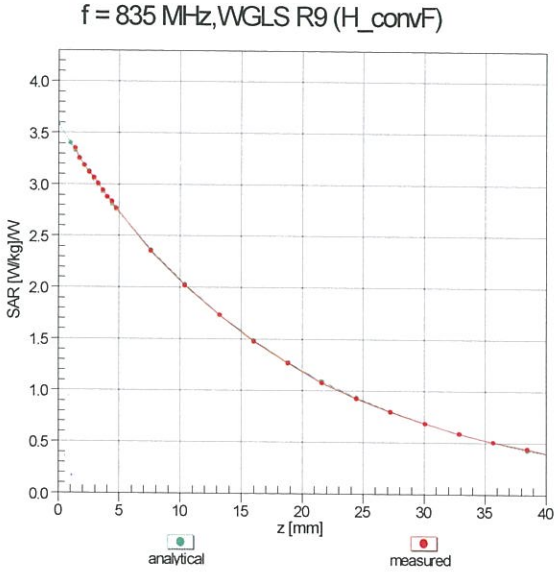
Dynamic Range f(SAR$_{head}$)
(TEM cell , f_{eval}= 1900 MHz)

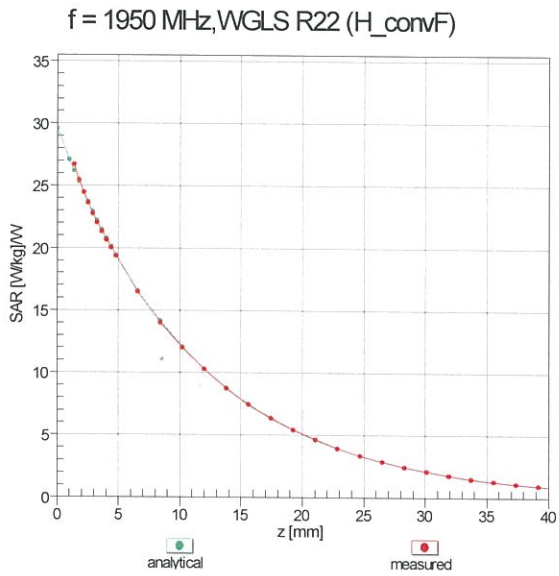




Uncertainty of Linearity Assessment: ± 0.6% (k=2)

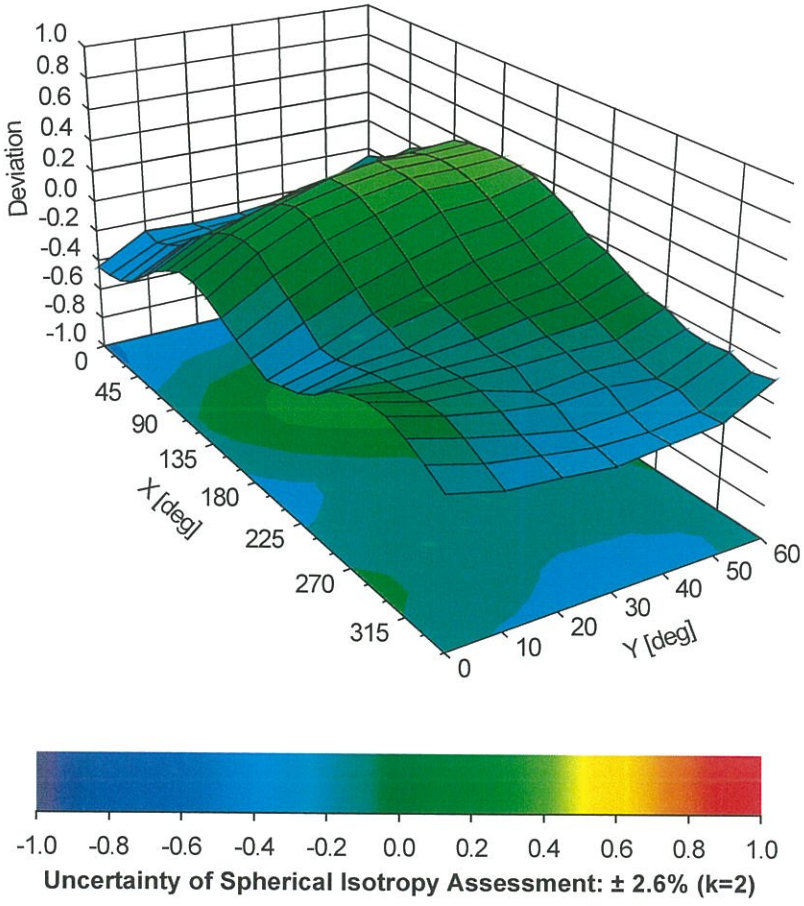
Conversion Factor Assessment





Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



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

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

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

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

Accreditation No.: SCS 0108

Client Dekra-TW (Auden)

Certificate No: EX3-7631_Jan22

CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:7631

Calibration procedure(s): QA CAL-01.v9, QA CAL-12.v9, QA CAL-14.v6, QA CAL-23.v5, QA CAL-25.v7
Calibration procedure for dosimetric E-field probes

Calibration date: January 24, 2022

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	09-Apr-21 (No. 217-03291/03292)	Apr-22
Power sensor NRP-Z91	SN: 103244	09-Apr-21 (No. 217-03291)	Apr-22
Power sensor NRP-Z91	SN: 103245	09-Apr-21 (No. 217-03292)	Apr-22
Reference 20 dB Attenuator	SN: CC2552 (20x)	09-Apr-21 (No. 217-03343)	Apr-22
DAE4	SN: 660	13-Oct-21 (No. DAE4-660_Oct21)	Oct-22
Reference Probe ES3DV2	SN: 3013	27-Dec-21 (No. ES3-3013_Dec21)	Dec-22
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-20)	In house check: Jun-22
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-20)	In house check: Jun-22
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-22

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

Issued: January 28, 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 (no uncertainty required). DCP does not depend on frequency nor media.
- *PAR:* PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z*: *A, B, C, D* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. *VR* is the maximum calibration range expressed in RMS voltage across the diode.
- *ConvF and Boundary Effect Parameters:* Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ 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).

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7631

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	0.57	0.61	0.56	± 10.1 %
DCP (mV)[B]	109.2	108.6	109.8	

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Max dev.	Max Unc[E] (k=2)
0	CW	X	0.00	0.00	1.00	0.00	178.5	± 3.3 %	± 4.7 %
		Y	0.00	0.00	1.00		178.2		
		Z	0.00	0.00	1.00		160.0		
10352-AAA	Pulse Waveform (200Hz, 10%)	X	1.36	60.00	5.96	10.00	60.0	± 3.6 %	± 9.6 %
		Y	1.59	61.16	7.03		60.0		
		Z	1.59	60.77	6.20		60.0		
10353-AAA	Pulse Waveform (200Hz, 20%)	X	0.87	60.00	4.94	6.99	80.0	± 2.8 %	± 9.6 %
		Y	0.83	60.00	5.33		80.0		
		Z	0.85	60.00	4.73		80.0		
10354-AAA	Pulse Waveform (200Hz, 40%)	X	0.50	60.00	3.95	3.98	95.0	± 2.0 %	± 9.6 %
		Y	2.00	64.00	5.00		95.0		
		Z	0.48	60.00	3.52		95.0		
10355-AAA	Pulse Waveform (200Hz, 60%)	X	15.11	149.95	2.36	2.22	120.0	± 1.9 %	± 9.6 %
		Y	9.12	158.36	14.54		120.0		
		Z	9.49	84.30	0.54		120.0		
10387-AAA	QPSK Waveform, 1 MHz	X	0.66	63.80	11.78	1.00	150.0	± 4.9 %	± 9.6 %
		Y	0.58	62.14	10.35		150.0		
		Z	0.56	65.41	13.25		150.0		
10388-AAA	QPSK Waveform, 10 MHz	X	1.40	65.24	13.54	0.00	150.0	± 1.2 %	± 9.6 %
		Y	1.26	63.78	12.64		150.0		
		Z	1.38	67.17	14.43		150.0		
10396-AAA	64-QAM Waveform, 100 kHz	X	1.84	65.65	16.40	3.01	150.0	± 0.7 %	± 9.6 %
		Y	1.82	65.69	16.48		150.0		
		Z	1.86	66.50	16.93		150.0		
10399-AAA	64-QAM Waveform, 40 MHz	X	2.88	66.07	14.84	0.00	150.0	± 3.0 %	± 9.6 %
		Y	2.74	65.19	14.31		150.0		
		Z	2.83	66.81	15.31		150.0		
10414-AAA	WLAN CCDF, 64-QAM, 40MHz	X	3.94	65.73	15.09	0.00	150.0	± 5.3 %	± 9.6 %
		Y	4.02	65.83	15.11		150.0		
		Z	3.76	66.29	15.35		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 E^2-field uncertainty inside TSL (see Pages 5 and 6).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7631

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	11.9	85.26	32.65	6.52	0.00	4.90	0.62	0.00	1.00
Y	13.1	94.65	33.40	4.53	0.00	4.98	0.74	0.00	1.01
Z	9.1	64.06	32.20	4.70	0.00	4.90	0.66	0.00	1.00

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-151.6
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

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

DASY/EASY - Parameters of Probe: EX3DV4 - SN:7631

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
450	43.5	0.87	11.88	11.88	11.88	0.16	1.30	± 13.3 %
750	41.9	0.89	10.47	10.47	10.47	0.49	0.84	± 12.0 %
835	41.5	0.90	10.12	10.12	10.12	0.43	0.88	± 12.0 %
900	41.5	0.97	10.01	10.01	10.01	0.49	0.81	± 12.0 %
1450	40.5	1.20	9.15	9.15	9.15	0.55	0.80	± 12.0 %
1640	40.2	1.31	9.10	9.10	9.10	0.32	0.86	± 12.0 %
1750	40.1	1.37	8.76	8.76	8.76	0.27	0.86	± 12.0 %
1950	40.0	1.40	8.35	8.35	8.35	0.25	0.86	± 12.0 %
2000	40.0	1.40	8.28	8.28	8.28	0.25	0.86	± 12.0 %
2300	39.5	1.67	8.33	8.33	8.33	0.30	0.90	± 12.0 %
2450	39.2	1.80	8.24	8.24	8.24	0.32	0.90	± 12.0 %
2600	39.0	1.96	8.04	8.04	8.04	0.21	0.90	± 12.0 %
3300	38.2	2.71	7.50	7.50	7.50	0.30	1.35	± 13.1 %
3500	37.9	2.91	7.45	7.45	7.45	0.35	1.30	± 13.1 %
3700	37.7	3.12	7.20	7.20	7.20	0.35	1.30	± 13.1 %
3900	37.5	3.32	7.10	7.10	7.10	0.40	1.60	± 13.1 %
4100	37.2	3.53	6.98	6.98	6.98	0.40	1.60	± 13.1 %
4200	37.1	3.63	6.75	6.75	6.75	0.40	1.70	± 13.1 %
4400	36.9	3.84	6.68	6.68	6.68	0.40	1.70	± 13.1 %
4600	36.7	4.04	6.65	6.65	6.65	0.40	1.70	± 13.1 %
4800	36.4	4.25	6.46	6.46	6.46	0.40	1.80	± 13.1 %
4950	36.3	4.40	6.27	6.27	6.27	0.40	1.80	± 13.1 %
5250	35.9	4.71	5.94	5.94	5.94	0.40	1.80	± 13.1 %
5600	35.5	5.07	5.24	5.24	5.24	0.40	1.80	± 13.1 %
5800	35.3	5.27	5.40	5.40	5.40	0.40	1.80	± 13.1 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.

[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.

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

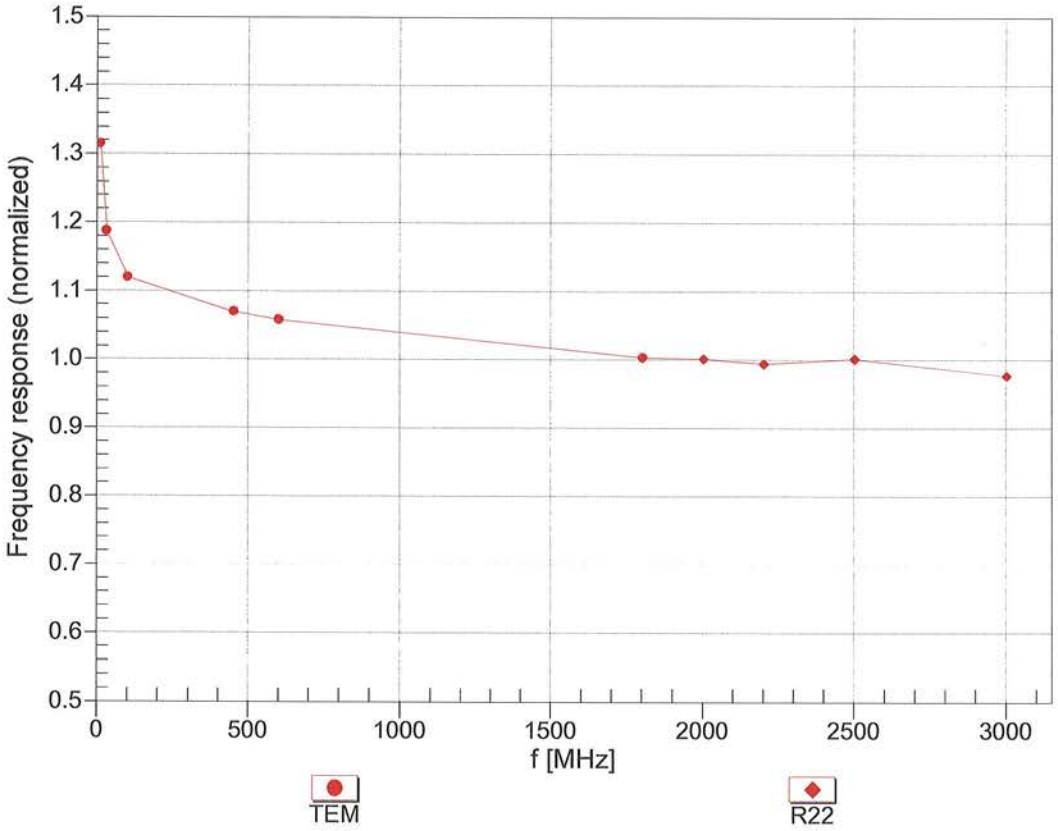
DASY/EASY - Parameters of Probe: EX3DV4 - SN:7631

Calibration Parameter Determined in Head Tissue Simulating Media

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

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

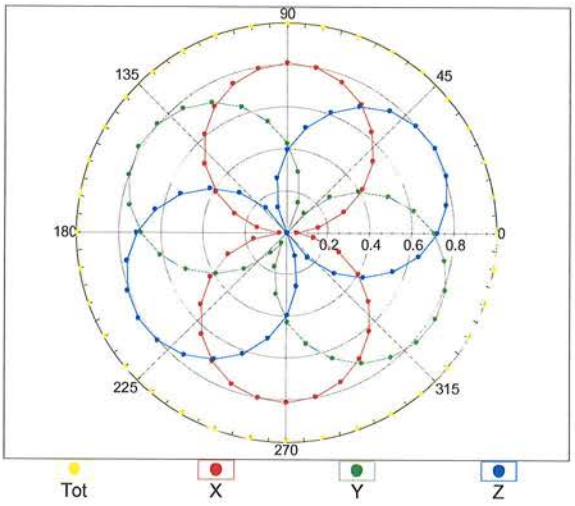
Frequency Response of E-Field
(TEM-Cell:ifi110 EXX, Waveguide: R22)



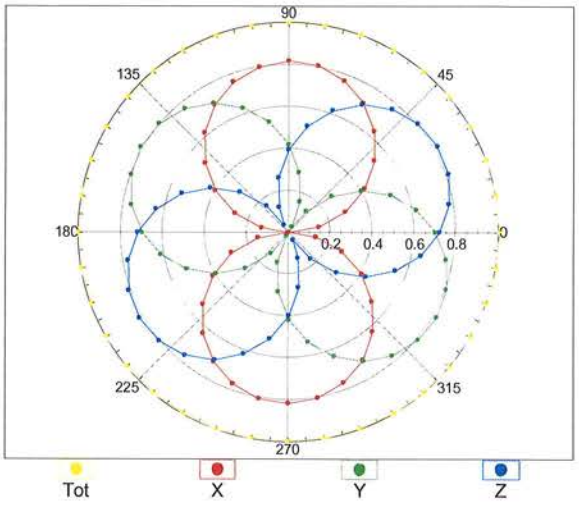
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

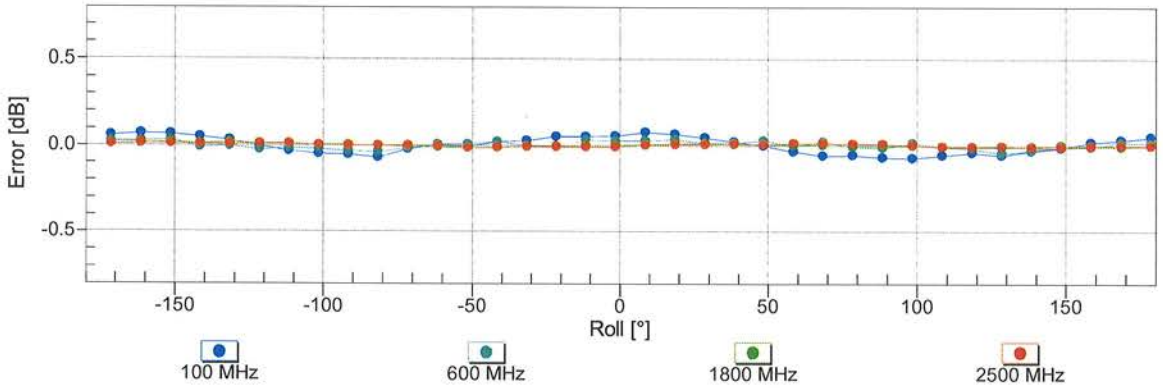
Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM



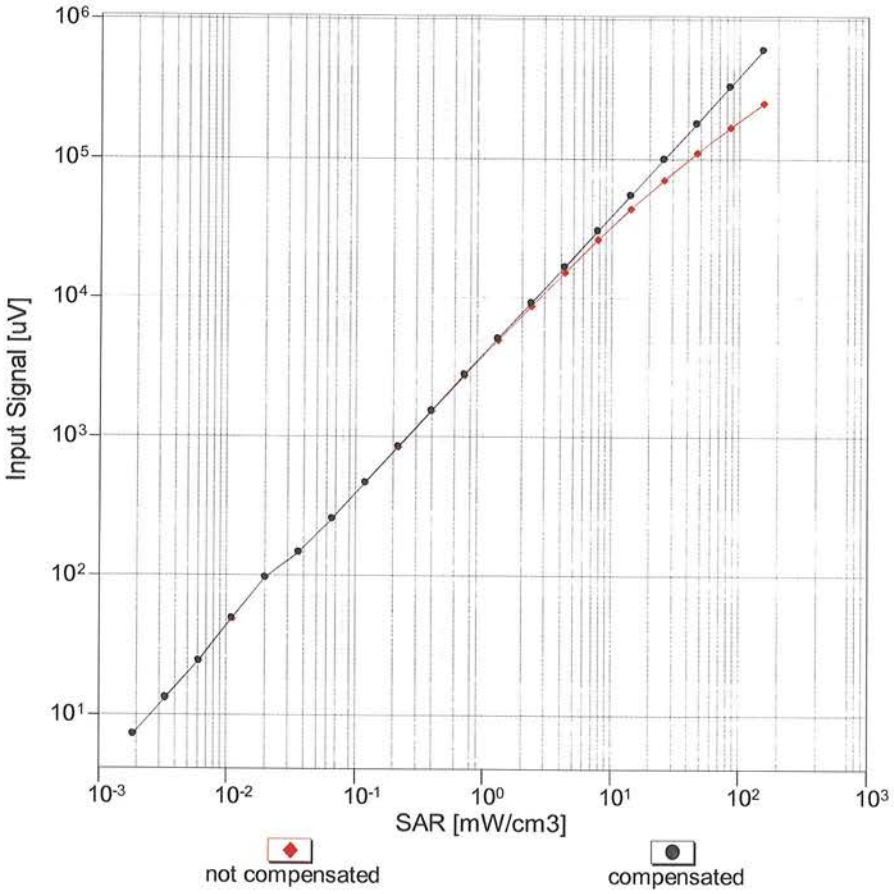
f=1800 MHz,R22

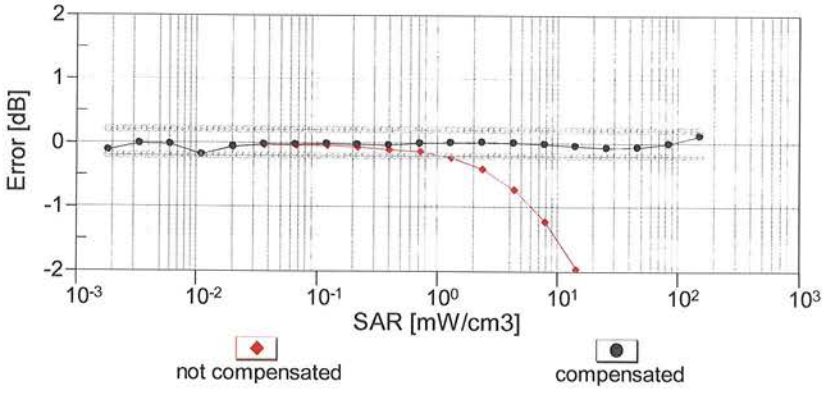




Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

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

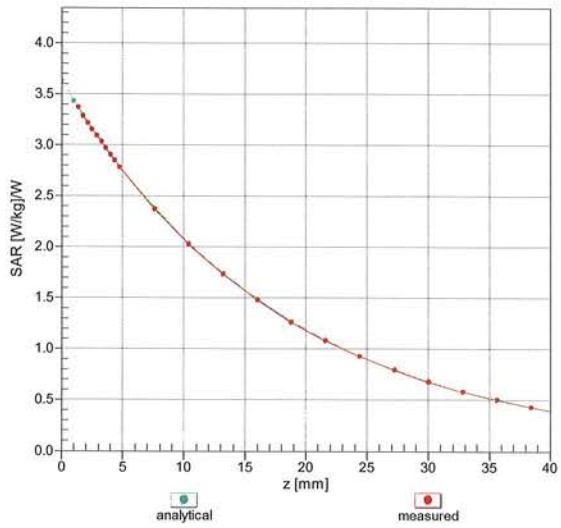




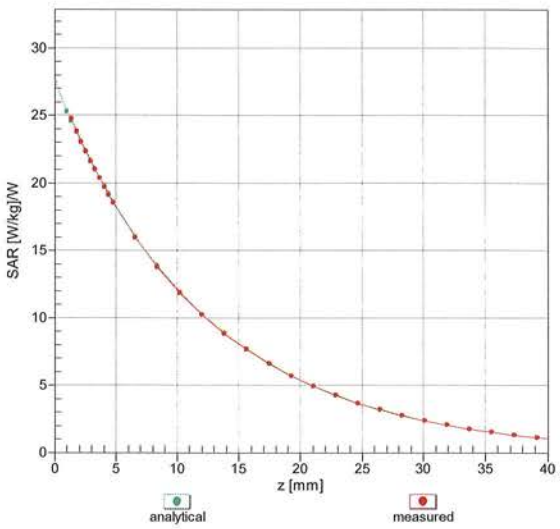
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment

f = 835 MHz,WGLS R9 (H_convF)

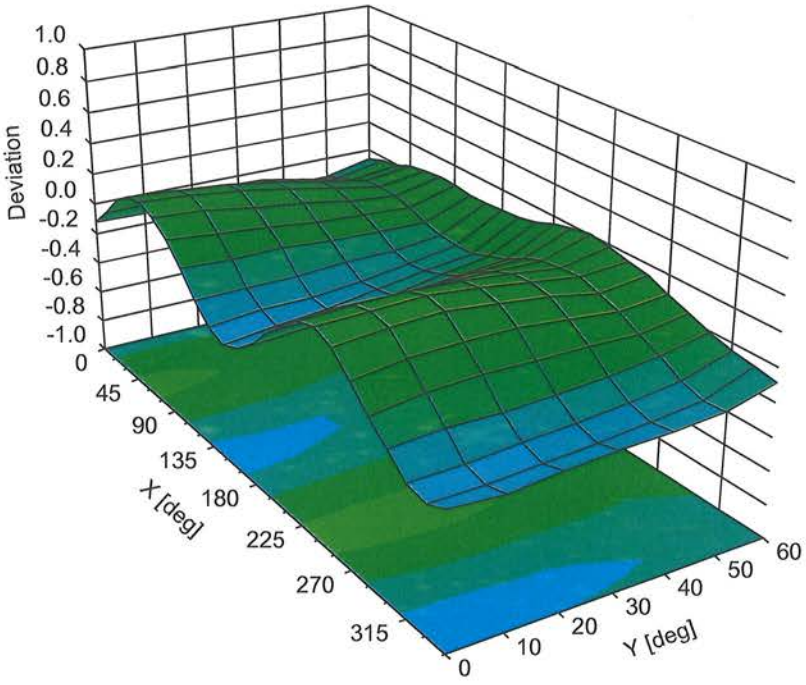


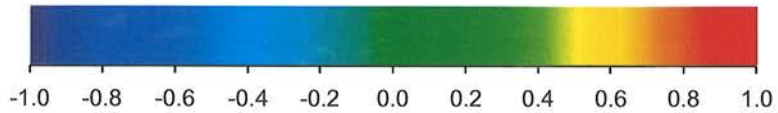
f = 1750 MHz,WGLS R22 (H_convF)



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz





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

Appendix: Modulation Calibration Parameters

UID	Rev	Communication System Name	Group	PAR (dB)	Unc^E (k=2)
0	-	CW	CW	0.00	± 4.7 %
10010	CAA	SAR Validation (Square, 100ms, 10ms)	Test	10.00	± 9.6 %
10011	CAB	UMTS-FDD (WCDMA)	WCDMA	2.91	± 9.6 %
10012	CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 1 Mbps)	WLAN	1.87	± 9.6 %
10013	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS-OFDM, 6 Mbps)	WLAN	9.46	± 9.6 %
10021	DAC	GSM-FDD (TDMA, GMSK)	GSM	9.39	± 9.6 %
10023	DAC	GPRS-FDD (TDMA, GMSK, TN 0)	GSM	9.57	± 9.6 %
10024	DAC	GPRS-FDD (TDMA, GMSK, TN 0-1)	GSM	6.56	± 9.6 %
10025	DAC	EDGE-FDD (TDMA, 8PSK, TN 0)	GSM	12.62	± 9.6 %
10026	DAC	EDGE-FDD (TDMA, 8PSK, TN 0-1)	GSM	9.55	± 9.6 %
10027	DAC	GPRS-FDD (TDMA, GMSK, TN 0-1-2)	GSM	4.80	± 9.6 %
10028	DAC	GPRS-FDD (TDMA, GMSK, TN 0-1-2-3)	GSM	3.55	± 9.6 %
10029	DAC	EDGE-FDD (TDMA, 8PSK, TN 0-1-2)	GSM	7.78	± 9.6 %
10030	CAA	IEEE 802.15.1 Bluetooth (GFSK, DH1)	Bluetooth	5.30	± 9.6 %
10031	CAA	IEEE 802.15.1 Bluetooth (GFSK, DH3)	Bluetooth	1.87	± 9.6 %
10032	CAA	IEEE 802.15.1 Bluetooth (GFSK, DH5)	Bluetooth	1.16	± 9.6 %
10033	CAA	IEEE 802.15.1 Bluetooth (PI/4-DQPSK, DH1)	Bluetooth	7.74	± 9.6 %
10034	CAA	IEEE 802.15.1 Bluetooth (PI/4-DQPSK, DH3)	Bluetooth	4.53	± 9.6 %
10035	CAA	IEEE 802.15.1 Bluetooth (PI/4-DQPSK, DH5)	Bluetooth	3.83	± 9.6 %
10036	CAA	IEEE 802.15.1 Bluetooth (8-DPSK, DH1)	Bluetooth	8.01	± 9.6 %
10037	CAA	IEEE 802.15.1 Bluetooth (8-DPSK, DH3)	Bluetooth	4.77	± 9.6 %
10038	CAA	IEEE 802.15.1 Bluetooth (8-DPSK, DH5)	Bluetooth	4.10	± 9.6 %
10039	CAB	CDMA2000 (1xRTT, RC1)	CDMA2000	4.57	± 9.6 %
10042	CAB	IS-54 / IS-136 FDD (TDMA/FDM, PI/4-DQPSK, Halfrate)	AMPS	7.78	± 9.6 %
10044	CAA	IS-91/EIA/TIA-553 FDD (FDMA, FM)	AMPS	0.00	± 9.6 %
10048	CAA	DECT (TDD, TDMA/FDM, GFSK, Full Slot, 24)	DECT	13.80	± 9.6 %
10049	CAA	DECT (TDD, TDMA/FDM, GFSK, Double Slot, 12)	DECT	10.79	± 9.6 %
10056	CAA	UMTS-TDD (TD-SCDMA, 1.28 Mcps)	TD-SCDMA	11.01	± 9.6 %
10058	DAC	EDGE-FDD (TDMA, 8PSK, TN 0-1-2-3)	GSM	6.52	± 9.6 %
10059	CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 2 Mbps)	WLAN	2.12	± 9.6 %
10060	CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 5.5 Mbps)	WLAN	2.83	± 9.6 %
10061	CAB	IEEE 802.11b WiFi 2.4 GHz (DSSS, 11 Mbps)	WLAN	3.60	± 9.6 %
10062	CAD	IEEE 802.11a/h WiFi 5 GHz (OFDM, 6 Mbps)	WLAN	8.68	± 9.6 %
10063	CAD	IEEE 802.11a/h WiFi 5 GHz (OFDM, 9 Mbps)	WLAN	8.63	± 9.6 %
10064	CAD	IEEE 802.11a/h WiFi 5 GHz (OFDM, 12 Mbps)	WLAN	9.09	± 9.6 %
10065	CAD	IEEE 802.11a/h WiFi 5 GHz (OFDM, 18 Mbps)	WLAN	9.00	± 9.6 %
10066	CAD	IEEE 802.11a/h WiFi 5 GHz (OFDM, 24 Mbps)	WLAN	9.38	± 9.6 %
10067	CAD	IEEE 802.11a/h WiFi 5 GHz (OFDM, 36 Mbps)	WLAN	10.12	± 9.6 %
10068	CAD	IEEE 802.11a/h WiFi 5 GHz (OFDM, 48 Mbps)	WLAN	10.24	± 9.6 %
10069	CAD	IEEE 802.11a/h WiFi 5 GHz (OFDM, 54 Mbps)	WLAN	10.56	± 9.6 %
10071	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 9 Mbps)	WLAN	9.83	± 9.6 %
10072	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 12 Mbps)	WLAN	9.62	± 9.6 %
10073	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 18 Mbps)	WLAN	9.94	± 9.6 %
10074	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 24 Mbps)	WLAN	10.30	± 9.6 %
10075	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 36 Mbps)	WLAN	10.77	± 9.6 %
10076	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 48 Mbps)	WLAN	10.94	± 9.6 %
10077	CAB	IEEE 802.11g WiFi 2.4 GHz (DSSS/OFDM, 54 Mbps)	WLAN	11.00	± 9.6 %
10081	CAB	CDMA2000 (1xRTT, RC3)	CDMA2000	3.97	± 9.6 %
10082	CAB	IS-54 / IS-136 FDD (TDMA/FDM, PI/4-DQPSK, Fullrate)	AMPS	4.77	± 9.6 %
10090	DAC	GPRS-FDD (TDMA, GMSK, TN 0-4)	GSM	6.56	± 9.6 %
10097	CAB	UMTS-FDD (HSDPA)	WCDMA	3.98	± 9.6 %
10098	CAB	UMTS-FDD (HSUPA, Subtest 2)	WCDMA	3.98	± 9.6 %
10099	DAC	EDGE-FDD (TDMA, 8PSK, TN 0-4)	GSM	9.55	± 9.6 %