SAR TEST REPORT

Applicant	iRay Technology Co., Ltd.
FCC ID	2ACHK-03210006
Product	LUX HD 43 DETECTOR
Model	LUX HD 43
Report No.	R2407A0993-S1
Issue Date	December 13, 2024

Eurofins TA Technology (Shanghai) Co., Ltd. tested the above equipment in accordance with the requirements in **IEEE 1528-2013, ANSI C95.1: 1992, IEEE C95.1: 1991.** The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

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1 Test Laboratory

1.1 Notes of the Test Report

This report shall not be reproduced in full or partial, without the written approval of **Eurofins TA Technology (Shanghai) Co., Ltd.** The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. Measurement Uncertainties were not taken into account and are published for informational purposes only. This report is written to support regulatory compliance of the applicable standards stated above.

1.2 Test Facility

FCC (Designation number: CN1179, Test Firm Registration Number: 446626)

Eurofins TA Technology (Shanghai) Co., Ltd. has been listed on the US Federal Communications Commission list of test facilities recognized to perform measurements.

A2LA (Certificate Number: 3857.01)

Eurofins TA Technology (Shanghai) Co., Ltd. has been listed by American Association for Laboratory Accreditation to perform measurement.

1.3 Testing Location

Company:	Eurofins TA Technology (Shanghai) Co., Ltd.
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1.4 Laboratory Environment

Temperature	Min. = 18°C, Max. = 25°C
Relative humidity	Min. = 20%, Max. = 80%
Ground system resistance	< 0.5 Ω
Ambient noise is checked and found very low and in compliance with requirement of standards. Reflection of surrounding objects is minimized and in compliance with requirement of standards.	

2 Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for the EUT are as follows:

Table 1: Highest Reported SAR

Mode	Highest Reported SAR (W/kg)
	Body SAR 1g (Separation 0mm)
Wi-Fi (2.4G) / 2.4G	0.011
Wi-Fi (5G)	0.049
Date of Testing: September 5, 2024 ~ September 16, 2024 Date of Sample Received: August 1, 2024	
Note: 1. The device is in compliance with SAR for Uncontrolled Environment /General Population exposure limits (1.6 W/kg) specified in ANSI C95.1: 1992/IEEE C95.1: 1991, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013. 2. All indications of Pass/Fail in this report are opinions expressed by Eurofins TA Technology (Shanghai) Co., Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only.	

3 Description of Equipment Under Test

Client Information

Applicant	iRay Technology Co., Ltd.
Applicant address	RM 202, Building 7, No. 590, Ruiqing RD., Zhangjiang East, Pudong, 201201 Shanghai, P.R.China
Manufacturer	Carestream Health, Inc.
Manufacturer address	150 Verona Street Rochester, NY, USA 14608

General Technologies

EUT Stage	Identical Prototype
Model	Lux HD 43
Lab internal SN	R2407A0993/S01
Hardware Version	FPGA MAIN: 2.81
Software Version	SDK 4.1
Antenna Type	Internal Antenna
EUT Accessory	
Medical Switching Power Supply	Manufacturer: Shenzhen Longxc Power Supply Co., LTD. Model: LXCP61-024300
Rechargeable Li-ion Battery Pack	Manufacturer: Carestream Health, Inc. Model: BATTERY-KX DC 11.55V, 4700mAh
CARESTREAM DRX-1	Manufacturer: Carestream Health, Inc. Model: DRX-TPC1 Input: 100-240V AC~50/60Hz 1.0A Output: 18V DC 2.0A
Control Box	Manufacturer: Carestream Health, Inc. Model: Control Box-WT
Note: The EUT is sent from the applicant to Eurofins TA and the information of the EUT is declared by the applicant.	

Wireless Technology and Frequency Range

<table>
<tr><th colspan="2">Wireless Technology</th><th>Modulation</th><th>Operating mode</th><th>Tx (MHz)</th><th>Rx (MHz)</th></tr>
<tr><td rowspan="4">Wi-Fi</td><td rowspan="2">2.4G</td><td>DSSS, OFDM</td><td>802.11b/g/n HT20/ax HE20</td><td>2412 ~ 2462</td><td>2412 ~ 2462</td></tr>
<tr><td>OFDM</td><td>802.11n HT40/ax HE40</td><td>2422 ~ 2452</td><td>2422 ~ 2452</td></tr>
<tr><td>5G</td><td>OFDM</td><td>802.11a/n HT20/ HT40/
ac VHT20/ VHT40/ VHT80/
ax HE20/ HE40/ HE80/</td><td>5150 ~ 5250
5725 ~ 5850</td><td>5150 ~ 5250
5725 ~ 5850</td></tr>
<tr><td colspan="5">Does this device support MIMO ☒Yes (2TX, 2RX) ☐No</td></tr>
<tr><td colspan="2">2.4G</td><td>ESB</td><td>/</td><td>2403 ~ 2481</td><td>2403 ~ 2481</td></tr>
</table>

4 Test Specification, Methods and Procedures

The tests documented in this report were performed in accordance with FCC 47 CFR § 2.1093, IEEE 1528- 2013, ANSI C95.1: 1992, IEEE C95.1: 1991, the following FCC Published RF exposure KDB procedures:

KDB 248227 D01 802.11Wi-Fi SAR v02r02
KDB 447498 D01 General RF Exposure Guidance v06
KDB 690783 D01 SAR Listings on Grants v01r03
KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04
KDB 865664 D02 RF Exposure Reporting v01r02
KDB 616217 D04 SAR for laptop and tablets v01r02

5 Operational Conditions during Test

5.1 Test Positions

According to KDB 616217 D04, SAR evaluation is required for back surface and edges of the devices. The back surface and edges of the tablet are tested with the tablet touching the phantom. Exposures from antennas through the front surface of the display section of a tablet are generally limited to the user's hands.

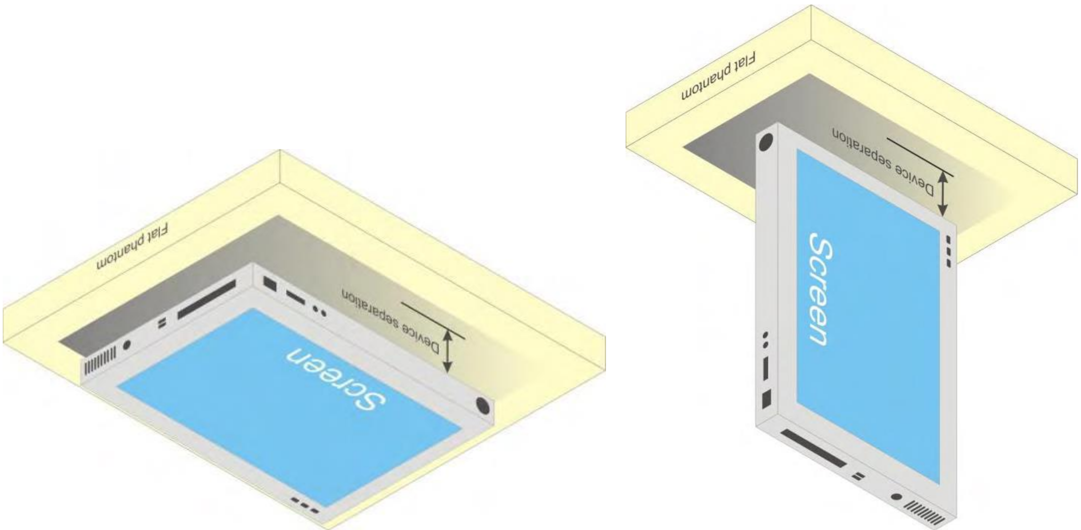


Fig-4.1 Illustration for Tablet Setup

5.2 Measurement Variability

Per FCC KDB Publication 865664 D01, SAR measurement variability was assessed for each frequency band, which was determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media were required for SAR measurements in a frequency band, the variability measurement procedures were applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. These additional measurements were repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device was returned to ambient conditions (normal room temperature) with the battery fully charged before it was re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

SAR Measurement Variability was assessed using the following procedures for each frequency band:
1) When the original highest measured SAR is ≥ 0.80 W/kg, the measurement was repeated once.
2) A second repeated measurement was preformed only if the ratio of largest to smallest SAR for the original and first repeated measurements was > 1.20 or when the original or repeated measurement was ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
3) A third repeated measurement was performed only if the original, first or second repeated measurement was ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.
4) Repeated measurements are not required when the original highest measured SAR is < 0.80 W/kg

The same procedures should be adapted for measurements according to extremity and occupational exposure limits by applying a factor of 2.5 for extremity exposure and a factor of 5 for occupational exposure to the corresponding SAR thresholds.

5.3 Test Configuration

5.2.1 Wi-Fi Test Configuration

SAR test reduction for 802.11 Wi-Fi transmission mode configurations are considered separately for DSSS and OFDM. An initial test position is determined to reduce the number of tests required for certain exposure configurations with multiple test positions. An initial test configuration is determined for each frequency band and aggregated band according to maximum output power, channel bandwidth, wireless mode configurations and other operating parameters to streamline the measurement requirements. For 2.4 GHz DSSS, either the initial test position or DSSS procedure is applied to reduce the number of SAR tests; These are mutually exclusive. For OFDM, an initial test position is only applicable to next to the ear, UMPC mini-tablet and hotspot mode configurations, which is tested using the initial test configuration to facilitate test reduction. For other exposure conditions with a fixed test position, SAR test reduction is determined using only the initial test configuration.

The multiple test positions require SAR measurements in head, hotspot mode or UMPC mini-tablet configurations may be reduced according to the highest reported SAR determined using the *initial test position(s)* by applying the DSSS or OFDM SAR measurement procedures in the required wireless mode test configuration(s). The *initial test position(s)* is measured using the highest measured maximum output power channel in the required wireless mode test configuration(s). When the *reported* SAR for the *initial test position* is:

- ≤ 0.4 W/kg, further SAR measurement is not required for the other test positions in that exposure configuration and wireless mode combination within the frequency band or aggregated band. DSSS and OFDM configurations are considered separately according to the required SAR procedures.
- 0.4 W/kg, SAR is repeated using the same wireless mode test configuration tested in the *initial test position* to measure the subsequent next closet/smallest test separation distance and maximum coupling test position, on the highest maximum output power channel, until the *reported* SAR is ≤ 0.8 W/kg or all required test positions are tested.
  - ✧ For subsequent test positions with equivalent test separation distance or when exposure is dominated by coupling conditions, the position for maximum coupling condition should be tested.
  - ✧ When it is unclear, all equivalent conditions must be tested.
- For all positions/configurations tested using the *initial test position* and subsequent test positions, when the *reported* SAR is > 0.8 W/kg, measure the SAR for these positions/configurations on the subsequent next highest measured output power channel(s) until the *reported* SAR is ≤ 1.2 W/kg or all required test channels are considered.
  - ✧ The additional power measurements required for this step should be limited to those necessary for identifying subsequent highest output power channels to apply the test reduction.

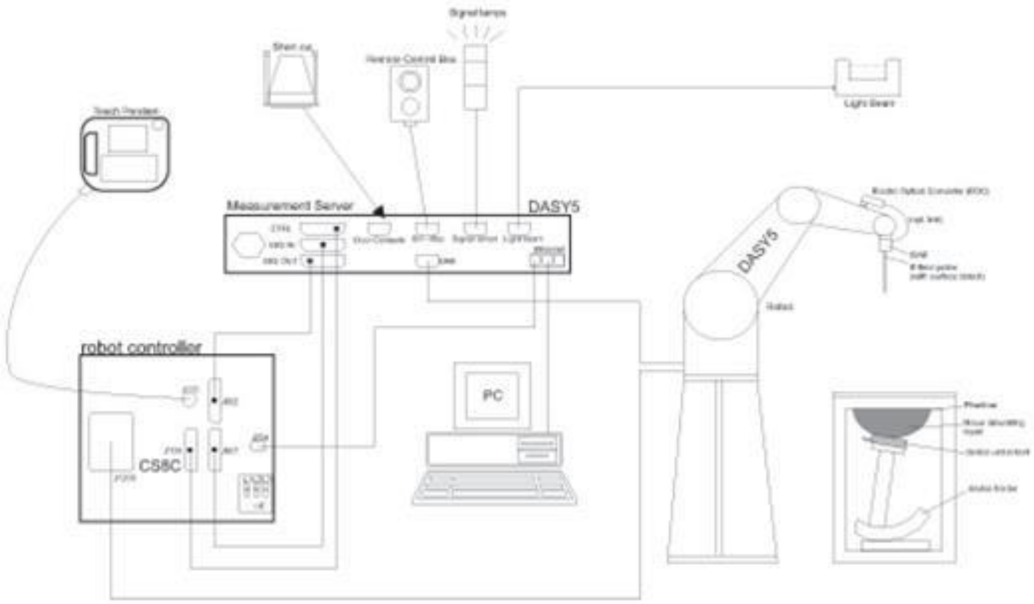
To determine the initial test position, Area Scans were performed to determine the position with the Maximum Value of SAR (measured). The position that produced the highest Maximum Value of SAR is considered the worst case position; thus used as the initial test position.

A Wi-Fi device must be configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools for SAR measurement.

6 SAR Measurements System Configuration

6.1 SAR Measurement Set-up

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).
- ➢ An isotropic Field probe optimized and calibrated for the targeted measurement.
- ➢ A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- ➢ The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- ➢ The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- ➢ The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- ➢ A computer running WinXP or Win7 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.

6.2 DASY5 E-field Probe System

The SAR measurements were conducted with the dosimetric probe EX3DV4 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation.

EX3DV4 Probe Specification

Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	ISO/IEC 17025 calibration service available
Frequency	10 MHz to > 6 GHz Linearity: ± 0.2 dB (30 MHz to 6 GHz)
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)
Dynamic Range	10 µW/g to > 100 mW/g Linearity: ± 0.2dB (noise: typically < 1 µW/g)
Dimensions	Overall length: 330 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). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.

E-field Probe Calibration

Each probe is calibrated according to a dosimetric assessment procedure with accuracy better than ± 10%. The spherical isotropy was evaluated and found to be better than ± 0.25dB. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested.

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies bellow 1 GHz, and in a wave guide above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees.

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

$$SAR = C\Delta T/\Delta t$$

Where: Δt = Exposure time (30 seconds),

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

ΔT = Temperature increase due to RF exposure.

Or

$$SAR = |E|^2\sigma/\rho$$

Where: σ = Simulated tissue conductivity,

ρ = Tissue density (kg/m^3).

6.3 SAR Measurement Procedure

Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

Area Scan

The area scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum 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 standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan), if only one zoom scan follows the area scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of zoom scans has to be increased accordingly.

Area scan parameters extracted from FCC KDB 865664 D01 SAR measurement 100 MHz to 6 GHz.

	≤3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 1 mm	½·δ·ln(2) ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: ΔxArea, ΔyArea	≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
	When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	

Zoom Scan

Zoom scans are used assess the peak spatial SAR values within a cubic averaging volume containing 1 gram and 10 gram of simulated tissue. The zoom scan measures points (refer to table below) within a cube shoes base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the zoom scan evaluates the averaged SAR for 1 gram and 10 gram and displays these values next to the job's label.

Zoom scan parameters extracted from FCC KDB 865664 D01 SAR measurement 100 MHz to 6 GHz.

<table>
<tr><td colspan="3"></td><td>≤3GHz</td><td>> 3 GHz</td></tr>
<tr><td colspan="3">Maximum zoom scan spatial resolution: $\triangle x_{zoom}\triangle y_{zoom}$</td><td>≤2GHz: ≤8mm
2 – 3GHz: ≤5mm*</td><td>3 – 4GHz: ≤5mm*
4 – 6GHz: ≤4mm*</td></tr>
<tr><td rowspan="3">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2">Uniform grid: $\triangle z_{zoom}(n)$</td><td>≤5mm</td><td>3 – 4GHz: ≤4mm
4 – 5GHz: ≤3mm
5 – 6GHz: ≤2mm</td></tr>
<tr><td rowspan="2">Graded grid</td><td>$\triangle z_{zoom}(1)$: between 1st two points closest to phantom surface</td><td>≤4mm</td><td>3 – 4GHz: ≤3mm
4 – 5GHz: ≤2.5mm
5 – 6GHz: ≤2mm</td></tr>
<tr><td>$\triangle z_{zoom}(n>1)$: between subsequent points</td><td colspan="2">≤1.5•$\triangle z_{zoom}(n-1)$</td></tr>
<tr><td>Minimum zoom scan volume</td><td colspan="2">X, y, z</td><td>≥30mm</td><td>3 – 4GHz: ≥28mm
4 – 5GHz: ≥25mm
5 – 6GHz: ≥22mm</td></tr>
<tr><td colspan="5">Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.
* When zoom scan is required and the <u>reported</u> SAR from the area scan based 1-g SAR estimation procedures of KDB 447498 is ≤ 1.4W/kg, ≤8mm, ≤7mm and ≤5mm zoom scan resolution may be applied, respectively, for 2GHz to 3GHz, 3GHz to 4GHz and 4GHz to 6GHz.</td></tr>
</table>

Volume Scan Procedures

The volume scan is used for assess overlapping SAR distributions for antennas transmitting in different frequency bands. It is equivalent to an oversized zoom scan used in standalone measurements. The measurement volume will be used to enclose all the simultaneous transmitting antennas. For antennas transmitting simultaneously in different frequency bands, the volume scan is measured separately in each frequency band. In order to sum correctly to compute the 1g aggregate SAR, the EUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing. When all volume scan were completed, the software, SEMCAD postprocessor can combine and subsequently superpose these measurement data to calculating the multiband SAR.

Power Drift Monitoring

All SAR testing is under the EUT install full charged battery and transmit maximum output power. In DASY measurement software, the power reference measurement and power drift measurement procedures are used for monitoring the power drift of EUT during SAR test. Both these procedures measure the field at a specified reference position before and after the SAR testing. The software will calculate the field difference in dB. If the power drifts more than 5%, the SAR will be retested.

7 Main Test Equipment

Name of Equipment	Manufacturer	Type/Model	Serial Number	Software Version	Last Cal.	Cal. Due Date
Network Analyzer	Agilent	E5071B	MY42404014	/	2024-05-07	2025-05-06
Dielectric Probe Kit	SPEAG	DAK-12	1132	/	2024-07-15	2025-07-14
Power Meter	Agilent	E4417A	GB41291714	/	2024-05-07	2025-05-06
Power Sensor	Agilent	N8481H	MY50350004	/	2024-05-07	2025-05-06
Power Sensor	Agilent	E9327A	US40441622	/	2024-05-07	2025-05-06
Signal Generator	KEYSIGHT	N5182B-X07	MY51350303	/	2023-12-05	2024-12-04
Dual Directional Coupler	UCL	UCL-DDC056G-S	20010600118	/	/	/
Amplifier	R&S	SCU40F	100649	/	/	/
Wireless Communication Tester	R&S	CMW 500	146734	/	2024-05-07	2025-05-06
E-field Probe	SPEAG	EX3DV4	7689	/	2024-06-04	2025-06-03
DAE	SPEAG	DAE4	1692	/	2023-11-08	2024-11-07
Validation Kit 2450MHz	SPEAG	D2450V2	786	/	2023-09-12	2026-09-11
Validation Kit 5GHz	SPEAG	D5GHzV2	1203	/	2022-12-09	2025-12-08
Software for Tissue	SPEAG	/	/	DAK 3.0.4.1	/	/
Temperature Probe	Auden	DTM3000	3905	/	2023-12-05	2024-12-04
Twin ELI Phantom	SPEAG	ELI v4.0	1179	/	/	/
Hygrothermograph	Anymetr	HTC - 1	TA2024A030	/	2024-05-06	2025-05-05
Test System	SPEAGA	TX90 XLspeag	F08/5AH5A1/A/01	52.10.4.1527	/	/

8 Tissue Dielectric Parameter Measurements & System Check

8.1 Tissue Verification

The temperature of the tissue-equivalent medium used during measurement must also be within 18°C to 25°C and within ± 2°C of the temperature when the tissue parameters are characterized. The dielectric parameters must be measured before the tissue-equivalent medium is used in a series of SAR measurements. The parameters should be re-measured after each 24 hours of use; or earlier if the dielectric parameters can become out of tolerance.

Target values

Frequency (MHz)	ε_r	σ(s/m)
2450	39.2	1.80
5250	35.9	4.71
5750	35.4	5.22

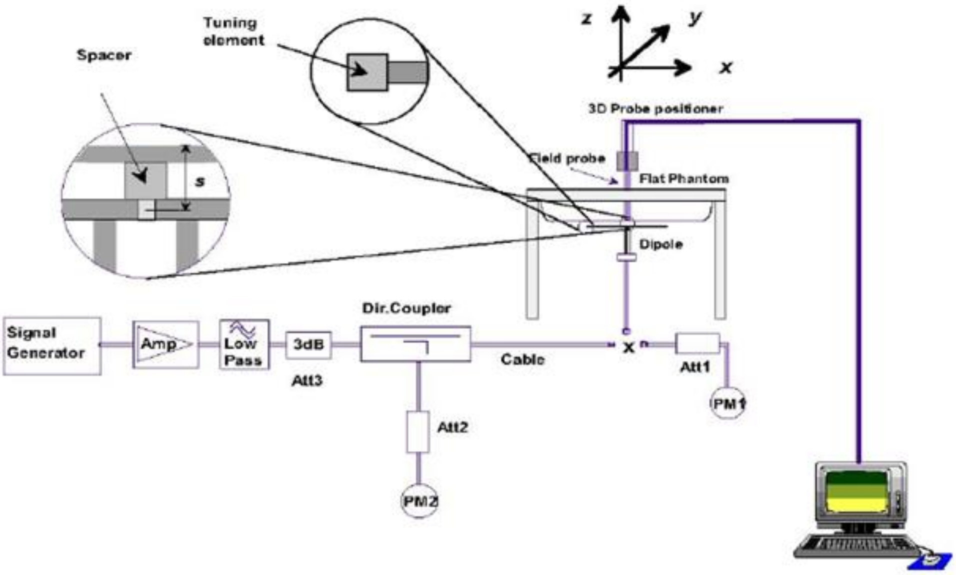
Measurements results

Frequency (MHz)	Test Date	Temp ℃	Measured Dielectric Parameters		Target Dielectric Parameters		Limit (Within ±5%)	
			ε_r	σ(s/m)	ε_r	σ(s/m)	Dev ε_r(%)	Dev σ(%)
2450	2024/9/16	21.5	40.75	1.78	39.2	1.80	3.95	-1.11
5250	2024/9/5	21.5	36.26	4.52	35.9	4.71	1.00	-4.03
5750	2024/9/6	21.5	35.10	5.09	35.4	5.22	-0.85	-2.49
Note: The depth of tissue-equivalent liquid in a phantom must be ≥ 15.0 cm.								

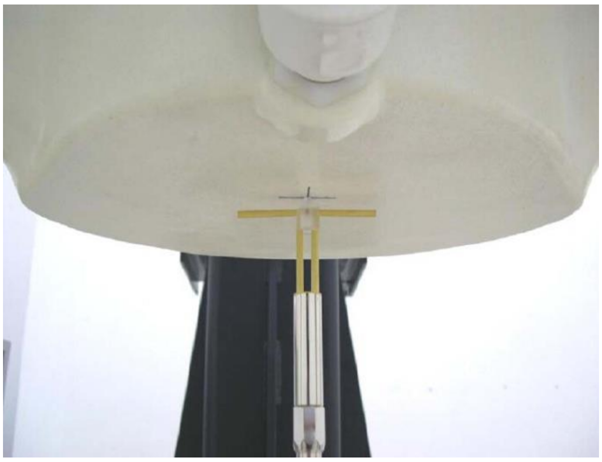
8.2 System Check

The manufacturer calibrates the probes annually. Dielectric parameters of the tissue simulates were measured using the dielectric probe kit and the network analyzer. A system check measurement for every day was made following the determination of the dielectric parameters of the Tissue simulates, using the dipole validation kit. The dipole antenna was placed under the flat section of the twin SAM phantom.

System check is performed regularly on all frequency bands where tests are performed with the DASY system.



Picture 1 System Check setup



Picture 2 Setup Photo

Justification for Extended SAR Dipole Calibrations

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

Dipole		Date of Measurement	Return Loss (dB)	Δ %	Impedance (Ω)			
					Real	ΔΩ	Imaginary	ΔΩ
Dipole D5GHzV2 (5250 MHz) SN: 1203	Head Liquid	12/9/2022	29.0	/	48.5	/	-3.20	/
		12/8/2023	28.4	-2.1	48.4	-0.1	-3.4	-0.2
Dipole D5GHzV2 (5750 MHz) SN: 1203	Head Liquid	12/9/2022	25.3	/	53.6	/	4.30	/
		12/8/2023	25.7	1.6%	53.1	-0.5	4.7	0.4

System Check Results

Frequency (MHz)	Test Date	Temp ℃	250mW Measured SAR_{1g} (W/kg)	1W Normalized SAR_{1g} (W/kg)	1W Target SAR_{1g} (W/kg)	Δ % (Limit ±10%)	Plot No.
2450	2024/9/16	21.5	13.70	54.80	52.60	4.18	1
Frequency (MHz)	**Test Date**	**Temp ℃**	**100mW Measured SAR_{1g} (W/kg)**	**1W Normalized SAR_{1g} (W/kg)**	**1W Target SAR_{1g} (W/kg)**	**Δ % (Limit ±10%)**	**Plot No.**
5250	2024/9/5	21.5	7.87	78.70	77.70	1.29	2
5750	2024/9/6	21.5	7.72	77.20	76.80	0.52	3
Note: Target Values used derive from the calibration certificate data storage and evaluation.							

9 Normal and Maximum Output Power

KDB 447498 D01 at the maximum rated output power and within the tune-up tolerance range specified for the product, but not more than 2 dB lower than the maximum tune-up tolerance limit.

9.1 WLAN Mode

Wi-Fi 2.4G Ant 1 / Mode	Channel /Frequency(MHz)	Maximum Output Power (dBm)	
		Tune-up	Meas.
802.11b (1M)	1/2412	17.00	15.02
	6/2437	17.50	16.40
	11/2462	17.50	16.59
802.11g (6M)	1/2412	17.50	15.64
	6/2437	17.50	17.20
	11/2462	17.50	**17.48**
802.11n-HT20 (MCS0)	1/2412	15.50	13.18
	6/2437	15.50	13.71
	11/2462	15.50	14.27
802.11n-HT40 (MCS0)	3/2422	13.50	11.30
	6/2437	13.50	11.60
	9/2452	13.50	11.74
802.11ax VHT20 (MCS0)	1/2412	14.50	12.40
	6/2437	14.50	12.82
	11/2462	14.50	13.37
802.11ax VHT40 (MCS0)	3/2422	13.50	11.73
	6/2437	13.50	11.96
	9/2452	13.50	12.19
Note: Initial test configuration is 802.11g mode.			

Wi-Fi 2.4G Ant 2 / Mode	Channel /Frequency(MHz)	Maximum Output Power (dBm)	
		Tune-up	Meas.
802.11b (1M)	1/2412	17.00	15.38
	6/2437	17.00	15.76
	11/2462	17.00	15.52
802.11g (6M)	1/2412	17.00	15.18
	6/2437	17.00	**16.33**
	11/2462	17.00	16.06
802.11n-HT20	1/2412	15.00	12.78

(MCS0)	6/2437	15.00	13.68
	11/2462	15.00	13.76
802.11n-HT40 (MCS0)	3/2422	13.00	11.26
	6/2437	13.00	11.64
	9/2452	13.00	11.88
802.11ax VHT20 (MCS0)	1/2412	14.00	12.51
	6/2437	14.00	13.03
	11/2462	14.00	13.17
802.11ax VHT40 (MCS0)	3/2422	13.00	11.63
	6/2437	13.00	12.06
	9/2452	13.00	12.35
Note: Initial test configuration is 802.11g mode.			

Wi-Fi 2.4G	Channel /Frequency(MHz)	Maximum Output Power (dBm)			
Mode		Tune-up	Meas.	Ant 1	Ant 2
802.11n-HT20 (MCS0)	1/2412	17.50	16.06	13.09	13.01
	6/2437	17.50	16.36	13.22	13.47
	11/2462	17.50	**16.36**	13.59	13.09
802.11n-HT40 (MCS0)	3/2422	15.00	13.84	10.87	10.78
	6/2437	15.00	14.10	11.08	11.10
	9/2452	15.00	14.20	11.22	11.17
802.11ax VHT20 (MCS0)	1/2412	16.00	15.10	12.15	12.03
	6/2437	16.00	15.54	12.40	12.65
	11/2462	16.00	15.64	12.87	12.38
802.11ax VHT40 (MCS0)	3/2422	15.00	14.20	11.21	11.17
	6/2437	15.00	14.44	11.37	11.48
	9/2452	15.00	14.67	11.65	11.67
Note: Initial test configuration is 802.11n-HT20 mode.					

Mode	Channel /Frequency(MHz)	Maximum Output Power (dBm)	
		Tune-up	Meas.
2.4G	2/2403	8.00	7.16
	15/2442	8.00	7.21
	27/2478	8.00	7.07
	28/2481	8.00	7.02

Wi-Fi 5G (U-NII-1) Ant 1 / Mode	Channel /Frequency(MHz)	Maximum Output Power (dBm)	
		Tune-up	Meas.
802.11a (6M)	36/5180	16.00	14.71
	44/5220	16.00	14.91
	48/5240	16.00	15.24
802.11n-HT20 (MCS0)	36/5180	16.00	14.63
	44/5220	16.00	14.91
	48/5240	16.00	15.23
802.11n-HT40 (MCS0)	38/5190	16.50	14.89
	46/5230	16.50	15.20
802.11ac-VHT20 (MCS0)	36/5180	16.00	14.57
	44/5220	16.00	14.87
	48/5240	16.00	15.20
802.11ac-VHT40 (MCS0)	38/5190	16.00	14.98
	46/5230	16.00	15.29
802.11ac-VHT80 (MCS0)	42/5210	14.50	13.51
802.11ax-HE20 (MCS0)	36/5180	16.00	14.90
	44/5220	16.00	15.17
	48/5240	16.50	15.53
802.11ax-HE40 (MCS0)	38/5190	16.00	15.14
	46/5230	16.50	**15.80**
802.11ax-HE80 (MCS0)	42/5210	14.50	13.88
Note. Initial test configuration is 802.11ax-HE40 mode, since the highest maximum output power.			

Wi-Fi 5G (U-NII-1) Ant 2 / Mode	Channel /Frequency(MHz)	Maximum Output Power (dBm)	
		Tune-up	Meas.
802.11a (6M)	36/5180	16.00	15.17
	44/5220	16.00	15.37
	48/5240	16.00	15.51
802.11n-HT20 (MCS0)	36/5180	16.00	15.23
	44/5220	16.00	15.58
	48/5240	16.00	15.70
802.11n-HT40 (MCS0)	38/5190	16.50	15.35
	46/5230	16.50	15.72
802.11ac-VHT20 (MCS0)	36/5180	16.00	15.26
	44/5220	16.00	15.46

	48/5240	16.00	15.71
802.11ac-VHT40 (MCS0)	38/5190	16.00	15.24
	46/5230	16.00	15.66
802.11ac-VHT80 (MCS0)	42/5210	14.50	13.39
802.11ax-HE20 (MCS0)	36/5180	16.00	15.50
	44/5220	16.00	15.81
	48/5240	16.50	**16.00**
802.11ax-HE40 (MCS0)	38/5190	16.00	15.68
	46/5230	16.50	15.96
802.11ax-HE80 (MCS0)	42/5210	14.50	13.78
Note. Initial test configuration is 802.11ax-HE20 mode, since the highest maximum output power.			

Wi-Fi 5G (U-NII-1)	Channel /Frequency(MHz)	Maximum Output Power (dBm)			
Mode		Tune-up	Meas.	Ant 1	Ant 2
802.11a (6M)	36/5180	18.50	17.96	14.71	15.17
	44/5220	18.50	18.15	14.91	15.37
	48/5240	18.50	**18.38**	15.24	15.51
802.11n-HT20 (MCS0)	36/5180	18.50	17.58	14.33	14.80
	44/5220	18.50	17.33	14.11	14.52
	48/5240	18.50	17.44	14.20	14.65
802.11n-HT40 (MCS0)	38/5190	19.00	17.31	14.15	14.44
	46/5230	19.00	17.62	14.49	14.73
802.11ac-VHT20 (MCS0)	36/5180	18.50	16.72	13.46	13.95
	44/5220	18.50	16.84	13.64	14.00
	48/5240	18.50	16.94	13.72	14.12
802.11ac-VHT40 (MCS0)	38/5190	18.50	17.23	14.05	14.38
	46/5230	18.50	17.51	14.38	14.61
802.11ac-VHT80 (MCS0)	42/5210	17.00	15.72	12.85	12.56
802.11ax-HE20 (MCS0)	36/5180	18.50	17.31	14.06	14.52
	44/5220	18.50	17.50	14.35	14.63
	48/5240	18.50	17.42	14.19	14.62
802.11ax-HE40 (MCS0)	38/5190	18.50	17.69	14.54	14.82
	46/5230	18.50	18.05	14.92	15.15
802.11ax-HE80 (MCS0)	42/5210	17.00	16.41	13.55	13.24
Note. Initial test configuration is 802.11a mode, since the highest maximum output power.					

Wi-Fi 5G (U-NII-3) Ant 1	Channel /Frequency(MHz)	Maximum Output Power (dBm)	
Mode		Tune-up	Meas.
802.11a (6M)	149/5745	17.00	**15.88**
	157/5785	17.00	15.36
	165/5825	17.00	15.75
802.11n-HT20 (MCS0)	149/5745	16.50	15.64
	157/5785	16.50	15.24
	165/5825	16.50	15.75
802.11n-HT40 (MCS0)	151/5755	16.50	15.27
	159/5795	16.50	15.10
802.11ac-VHT20 (MCS0)	149/5745	16.50	15.70
	157/5785	16.50	15.31
	165/5825	16.50	15.81
802.11ac-VHT40 (MCS0)	151/5755	16.50	15.37
	159/5795	16.50	15.17
802.11ac-VHT80 (MCS0)	155/5775	16.50	15.21
802.11ax-HE20 (MCS0)	149/5745	16.50	15.56
	157/5785	16.50	15.31
	165/5825	16.50	15.70
802.11ax-HE40 (MCS0)	151/5755	16.50	15.87
	159/5795	16.50	15.39
802.11ax-HE80 (MCS0)	155/5775	16.50	14.79
Note. Initial test configuration is 802.11a mode, since the highest maximum output power.			

Wi-Fi 5G (U-NII-3) Ant 2	Channel /Frequency(MHz)	Maximum Output Power (dBm)	
Mode		Tune-up	Meas.
802.11a (6M)	149/5745	17.00	15.97
	157/5785	17.00	16.08
	165/5825	17.00	16.15
802.11n-HT20 (MCS0)	149/5745	16.50	15.96
	157/5785	16.50	16.09
	165/5825	16.50	16.09
802.11n-HT40 (MCS0)	151/5755	16.50	15.94
	159/5795	16.50	16.26
802.11ac-VHT20 (MCS0)	149/5745	16.50	15.93
	157/5785	16.50	16.05

	165/5825	16.50	16.11
802.11ac-VHT40 (MCS0)	151/5755	16.50	15.94
	159/5795	16.50	16.19
802.11ac-VHT80 (MCS0)	155/5775	16.50	16.14
802.11ax-HE20 (MCS0)	149/5745	16.50	16.27
	157/5785	16.50	**16.48**
	165/5825	16.50	16.42
802.11ax-HE40 (MCS0)	151/5755	16.50	16.43
	159/5795	16.50	16.48
802.11ax-HE80 (MCS0)	155/5775	16.50	16.44
Note. Initial test configuration is 802.11ax-HE20 mode, since the highest maximum output power.			

Wi-Fi 5G (U-NII-3)	Channel /Frequency(MHz)	Maximum Output Power (dBm)			
Mode		Tune-up	Meas.	Ant 1	Ant 2
802.11a (6M)	149/5745	19.50	18.93	15.88	15.97
	157/5785	19.50	18.75	15.36	16.08
	165/5825	19.50	**18.97**	15.75	16.15
802.11n-HT20 (MCS0)	149/5745	19.00	17.68	14.73	14.60
	157/5785	19.00	17.35	14.20	14.48
	165/5825	19.00	18.24	15.43	15.02
802.11n-HT40 (MCS0)	151/5755	19.00	17.61	14.59	14.62
	159/5795	19.00	17.46	14.31	14.59
802.11ac-VHT20 (MCS0)	149/5745	19.00	17.57	14.60	14.53
	157/5785	19.00	17.35	14.20	14.48
	165/5825	19.00	17.43	14.57	14.26
802.11ac-VHT40 (MCS0)	151/5755	19.00	17.16	14.13	14.18
	159/5795	19.00	17.15	13.97	14.32
802.11ac-VHT80 (MCS0)	155/5775	19.00	17.41	14.33	14.48
802.11ax-HE20 (MCS0)	149/5745	19.00	17.69	14.68	14.67
	157/5785	19.00	17.61	14.42	14.77
	165/5825	19.00	17.71	14.88	14.50
802.11ax-HE40 (MCS0)	151/5755	19.00	17.78	14.77	14.78
	159/5795	19.00	17.80	14.62	14.97
802.11ax-HE80 (MCS0)	155/5775	19.00	18.02	14.94	15.08
Note. Initial test configuration is 802.11a mode, since the highest maximum output power.					

10 Measured and Reported (Scaled) SAR Results

10.1 EUT Antenna Locations

Overall (W x H x D): 460mm x 460mm x 15mm				
Area Scan / Antenna	Scan 1	Scan 2	Scan 3	Scan 4
Antenna 1	Yes	Yes	Yes	Yes
Antenna 2	Yes	Yes	Yes	Yes

10.2 Standalone SAR Test Exclusion Considerations

Per KDB 447498 D01 v06, the SAR exclusion threshold is defined by the following:

MHz	5	10	15	20	25	mm
150	39	77	116	155	194	*SAR Test Exclusion Threshold* (mW)
300	27	55	82	110	137	
450	22	45	67	89	112	
835	16	33	49	66	82	
900	16	32	47	63	79	
1500	12	24	37	49	61	
1900	11	22	33	44	54	
2450	10	19	29	38	48	
3600	8	16	24	32	40	
5200	7	13	20	26	33	
5400	6	13	19	26	32	
5800	6	12	19	25	31	

Band	Configuration	Frequency (MHz)	Separation Distance (mm)	Maximum Power (dBm)	Maximum Power (mW)	Limit (mW)	Standalone SAR
2.4GHz	Body	2450	<5	8.00	6.310	10	Yes

10.3 Measured SAR Results

Note:

1. The value with blue color is the maximum SAR Value of each test band.

Body SAR

Band	Antenna	Test Position	Dist. (mm)	Mode	Duty Cycle	Channel /Frequency (MHz)	Tune-up (dBm)	Measured power (dBm)	1 Zone Area Scan SAR 1g	2 Zone Area Scan SAR 1g	3 Zone Area Scan SAR 1g	4 Zone Area Scan SAR 1g	Worst Zone Zoom Scan SAR 1g	Power Drift (dB)	Scaling Factor	Report SAR1g (W/kg)	Plot No.
Wi-Fi 2.4G	ANT1	Front Side	0	802.11b	99.0%	11/2462	17.50	16.59	0.008	0.006	0.001	0.001	0.009	0.030	1.25	0.011	4
	ANT2	Front Side	0	802.11b	99.0%	6/2437	17.00	15.76	0.004	0.002	0.001	0.001	0.008	-0.020	1.34	0.011	/
Wi-Fi 5G U-NII-1	ANT1	Front Side	0	802.11n HT40	95.9%	46/5230	16.50	15.20	0.014	0.016	0.018	0.004	0.029	-0.100	1.41	0.041	/
	ANT2	Front Side	0	802.11n HT40	95.9%	46/5230	16.50	15.72	0.015	0.016	0.015	0.018	0.029	0.010	1.25	0.036	/
Wi-Fi 5G U-NII-3	ANT1	Front Side	0	802.11a	96.9%	149/5745	17.00	15.88	0.015	0.023	0.022	0.023	0.035	-0.050	1.34	0.046	/
	ANT2	Front Side	0	802.11a	96.9%	165/5825	17.00	16.15	0.019	0.018	0.006	0.017	0.039	-0.130	1.25	0.049	5

10.4 Simultaneous Transmission Analysis

Simultaneous Transmission Configurations	Body
Wi-Fi 2.4GHz / 2.4GHz + Wi-Fi 5GHz	No

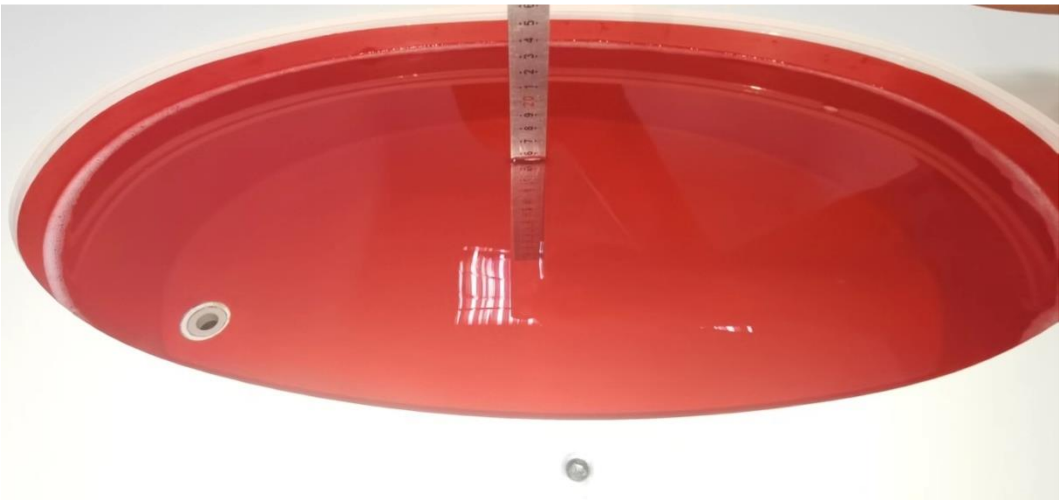
11 Measurement Uncertainty

Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528- 2013 is not required in SAR reports submitted for equipment approval.

ANNEX A: Test Layout

Tissue Simulating Liquids

For the measurement of the field distribution inside the flat phantom with DASY, the phantom must be filled with around 25 liters of homogeneous tissue simulating liquid. For SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is ＞15 cm, which is shown as below.



Picture 3: Liquid depth in the flat Phantom

ANNEX B: System Check Results

Plot 1 System Performance Check at 2450 MHz TSL

DUT: Dipole 2450 MHz; Type: D2450V2; Serial: D2450V2

Date: 2024/9/16

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

Medium parameters used: f = 2450 MHz; σ = 1.78 S/m; ε_r = 40.75; ρ = 1000 kg/m^3

Ambient Temperature:22.3 ℃ Liquid Temperature: 21.5℃

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN7689; ConvF(7.62, 8.01, 8.14); Calibrated: 2024/6/4

Electronics: DAE4 SN1692; Calibrated: 2023/11/8

Phantom: ELI v4.0; Type: QDOVA001BB;

Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

d=10mm, Pin=250mW/Area Scan (4x7x1): Measurement grid: dx=12mm, dy=12mm

Maximum value of SAR (measured) = 14.26 W/kg

d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 88.834 V/m; Power Drift = 0.015 dB

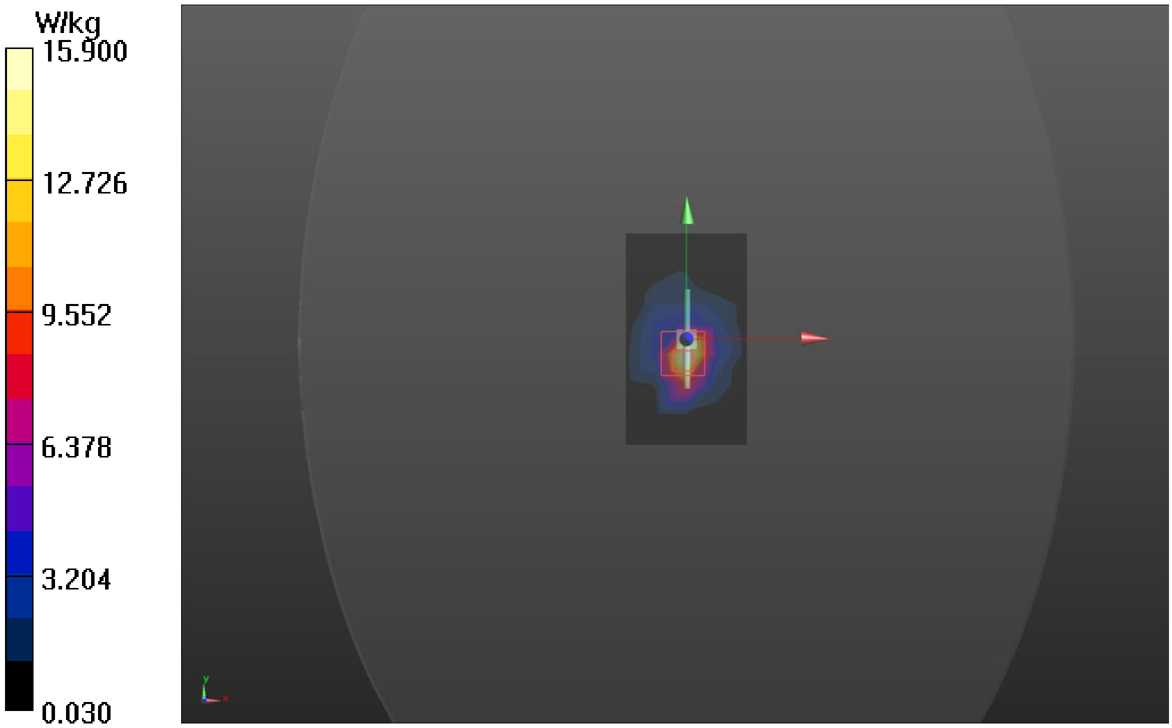
Peak SAR (extrapolated) = 30.10 W/kg

SAR(1 g) = 13.7 W/kg; SAR(10 g) = 6.22 W/kg

Smallest distance from peaks to all points 3 dB below = 8.9 mm

Ratio of SAR at M2 to SAR at M1 = 47%

Maximum value of SAR (measured) = 15.90 W/kg



Plot 2 System Performance Check at 5250 MHz TSL

DUT: Dipole 5250 MHz; Type: D5GHzV2; Serial: D5GHzV2

Date: 2024/9/5

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

Medium parameters used: f = 5250 MHz; σ = 4.52 S/m; ε_r = 36.26; ρ = 1000 kg/m^3

Ambient Temperature:22.3 ℃ Liquid Temperature: 21.5℃

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN7689; ConvF(5.87, 6.17, 6.27); Calibrated: 2024/6/4

Electronics: DAE4 SN1692; Calibrated: 2023/11/8

Phantom: ELI v4.0; Type: QDOVA001BB;

Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

d=10mm, Pin=100mW/Area Scan (6x10x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 9.14 W/kg

d=10mm, Pin=100mW/Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 33.654 V/m; Power Drift = -0.095 dB

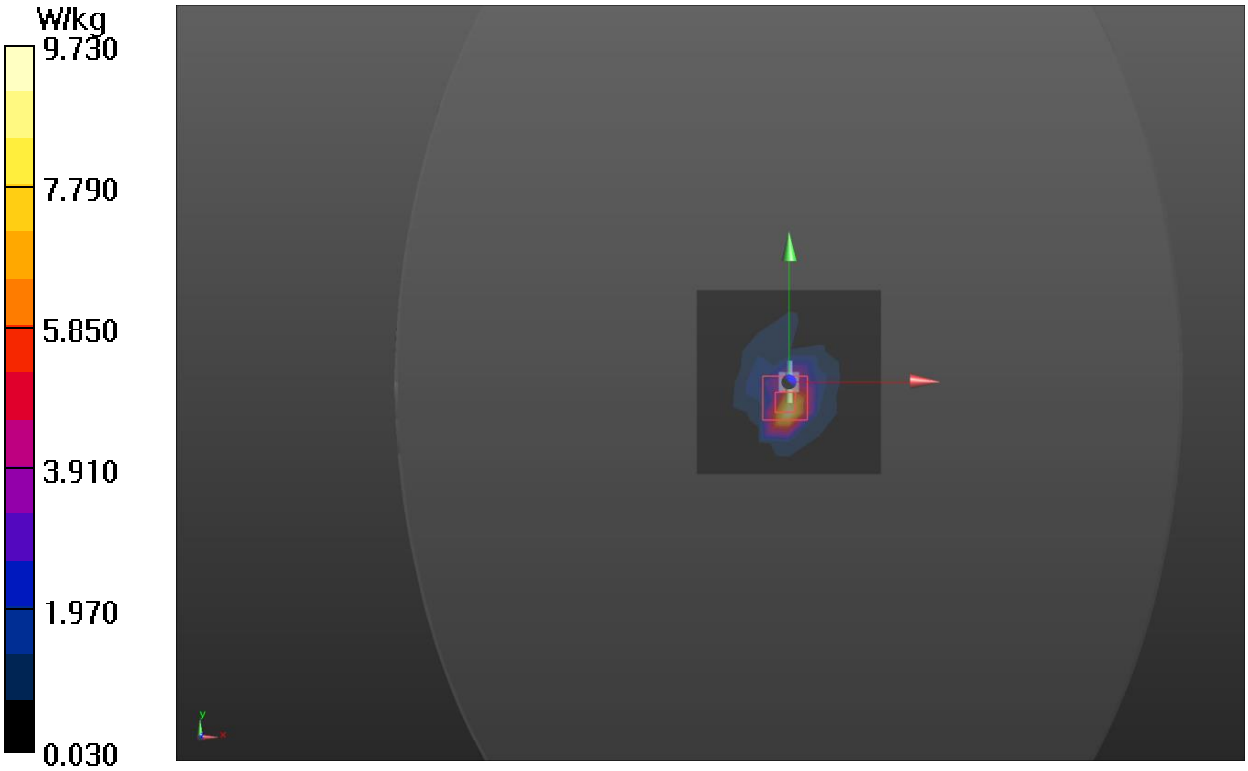
Peak SAR (extrapolated) = 52.20 W/kg

SAR(1 g) = 7.87 W/kg; SAR(10 g) = 2.25 W/kg

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

Ratio of SAR at M2 to SAR at M1 = 63%

Maximum value of SAR (measured) = 9.73 W/kg



Plot 3 System Performance Check at 5750 MHz TSL

DUT: Dipole 5750 MHz; Type: D5GHzV2; Serial: D5GHzV2

Date: 2024/9/6

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

Medium parameters used: f = 5800 MHz; σ = 5.09 S/m; ε_r = 35.10; ρ = 1000 kg/m^3

Ambient Temperature:22.3 ℃ Liquid Temperature: 21.5℃

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN7689; ConvF(5.31, 5.59, 5.68); Calibrated: 2024/6/4

Electronics: DAE4 SN1692; Calibrated: 2023/11/8

Phantom: ELI v4.0; Type: QDOVA001BB;

Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

d=10mm, Pin=100mW/Area Scan (6x10x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (interpolated) = 8.52 W/kg

d=10mm, Pin=100mW/Zoom Scan (8x8x7)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=1.4mm

Reference Value = 26.758 V/m; Power Drift = -0.080 dB

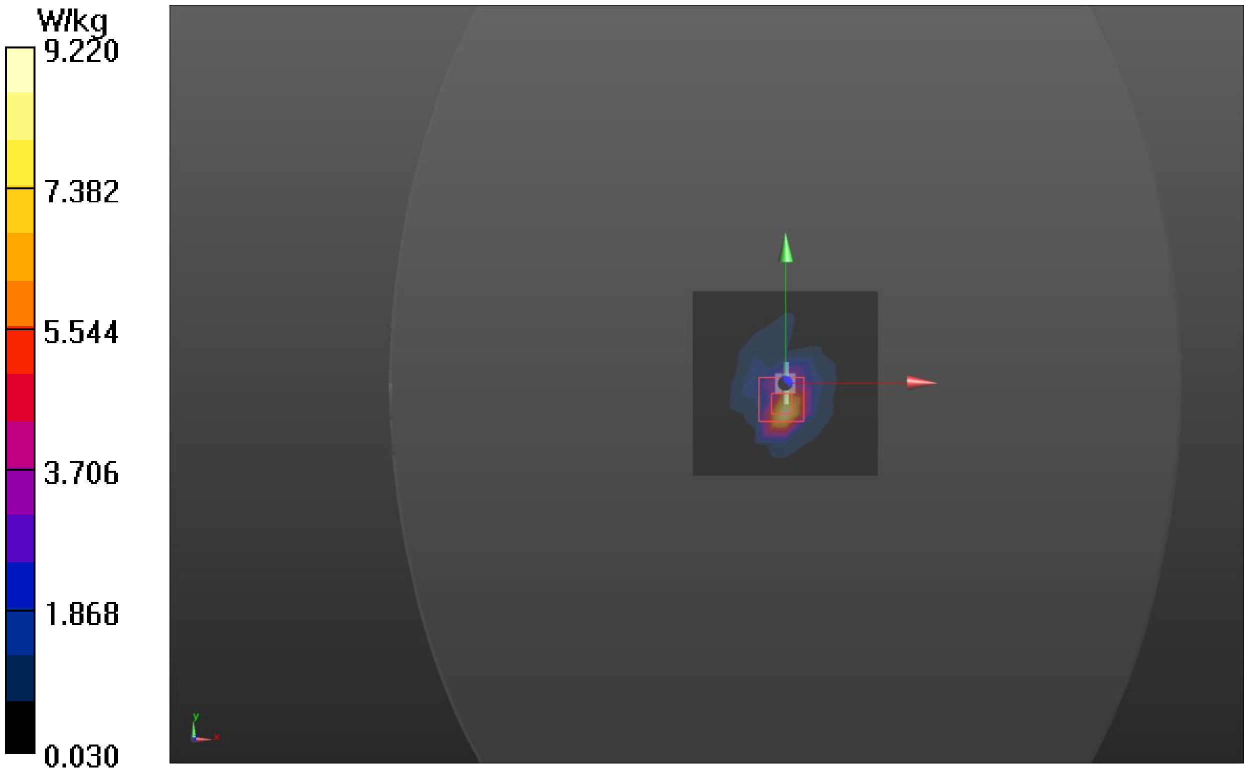
Peak SAR (extrapolated) = 24.52 W/kg

SAR(1 g) = 7.72 W/kg; SAR(10 g) = 2.13 W/kg

Smallest distance from peaks to all points 3 dB below = 9.4 mm

Ratio of SAR at M2 to SAR at M1 = 61.4%

Maximum value of SAR (measured) = 9.22 W/kg



ANNEX C: Highest Graph Results

Plot 4 802.11b Front Side High (Distance 0mm)

Date: 2024/9/16

Communication System: UID 0, 802.11b (0); Frequency: 2462 MHz;Duty Cycle: 1:1.01

Medium parameters used (interpolated): f = 2462 MHz; σ = 1.79 S/m; ε_r = 40.02; ρ = 1000 kg/m^3

Ambient Temperature:22.3 ℃ Liquid Temperature: 21.5℃

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN7689; ConvF(7.62, 8.01, 8.14); Calibrated: 2024/6/4

Electronics: DAE4 SN1692; Calibrated: 2023/11/8

Phantom: ELI v4.0; Type: QDOVA001BB;

Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

Front Side 0mm/High/Area Scan (24x32x1): Measurement grid: dx=12mm, dy=12mm

Maximum value of SAR (measured) = 0.011 W/kg

Front Side 0mm/High/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 1.629 V/m; Power Drift = 0.03 dB

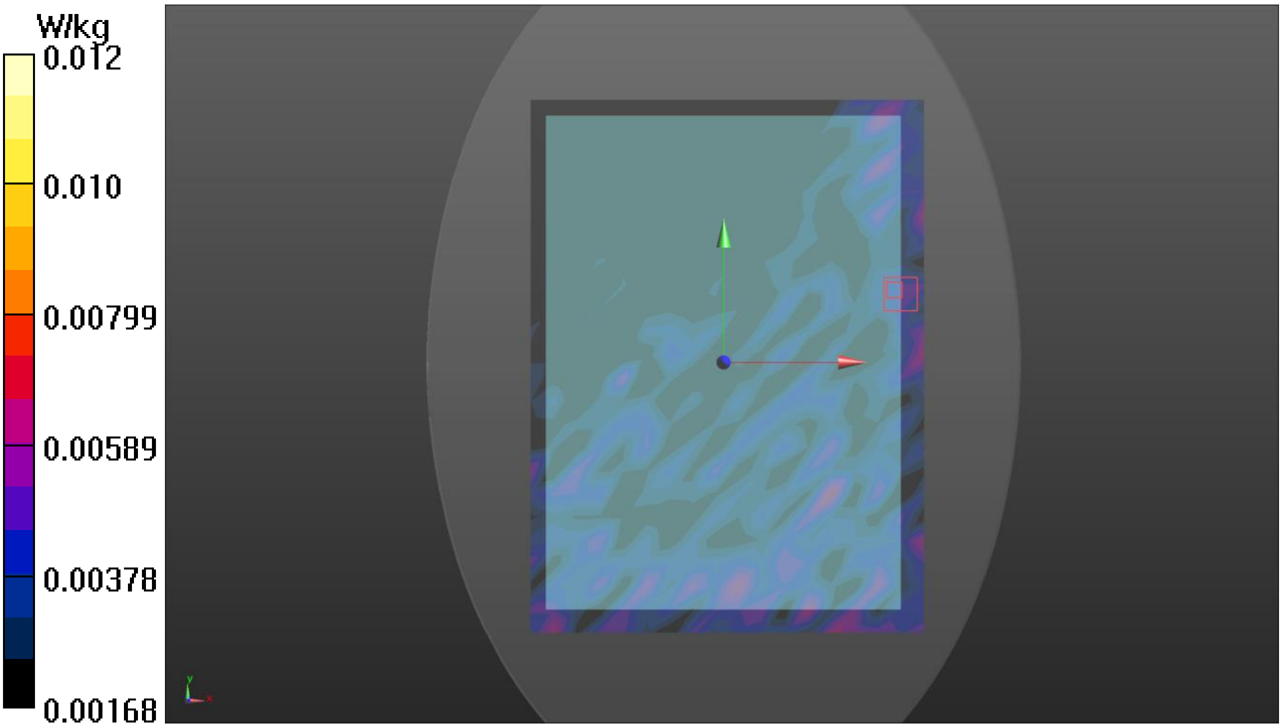
Peak SAR (extrapolated) = 0.018 W/kg

SAR(1 g) = 0.009 W/kg; SAR(10 g) = 0.007 W/kg

Smallest distance from peaks to all points 3 dB below = 12.4 mm

Ratio of SAR at M2 to SAR at M1 = 71.6%

Maximum value of SAR (measured) = 0.012 W/kg



Plot 5 802.11a U-NII-3 Front Side High (Distance 0mm)

Date: 2024/9/6

Communication System: UID 0, 802.11a (0); Frequency: 5825 MHz;Duty Cycle: 1:1.03

Medium parameters used: f = 5825 MHz; σ = 5.18 S/m; ε_r = 34.98; ρ = 1000 kg/m^3

Ambient Temperature:22.3 ℃ Liquid Temperature: 21.5℃

Phantom section: Flat Section

DASY5 Configuration:

Sensor-Surface: 1.4mm (Mechanical Surface Detection)

Probe: EX3DV4 - SN7689; ConvF(5.31, 5.59, 5.68); Calibrated: 2024/6/4

Electronics: DAE4 SN1692; Calibrated: 2023/11/8

Phantom: ELI v4.0; Type: QDOVA001BB;

Measurement SW: DASY52, Version 52.10 (4); SEMCAD X Version 14.6.14 (7483)

Front Side 0mm/High/Area Scan (29x38x1): Measurement grid: dx=10mm, dy=10mm

Maximum value of SAR (measured) = 0.041 W/kg

Front Side 0mm/High/Zoom Scan (7x7x12)/Cube 0: Measurement grid: dx=4mm, dy=4mm, dz=2mm

Reference Value = 1.715 V/m; Power Drift = -0.13 dB

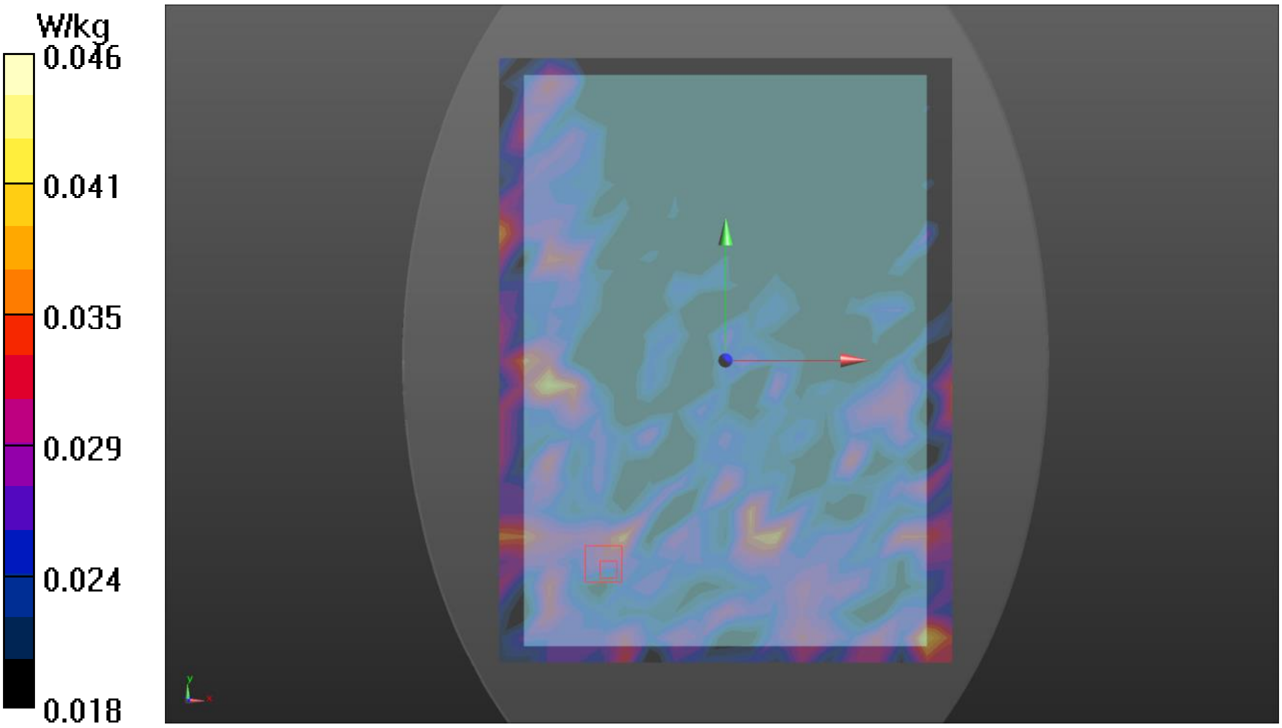
Peak SAR (extrapolated) = 0.048 W/kg

SAR(1 g) = 0.039 W/kg; SAR(10 g) = 0.032 W/kg

Smallest distance from peaks to all points 3 dB below = 11.4 mm

Ratio of SAR at M2 to SAR at M1 = 53.9%

Maximum value of SAR (measured) = 0.046 W/kg



ANNEX D: Probe Calibration Certificate (SN: 7689)

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

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
Servizio svizzero di taratura
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Accreditation No.: **SCS 0108**

Client: **TA Shanghai**

Certificate No.: **EX-7689_Jun24**

CALIBRATION CERTIFICATE

Object: EX3DV4 - SN:7689

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

Calibration date: June 04, 2024

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP2	SN: 104778	26-Mar-24 (No. 217-04036/04037)	Mar-25
Power sensor NRP-Z91	SN: 103244	26-Mar-24 (No. 217-04036)	Mar-25
OCP DAK-3.5 (weighted)	SN: 1249	05-Oct-23 (OCP-DAK3.5-1249_Oct23)	Oct-24
OCP DAK-12	SN: 1016	05-Oct-23 (OCP-DAK12-1016_Oct23)	Oct-24
Reference 20 dB Attenuator	SN: CC2552 (20x)	26-Mar-24 (No. 217-04046)	Mar-25
DAE4	SN: 660	23-Feb-24 (No. DAE4-660_Feb24)	Feb-25
Reference Probe EX3DV4	SN: 7349	03-Nov-23 (No. EX3-7349_Nov23)	Nov-24

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

	Name	Function	Signature
Calibrated by	Joanna Lleshaj	Laboratory Technician	
Approved by	Sven Kühn	Technical Manager	

Issued: June 4, 2024

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

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Glossary

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

Calibration is Performed According to the Following Standards:

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

Methods Applied and Interpretation of Parameters:

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

EX3DV4 - SN:7689 June 04, 2024

Parameters of Probe: EX3DV4 - SN:7689

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc ($k = 2$)
Norm ($\mu V/(V/m)^2$) [A]	0.56	0.61	0.60	±10.1%
DCP (mV) [B]	102.7	103.5	104.8	±4.7%

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B $dB\sqrt{\mu V}$	C	D dB	VR mV	Max dev.	Max Unc[E] $k = 2$
0	CW	X	0.00	0.00	1.00	0.00	123.5	±1.1%	±4.7%
		Y	0.00	0.00	1.00		119.7		
		Z	0.00	0.00	1.00		140.9		
10352	Pulse Waveform (200Hz, 10%)	X	1.60	61.02	6.64	10.00	60.0	±2.5%	±9.6%
		Y	1.42	60.16	6.02		60.0		
		Z	1.73	61.65	6.95		60.0		
10353	Pulse Waveform (200Hz, 20%)	X	0.79	60.00	4.97	6.99	80.0	±2.2%	±9.6%
		Y	0.82	60.00	4.79		80.0		
		Z	10.00	72.00	9.00		80.0		
10354	Pulse Waveform (200Hz, 40%)	X	0.32	149.82	0.95	3.98	95.0	±2.8%	±9.6%
		Y	20.00	72.00	7.00		95.0		
		Z	0.20	139.27	0.20		95.0		
10355	Pulse Waveform (200Hz, 60%)	X	0.29	60.00	2.80	2.22	120.0	±1.7%	±9.6%
		Y	8.70	158.89	15.99		120.0		
		Z	9.34	158.65	18.11		120.0		
10387	QPSK Waveform, 1 MHz	X	0.72	66.25	13.93	1.00	150.0	±3.8%	±9.6%
		Y	0.59	64.27	12.38		150.0		
		Z	0.79	67.02	14.20		150.0		
10388	QPSK Waveform, 10 MHz	X	1.50	66.93	14.73	0.00	150.0	±1.3%	±9.6%
		Y	1.37	65.88	13.93		150.0		
		Z	1.55	67.15	14.85		150.0		
10396	64-QAM Waveform, 100 kHz	X	1.72	64.78	16.18	3.01	150.0	±0.9%	±9.6%
		Y	1.71	64.79	15.98		150.0		
		Z	1.75	65.00	16.24		150.0		
10399	64-QAM Waveform, 40 MHz	X	2.95	66.69	15.41	0.00	150.0	±1.6%	±9.6%
		Y	2.86	66.30	15.09		150.0		
		Z	2.87	66.14	15.14		150.0		
10414	WLAN CCDF, 64-QAM, 40 MHz	X	3.96	66.18	15.49	0.00	150.0	±3.0%	±9.6%
		Y	3.86	65.92	15.26		150.0		
		Z	4.05	66.38	15.59		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] Linearization parameter uncertainty for maximum specified field strength.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

Parameters of Probe: EX3DV4 - SN:7689

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	10.8	78.12	33.65	2.19	0.00	4.90	0.42	0.00	1.00
y	10.5	76.45	33.69	3.63	0.00	4.91	0.50	0.00	1.00
z	11.2	81.08	33.46	3.12	0.00	4.90	0.41	0.00	1.00

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle	-2.4°
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	9 mm
Tip Diameter	2.5 mm
Probe Tip to Sensor X Calibration Point	1 mm
Probe Tip to Sensor Y Calibration Point	1 mm
Probe Tip to Sensor Z Calibration Point	1 mm
Recommended Measurement Distance from Surface	1.4 mm

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

Parameters of Probe: EX3DV4 - SN:7689

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz)[C]	Relative Permittivity[F]	Conductivity[F] (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha[G]	Depth[G] (mm)	Unc[H] ($k = 2$)
13	55.0	0.75	14.55	15.41	17.14	0.00	1.25	±13.3%
750	41.9	0.89	9.58	10.07	10.24	0.34	1.27	±11.0%
835	41.5	0.90	9.44	9.92	10.09	0.34	1.27	±11.0%
1750	40.1	1.37	8.01	8.42	8.56	0.35	1.27	±11.0%
1900	40.0	1.40	7.88	8.28	8.42	0.35	1.27	±11.0%
2000	40.0	1.40	7.78	8.18	8.32	0.35	1.27	±11.0%
2300	39.5	1.67	7.65	8.04	8.17	0.35	1.27	±11.0%
2450	39.2	1.80	7.62	8.01	8.14	0.35	1.27	±11.0%
2600	39.0	1.96	7.39	7.77	7.89	0.35	1.27	±11.0%
3300	38.2	2.71	6.80	7.15	7.27	0.36	1.27	±13.1%
3500	37.9	2.91	6.76	7.11	7.22	0.36	1.27	±13.1%
3700	37.7	3.12	6.71	7.05	7.17	0.36	1.27	±13.1%
3900	37.5	3.32	6.51	6.84	6.95	0.37	1.27	±13.1%
4100	37.2	3.53	6.39	6.72	6.83	0.37	1.27	±13.1%
4400	36.9	3.84	6.31	6.63	6.74	0.37	1.27	±13.1%
4600	36.7	4.04	6.28	6.59	6.70	0.37	1.27	±13.1%
4800	36.4	4.25	6.21	6.53	6.64	0.37	1.27	±13.1%
4950	36.3	4.40	6.11	6.42	6.53	0.36	1.27	±13.1%
5250	35.9	4.71	5.87	6.17	6.27	0.33	1.27	±13.1%
5600	35.5	5.07	5.33	5.60	5.70	0.29	1.27	±13.1%
5750	35.4	5.22	5.31	5.59	5.68	0.28	1.27	±13.1%

[C] Frequency validity above 300 MHz of ±100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ±50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ±10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4–9 MHz, and ConvF assessed at 13 MHz is 9–19 MHz. Above 5 GHz frequency validity can be extended to ±110 MHz.
[F] The probes are calibrated using tissue simulating liquids (TSL) that deviate for ε and σ by less than ±5% from the target values (typically better than ±3%) and are valid for TSL with deviations of up to ±10% if SAR correction is applied.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ±1% for frequencies below 3 GHz and below ±2% for frequencies between 3–6 GHz at any distance larger than half the probe tip diameter from the boundary.
[H] The stated uncertainty is the total calibration uncertainty ($k = 2$) of Norm-ConvF. Therefore, The uncertainty stated is equivalent to the uncertainty component with the symbol CF in Table 9 of IEC/IEEE 62209-1528:2020.

Parameters of Probe: EX3DV4 - SN:7689

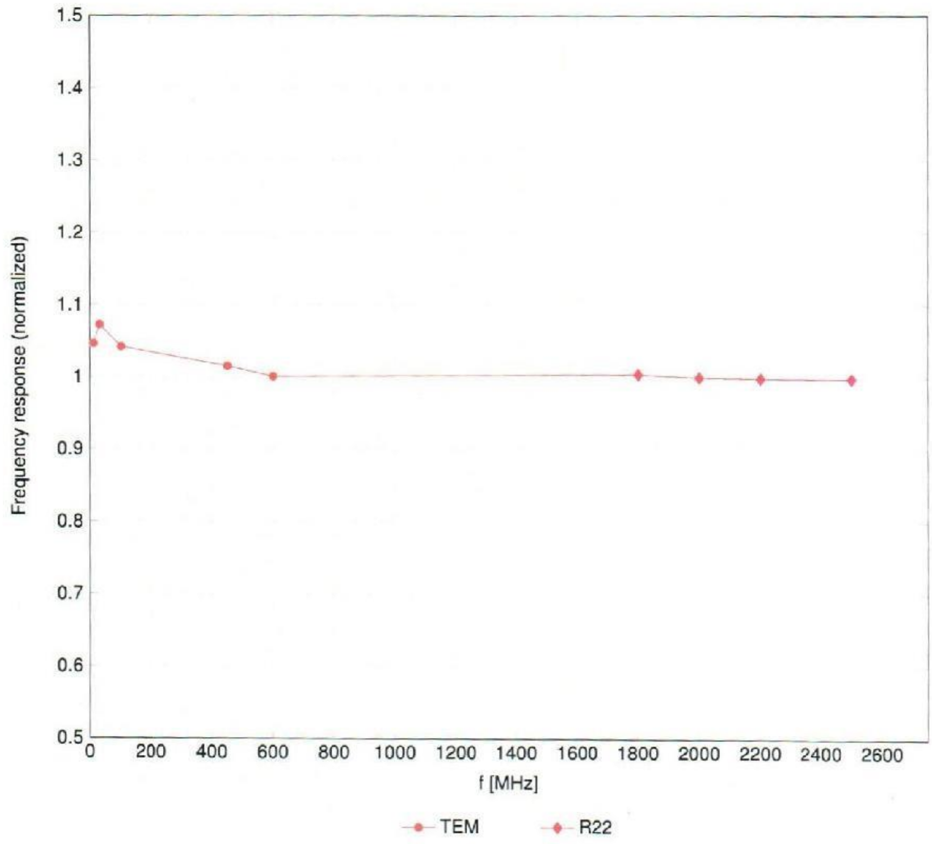
Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz)[C]	Relative Permittivity[F]	Conductivity[F] (S/m)	ConvF X	ConvF Y	ConvF Z	Alpha[G]	Depth[G] (mm)	Unc[H] ($k = 2$)
6500	34.5	6.07	6.03	6.33	6.44	0.20	1.27	±18.6%

[C] Frequency validity at 6.5 GHz is −600/+700 MHz, and ±700 MHz at or above 7 GHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band.
[F] The probes are calibrated using tissue simulating liquids (TSL) that deviate for ε and σ by less than ±10% from the target values (typically better than ±6%) and are valid for TSL with deviations of up to ±10%.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ±1% for frequencies below 3 GHz; below ±2% for frequencies between 3–6 GHz; and below ±4% for frequencies between 6–10 GHz at any distance larger than half the probe tip diameter from the boundary.
[H] The stated uncertainty is the total calibration uncertainty ($k = 2$) of Norm·ConvF. Therefore, The uncertainty stated is equivalent to the uncertainty component with the symbol CF in Table 9 of IEC/IEEE 62209-1528:2020.

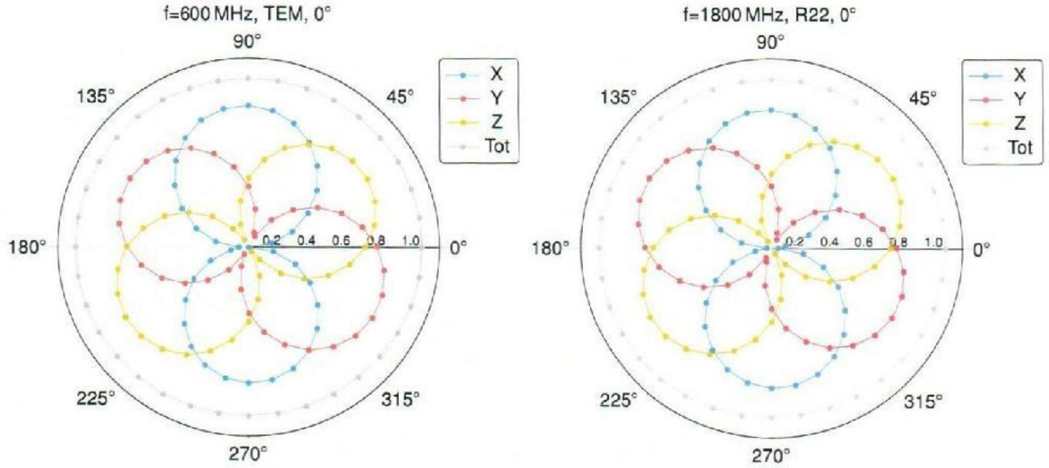
Frequency Response of E-Field

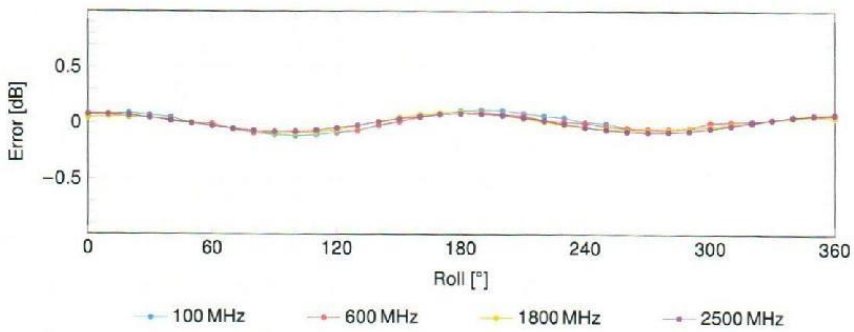
(TEM-Cell:ifi110 EXX, Waveguide:R22)



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

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





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