SAR Evaluation Report

DUT Information	
Manufacturer	Märklin
Model Name	Mobile Station WLAN
FCC ID	2A532WGM160P
IC Number	29966-WGM160P
DUT Type	hand-held wireless controller for model railroad
Intended Use	☒ < 20 cm to human body (portable device) ☐ > 20 cm to human body (mobile/fixed device) ☐ - ☐ next to the ear ☐ body-worn ☐ limb-worn ☒ hand-held ☐ front-of-face ☐ body supported ☐ clothing-integrated
Prepared by	
Testing Laboratory	IMST GmbH, Test Center Carl-Friedrich-Gauß-Str. 2 – 4 47475 Kamp-Lintfort Germany
Laboratory Accreditation	The Test Center facility 'Dosimetric Test Lab' within IMST GmbH is accredited by the German National 'Deutsche Akkreditierungsstelle GmbH (DAkkS)' for testing according to the scope as listed in the accreditation certificate: D-PL-12139-01-01. The German Bundesnetzagentur (BNetzA) recognizes IMST GmbH as CAB-EMC on the basis of the Council Decision of 22. June 1998 concerning the conclusion of the MRA between the European Community and the United States of America (1999/178/EC) in accordance with § 4 of the Recognition Ordinance of 11. January 2016. The recognition is valid until 20. July 2026 under the registration number: BNetzA-CAB-16/21-14/1.
Prepared for	
Applicant	Gebr. Märklin & Cie GmbH Stuttgarter Str. 55-57 73033 Göppingen Germany
Test Specification	
Applied Standard / Rule	FCC CFR 47 § 2.1093; IEC/IEEE 62209-1528; RSS-102 Issue 5
Exposure Category	☒ general public / uncontrolled exposure ☐ occupational / controlled exposure
Test Result	☒ PASS ☐ FAIL
Report Information	
Data Stored	6220619
Issue Date	December 27, 2022
Revision Date	August 31, 2023
Revision Number*	2
	***A new revision replaces all previous revisions and thus, become invalid herewith.**
Remarks	This report relates only to the item(s) evaluated. This report shall not be reproduced, except in its entirety, without the prior written approval of IMST GmbH. The results and statements contained in this report reflect the evaluation for the certain model described above. The manufacturer is responsible for ensuring that all production devices meet the intent of the requirements described in this report.

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SAR_FCC_ISED_Project_HHB_v2.3

1 Subject of Investigation and Test Results

The Mobile Station WLAN is a new hand-held wireless controller for model railroad from Märklin operating in IEEE 802.11 b/g/n standard.

The objective of the measurements done by IMST was the dosimetric assessment of one Mobile Station WLAN in extremity exposure configuration.

1.1 Technical Data of DUT

Product Specifications		
Manufacturer	Märklin	
Model Name	Mobile Station WLAN	
SN	SAR01	
Integrated Transmitter	SiLabs WGM16	
Operation Mode	IEEE 802.11 b/g/n (WLAN 2.4GHz)	
Frequency Range	2412 – 2462 MHz	
Antenna Type	integrated	
Maximum Output Power	refer chapter 7.3	
Power Supply	4x AAA 1.5V (LR03)	
Available Accessories	N/A-	
DUT Stage	☐ production unit	☒ identical prototype
Notes:		

1.2 Sketch of DUT

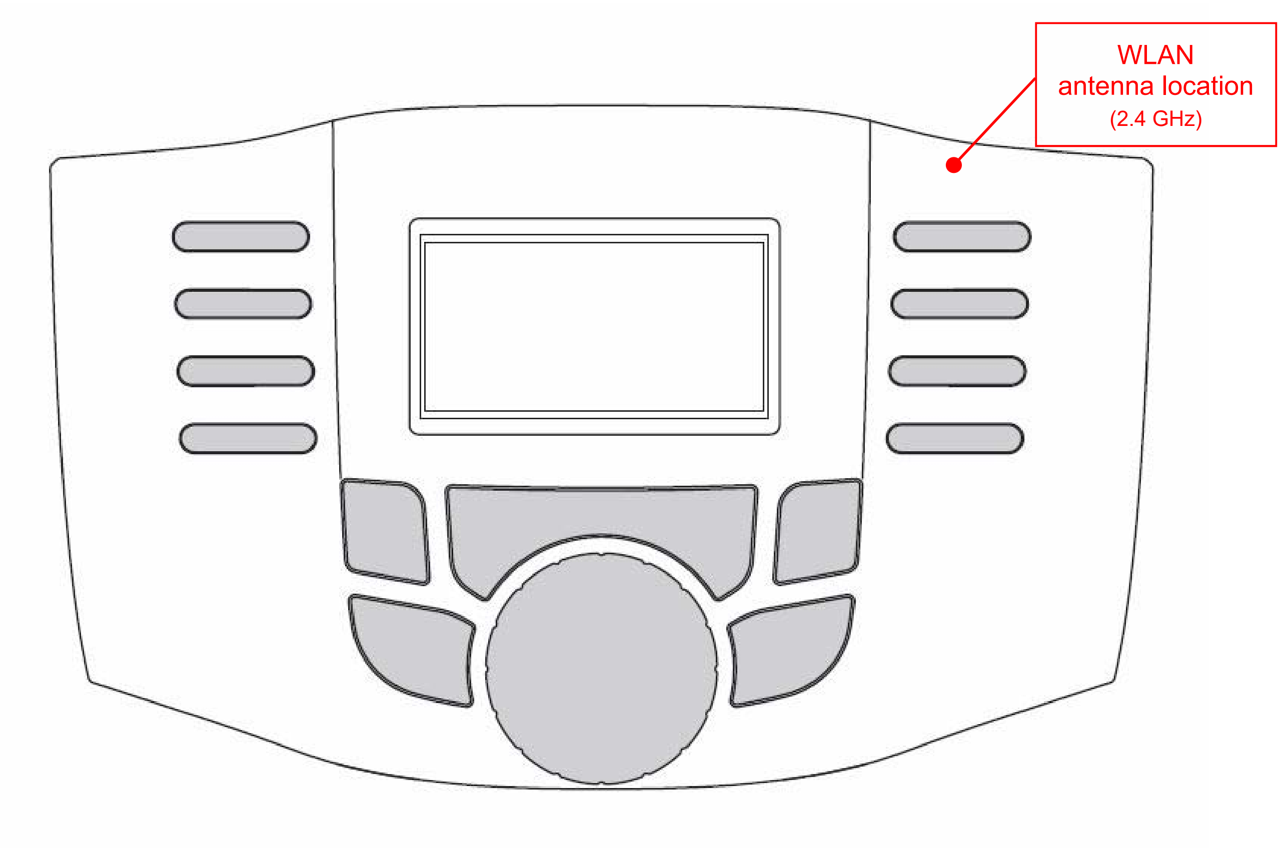


Fig. 1: Sketch of DUT and antenna location.

1.3 Test Specification / Normative References

The tests documented in this report have been performed according to the standards and rules described below.

Test Specifications		
Test Standard / Rule	**Description**	**Issue Date**
☒ 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-mounted wireless communication devices – Part 1528: Human models, instrumentation, and procedures (4 MHz to 10 GHz)	October, 2020
☐ FCC CFR 47 § 2.1091	Code of Federal Regulations; Title 47. Radiofrequency radiation exposure evaluation: **Mobile Devices.**	October 01, 2010
☒ FCC CFR 47 § 2.1093	Code of Federal Regulations; Title 47. Radiofrequency radiation exposure evaluation: **Portable Devices.**	October 01, 2010
☒ RSS-102, Issue 5	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands); and reference to IEEE 95.3	March, 2015
Measurement Methodology KDB		
☒ KDB 865664 D01 v01r04	SAR measurement 100 MHz to 6 GHz	August 07, 2015
☒ KDB 865664 D02 v01r01	Exposure Reporting	October 23, 2015
Product KDB		
☒ KDB 447498 D01 v06	General RF Exposure Guidance	October 23, 2015
☒ KDB 648474 D04 v01r03	Handset SAR	October 23, 2015
Technology KDB		
☒ KDB 248227 D01 v02r02	802.11 Wi-Fi SAR	October 23, 2015

1.4 Attestation of Test Results

Highest Reported SAR10g [W/kg]				
Exposure Configuration		**Equipment Class**	**Limit SAR_{10g}**	**Verdict**
		DTS (IEEE 802.11)		
Standalone TX	Extremity	0.439	4.0	PASS

Notes: To establish a connection at a specific channel and with maximum output power, engineering test software has been used. All measured SAR results and configurations are shown in chapter 7.3 on page 16.

2 Quality Assurance

The responsible test engineer states that all the measurements and evaluations have been performed under the guidelines of the valid quality assurance plan according to EN ISO IEC 17025-2017.

Prepared by: .... Reviewed by: ....

Alexander Rahn
Test Engineer

Jens Lerner
Quality Assurance

3 Exposure Criteria and Limits

3.1 SAR Limits

Human Exposure Limits				
Condition	Uncontrolled Environment (General Population)		Controlled Environment (Occupational)	
	SAR Limit [W/kg]	Mass Avg.	SAR Limit [W/kg]	Mass Avg.
SAR averaged over the whole body mass	0.08	whole body	0.4	whole body
Peak spatially-averaged SAR for the head, neck & trunk	1.6	1g of tissue*	8.0	1g of tissue*
Peak spatially-averaged SAR in the limbs	4.0	10g of tissue*	20.0	10g of tissue*
Note: *Defined as a tissue volume in the shape of a cube				

Table 1: SAR limits specified in IEEE Standard C95.1-2005 and Health Canada's Safety Code 6.

In this report the comparison between the exposure limits and the measured data is made using the spatial peak SAR; the power level of the device under test guarantees that the whole body averaged SAR is not exceeded.

3.2 Exposure Categories

General Public / Uncontrolled Exposure
General population comprises individuals of all ages and of varying health status, and may include particularly susceptible groups or individuals. In many cases, members of the public are unaware of their exposure to electromagnetic fields. Moreover, individual members of the public cannot reasonably be expected to take precautions to minimize or avoid exposure.
Occupational / Controlled Exposure
The occupationally exposed population consists of adults who are generally exposed under known conditions and are trained to be aware of potential risk and to take appropriate precautions.

Table 2: RF exposure categories.

3.3 Distinction between Maximum Permissible Exposure and SAR Limits

The biological relevant parameter describing the effects of electromagnetic fields in the frequency range of interest is the specific absorption rate SAR (dimension: power/mass). It is a measure of the power absorbed per unit mass. The SAR may be spatially averaged over the total mass of an exposed body or its parts. The SAR is calculated from the r.m.s. electric field strength *E* inside the human body, the conductivity σ and the mass density ρ of the biological tissue:

$$SAR = \sigma \frac{E^2}{\rho} = c \left. \frac{\partial T}{\partial t} \right|_{t \to 0+} \quad . \qquad (1)$$

The specific absorption rate describes the initial rate of temperature rise $\partial T / \partial t$ as a function of the specific heat capacity *c* of the tissue. A limitation of the specific absorption rate prevents an excessive heating of the human body by electromagnetic energy.

As it is sometimes difficult to determine the SAR directly by measurement (e.g. whole body averaged SAR), the standard specifies more readily measurable maximum permissible exposures in terms of external electric *E* and magnetic field strength *H* and power density *S*, derived from the SAR limits. The limits for *E*, *H* and *S* have been fixed so that even under worst case conditions, the limits for the specific absorption rate SAR are not exceeded.

4 The Measurement System

DASY is an abbreviation of „Dosimetric Assessment System“ and describes a system that is able to determine the SAR distribution inside a phantom of a human being according to different standards. The DASY4 system consists of the following items as shown in Fig: 2. Additionally, Fig: 3 shows the equipment, similar to the installations in other laboratories.

- Fully compliant with all current measurement standards as stated in Fig. 4
- High precision robot with controller
- Measurement server (for surveillance of the robot operation and signal filtering)
- Data acquisition electronics DAE (for signal amplification and filtering)
- Field probes calibrated for use in liquids
- Electro-optical converter EOC (conversion from the optical into a digital signal)
- Light beam (improving of the absolute probe positioning accuracy)
- Two SAM phantoms filled with tissue simulating liquid
- DASY4 software
- SEMCAD

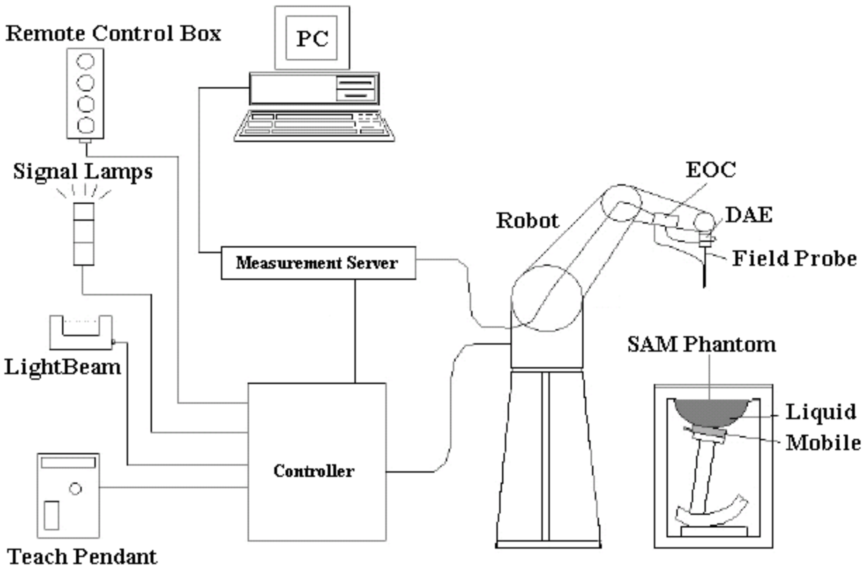


Fig. 2: The DASY4 measurement system.

Fig. 3: The measurement set-up with a DASY system and phantoms containing tissue simulating liquid.

The DUT operating at the maximum power level is placed by a non-metallic device holder (delivered from Schmid & Partner) in the above described positions at a shell phantom of a human being. The distribution of the electric field strength *E* is measured in the tissue simulating liquid within the shell phantom. For this miniaturised field probes with high sensitivity and low field disturbance are used. Afterwards the corresponding SAR values are calculated with the known electrical conductivity σ and the mass density ρ of the tissue in the SEMCAD FDTD software. The software is able to determine the averaged SAR values (averaging region 1 g or 10 g) for compliance testing.

The measurements are done by two scans: first a coarse scan determines the region of the maximum SAR, afterwards the averaged SAR is measured in a second scan within the shape of a cube.

4.1 Phantoms

TWIN SAM PHANTOM V4.0	
	Specific Anthropomorphic Mannequin delivered by Schmid & Partner Engineering AG. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. The details and the Certificate of conformity can be found in Fig. 5 on page 33.
Shell Thickness	2 ± 0.2 mm (6 ± 0.2 mm at ear point)
Dimensions	Length: 1000 mm; Width: 500 mm Height: adjustable feet
Filling Volume	approx. 25 liters

ELI PHANTOM V4.0	
	Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. The details and the Certificate of conformity can be found in Fig. 11 on page 34.
Shell Thickness	2.0 ± 0.2 mm (bottom plate)
Dimensions	Major axis: 600 mm Minor axis: 400 mm
Filling Volume	approx. 30 liters

4.2 E-Field-Probes

For the measurements the Dosimetric E-Field Probes ET3DV6R or EX3DV4 with following specifications are used. They are manufactured and calibrated in accordance with FCC and IEC/IEEE 62209-1528 recommendations annually by Schmid & Partner Engineering AG.

ET3DV6R	
Construction	Symmetrical design with triangular core Built-in optical fiber for surface detection system (ET3DV6 only) Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Dimensions	Overall length: 337 mm (Tip: 16 mm) Tip diameter: 6.8 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.7 mm
Frequency	10 MHz to 2.3 GHz Linearity: ± 0.2 dB (30 MHz to 2.3 GHz)
Directivity	Axial isotropy: ± 0.2 dB in TSL (rotation around probe axis) Spherical isotropy: ± 0.4 dB in TSL (rotation normal to probe axis)
Dynamic Range	5 µW/g to > 100 mW/g; Linearity: ± 0.2 dB
Calibration Range	450 MHz / 750 MHz / 835 MHz / 1750 MHz / 1900 MHz

EX3DV4	
Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
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
Frequency	10 MHz to > 6 GHz Linearity: ± 0.2 dB (30 MHz to 6 GHz)
Directivity	Axial isotropy: ± 0.3 dB in TSL (rotation around probe axis) Spherical isotropy: ± 0.5 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)
Calibration Range	2450 MHz / 2600 MHz / 5250 MHz / 5600 MHz / 5800 MHz

5 Measurement Procedure

5.1 General Requirement

The test shall be performed in a laboratory with an environment which avoids influence on SAR measurements by ambient EM sources and any reflection from the environment itself. The ambient temperature shall be in the range of 20°C to 26°C and 30-70% humidity. All tests have been conducted according the latest version of all relevant KDBs.

5.2 Test Position of DUT operating next to the Human Body

Body-worn operating configurations are tested with available accessories applied on the device and positioned against a flat phantom in a normal use configuration. Per FCC KDB 648474, Body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in KDB 447498 should be used to test for body-worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body worn accessory test separation distance is greater than or equal to that required for hotspot mode, when applicable. When the reported SAR for body worn accessory, measured without headset connected to the handset, is > 1.2 W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body worn accessory with a headset attached to the handset.

For purpose of determining test requirements, accessories may be divided into two categories: those that do not contain metallic components and those that do. For multiple accessories that do not contain metallic components, the device may be tested only with that accessory which provides the closest spacing to the body.

For multiple accessories that contain metallic components, the device must be tested with each accessory that contains a unique metallic component. If multiple accessories share an identical metallic component, only the accessory that provides the closest spacing to the body must be tested.

Devices that are designed to operate on the body of users using lanyards and straps, or without requiring additional body worn accessories, must be tested for SAR compliance using a conservative minimum test separation distance ≤ 5 mm to support compliance. Nevertheless, all accessories that contain metallic components must be tested for compliance additionally.

5.2.1 Test to be Performed

For devices with retractable antenna the SAR test shall be performed with the antenna fully extended and fully retracted. Other factors that may affect the exposure shall also be tested. For example, optional antennas or optional battery packs which may significantly change the volume, lengths, flip open/closed, etc. of the device, or any other accessories which might have the potential to considerably increase the peak spatial-average SAR value.

The SAR test shall be performed at the high, middle and low frequency channels of each operating mode. If the SAR measured at the middle channel resp. that channel with the highest output power for each test configuration is < 0.4 W/kg, testing at the high and low channels is optional.

5.3 Measurement Procedure

The following steps are used for each test position:

- Establish a call with the maximum output power with a base station simulator. The connection between the mobile phone and the base station simulator is established via air interface.
- Measurement of the local E-field value at a fixed location (P1). This value serves as a reference value for calculating a possible power drift.
- Measurement of the SAR distribution with resolution settings for area scan and zoom scan according IEC/IEEE 6209-1528 as shown in Table *3*.
- The used extrapolation and interpolation routines are all based on the modified Quadratic Shepard´s method [DASY4].
- Repetition of the E-field measurement at the fixed location (P1) and repetition of the whole procedure if the two results differ by more than ± 0.21dB.

Area Scan		
Parameter	**f ≤ 3 GHz**	**3 GHz < f ≤ 10 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 spacing between adjacent measured points in mm	20, or half of the corresponding zoom scan length, whichever is smaller	60/f, or half of the corresponding zoom scan length, whichever is smaller
Maximum angle between the probe axis and the phantom surface	5° ± 1° (flat phantom) 30° ± 1°(other phantoms)	5° ± 1° (flat phantom) 20° ± 1°(other phantoms)
Zoom Scan		
Maximum distance between the closest measured points and the phantom surface	5 mm	½·δ ln(2) [a]
Maximum angle between the probe axis and the phantom surface	5° ± 1° (flat phantom) 30° ± 1°(other phantoms)	5° ± 1° (flat phantom) 20° ± 1°(other phantoms)
Maximum spacing between measured points in the x- and y-directions (Δx and Δy)	8 mm	24/f [b]
Uniform grid: ΔZ_1 Maximum spacing between measured points in the direction normal to the phantom shell	5 mm	10/(f − 1)
Minimum edge length of the zoom scan volume in the x- and y-directions (L_z in O.8.3.2)	30 mm	22 mm
Minimum edge length of the zoom scan volume in the direction normal to the phantom shell (L_h in O.8.3.2 in mm)	30 mm	22 mm
Note:	[a] δ is the penetration depth for a plane-wave incident normally on a planar half-space. [b] This is the maximum spacing allowed, which might not work for all circumstance	

Table 3: Parameters for SAR scan procedures.

5.4 Additional Information for IEEE 802.11 (WiFi) Transmitters

According to KDB 248227 D01, for both DSSS and OFDM wireless modes an initial test position must be established for each applicable exposure configuration using either:

- Design implementation defined by the manufacturer, or
- Investigative results by the test lab based on:
    - o Exclusions based on the distance from the antenna to the surface, or
    - o Highest measured SAR from the area-scan-only measurements on all applicable test positions at the Initial Test Configuration, if found to require SAR tests.

Then, the initial test position procedure defines the required complete SAR scan measurements on each exposure configuration as following:

- When the reported SAR of the initial test position is ≤ 0.4 W/kg, further SAR measurements is not required for the remaining test positions in that configuration as well as 802.11 transmission mode combinations within the frequency or aggregated band.
- When the reported SAR of the initial test position is > 0.4 W/kg, further SAR measurements is required in the initial test position or next closest/smallest test separation distance based on manufacturer justification, on the following highest maximum output power channel, until the reported SAR is ≤ 0.8 W/kg or all required test positions are tested.
- When the reported SAR for all initial and subsequent test positions is > 0.8 W/kg, further SAR measurements is required on these positions on the subsequent next highest measured output power channels, until the reported SAR is ≤ 1.2 W/kg or all required channels have been tested.

For OFDM transmission configurations in 2.4 GHz and 5 GHz bands, it is important to determine SAR Initial Test Configuration for each stand alone and aggregated frequency band according to the maximum output power and tune-up tolerance specified for production units. The procedure is as following:

- Highest output power channel is chosen; if there are channels with same maximum output power then the closest to the mid-band frequency is preferred. If there are more than one channel with same maximum output power and same distance to the mid-band frequency, then the channel with the higher frequency is preferred.
- When SAR measurement is required for a subsequent test configuration and the channel bandwidth is smaller than that in the initial test configuration, all channels in the subsequent test configuration that overlap with the larger bandwidth channel tested in the initial test configuration should be used to determine the highest maximum output power channel in the subsequent test configuration.

Along with the initial test position reduction guidelines, the following procedures are also applied to SAR measurement requirements when multiple OFDM configurations are supported:

- When the reported SAR of the initial test configuration with the highest output power channel is > 0.8 W/kg, further SAR measurements is required for next highest output power channel in the initial test configuration, until the reported SAR is ≤ 1.2 W/kg or all required channels have been tested.
- When the reported SAR of the subsequent test configuration with the highest output power channel is > 1.2 W/kg, further SAR measurements is required for next highest output power channel in this test configuration, until the reported SAR is ≤ 1.2 W/kg or all required channels have been tested.
- When the reported SAR of the subsequent test configuration is > 1.2 W/kg, further SAR measurements for the following subsequent test configurations are required.

6 System Verification and Test Conditions

6.1 Date of Testing

Date of Testing			
Band	**Frequency [MHz]**	**Date of System Check**	**Date of SAR Measurement**
WiFi 2.4 GHz	2450	November 30, 2022	November 30, 2022

Table 4: Date of testing.

6.2 Environment Conditions

Environment Conditions		
Ambient Temperature[°C]	**Liquid Temperature [°C]**	**Humidity [%]**
22.0 ± 2	22.0 ± 2	40.0 ± 10
Notes: To comply with the required noise level (less than 12 mW/kg) periodically measurements without a DUT were conducted.		

Table 5: Environment Conditions.

6.3 Tissue Simulating Liquid Recipes

Tissue Simulating Liquid								
Frequency Range		**Water**	**Tween 20**	**Tween 80**	**Salt**	**Preventol**	**DGME**	**Triton X/100**
[MHz]		**[%]**	**[%]**	**[%]**	**[%]**	**[%]**	**[%]**	**[%]**
Head Tissue								
☐	450	50.8	47.5	-	1.6	0.1	-	-
☐	700 - 1000	52.8	46.0	-	1.1	0.1	-	-
☐	1600 - 1800	55.4	44.1	-	0.4	0.1	-	-
☐	1850 - 1980	55.2	44.5	-	0.2	0.1	-	-
☒	2000 - 2700	55.7	45.2	-	-	0.1	-	-
☐	5000 - 6000	65.5	-	-	-	-	17.25	17.25

Table 6: Recipes of the tissue simulating liquid.

6.4 Tissue Simulating Liquid Parameters

For the measurement of the following parameters the Speag DAK-3.5 dielectric probe kit is used, representing the open-ended coaxial probe measurement procedure.

Recommended values for the dielectric parameters of the tissue simulating liquids are given in IEEE 1528 and FCC published RF Exposure KDB Procedures. All tests were carried out using liquids with dielectric parameters within +/- 5% of the recommended values. The dielectric properties of the tissue simulating liquid have been measured within 24 h before SAR testing. The depth of the tissue simulant was at least 15.0 cm for all system check and device tests, measured from the ear reference point in case of the SAM phantom and from the inner surface of the flat phantom.

Tissue Simulating Liquids									
Ambient Temperature(C) : 22.0 ± 2			Liquid Temperature(C) : 23.0 ± 2			Humidity (%) : 40.0 ± 10			Date
Band	Frequency	Channel	Permittivity			Conductivity			
			Measured	Target	Delta	Measured	Target	Delta	
	[MHz]		ε'	ε'	+/- 5 [%]	σ [S/m]	σ [S/m]	+/- 5 [%]	
WLAN 2.4 GHz	2450	System Check	40.3	39.2	2.9	1.84	1.80	2.1	2022-Nov-30
	2412	1	40.5	39.3	3.0	1.80	1.76	1.9	
	2437	6	40.4	39.2	3.0	1.83	1.79	2.4	
	2462	11	40.3	39.2	2.9	1.85	1.81	2.1	

Table 7: Parameters of the head tissue simulating liquid.

6.5 Simplified Performance Checking

The simplified performance check was realized using the dipole validation kit. The input power of the dipole antenna was 250 mW (CW) and it was placed under the flat part of the SAM phantom. The target and measured results are listed in the table 8 and shown in Appendix C - System Verification Plots.

The target values were adopted from the calibration certificates found also in the appendix.

System Check Results										
Frequency [MHz]	Dipole #SN	Measured				Target		Delta		Date
		with 250 mW		scaled to 1 W		normalized to 1 W		+/- 10 [%]		
		1g	10g	1g	10g	1g	10g	1g	10g	
2450	D2450V2 #709	13.60	6.33	54.40	25.32	52.00	24.50	4.62	3.35	Nov. 30, 2022
Notes:										

Table 8: Dipole target and measured results.

7 SAR Measurement Conditions and Results

7.1 SAR Measurement Conditions

Test Conditions				
Band	**TX Range [MHz]**	**Used Channels**	**Crest Factor**	**Phantom**
WLAN 2.4 GHz	2412.0 – 2462.0	1, 6, 11	1	SAM Twin Phantom V4.0
Notes:				

Table 9: Used channels and crest factors during the test.

7.2 Tune-Up Information

Tune-Up Output Power			
Band	**Frequency [MHz]**	**Mode**	**Tune-Up Limit [dBm]**
WLAN 2.4 GHz	2412.0 – 2462.0	802.11 b	16.65
		802.11 g	15.25
		802.11 n	14.95
Notes:			

Table 10: Maximum transmitting output power values declared by the manufacturer.

7.3 Measured Output Power

Max. Averaged Output Power (RMS) [dBm]										
2.4 GHz Range	**Frequency [MHz]**	**CH**	**SW PWL 16**							
			Data Rate [Mbit/s]							
Mode			**1**		**2**		**5.5**		**11**	
b	2412	1	14.70		14.70		14.60		14.60	
	2437	6	15.70		-		-		-	
	2462	11	14.70		14.1		13.8		13.8	
Mode	**Frequency [MHz]**	**CH**	**SW PWL 19**							
			Data Rate [Mbit/s]							
			6.0	**9**	**12**	**18**	**24**	**36**	**48**	**54**
g	2412	1	NR*	-	-	-	-	-	-	-
	2437	6	NR*	-	-	-	-	-	-	-
	2462	11	NR*	-	-	-	-	-	-	-
Mode	**Frequency [MHz]**	**CH**	**SW PWL 19**							
			MCS Index No.							
			MCS0	**MCS1**	**MCS2**	**MCS3**	**MCS4**	**MCS5**	**MCS6**	**MCS7**
n HT20	2412	1	NR*	-	-	-	-	-	-	-
	2437	6	NR*	-	-	-	-	-	-	-
	2462	11	NR*	-	-	-	-	-	-	-

Notes:

NR* = Not required. The maximum possible output power (tune-up limits) for IEEE 802.11 g/n are significantly lower than for IEEE 802.11 b. Therefore, IEEE 802.11 g/n modes have been excluded from testing.

When the same tune-up power limit is specified for multiple transmission modes in a frequency band, the lowest order modulation, lowest data rate and lowest order 802.11 b/g/n modes is used for SAR measurement.

Table 11: Conducted output power values for WLAN 2.4 GHz.

7.4 Standalone SAR Test Exclusion according to KDB 447498

SAR test exclusion is determined for the DUT according to KDB 447498 D01 with 1g SAR exclusion thresholds for 100 MHz to 6GHz at test separation distances ≤ 50 mm determined by:

*[(max power of channel. incl. tune-up tolerance. mW) / (min test separation distance. mm)] * [√f(GHz)]*

≤ 3.0 for 1g SAR and ≤ 7.5 for 10g extremity SAR, where

- f(GHz) is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

Standalone SAR Test Exclusion Consideration (FCC)												
Mode	Freq.	Distance	Output Power		Maximum Duty Cycle	Output Power (RMS)		Threshold Comparison Value	Exclusion Threshold SAR 10g	SAR Testing Exclusion	Estimated SAR Values	SAR Testing Required
	[MHz]	[mm]	[dBm]	[mW]	[%]	[dBm]	[mW]					
WLAN	2450	5	16.65	46.24	100.0	16.65	46.24	14.5	≤ 7.5	NO	measured	YES
Notes:												

Table 12: SAR test exclusion for the applicable transmitter according to KDB 447498.

When the standalone SAR test exclusion applies to an antenna that transmits simultaneously with other antennas the standalone SAR must be estimated according to KDB 447498 in order to determine simultaneous transmission SAR test exclusion:

- *(max. power of channel. including tune-up tolerance. mW)/(min. test separation distance. mm)]·[√f(GHz)/x] W/kg for test separation distances ≤ 50 mm;*

where x = 7.5 for 1-g SAR and x = 18.75 for 10-g SAR

When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

- *0.4 W/kg for 1g SAR and 1.0 W/kg for 10g SAR. when the test separation distance is > 50 mm*

7.5 SAR Test Exclusion Consideration according to RSS-102

Standalone SAR Test Exclusion Consideration (ISED)										
Mode	Freq.	Distance	Output Power		Maximum Duty Cycle	Output Power (RMS)		Exemption Limit for SAR 1g [mW]	SAR Testing Exclusion	SAR Testing Required
	[MHz]	[mm]	[dBm]	[mW]	[%]	[dBm]	[mW]	Extremity	Extremity	Extremity
WLAN	2450	5	16.65	46.24	100.0	16.65	46.24	10.0	NO	YES
Notes:										

Table 13: SAR test exclusion for the applicable transmitter according to RSS-102, section 2.5.1.

7.6 SAR Measurement Results

SAR assessment was conducted in the worst case configuration with output power values according to the tables in Chapter 7.3. According to KDB 447498 D01, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance limit shown in Chapter 7.2.

Reported SAR is calculated by the following formulas:

- Scaling factor tune up limit = tune-up limit power (mW) / RF power (mW)
- Scaling factor max. duty cycle = max. possible duty cycle / used duty cycle for SAR measurement
- Reported SAR = measured SAR * scaling factor tune up limit * scaling factor max. duty cycle

The plots with the highest measured SAR values are shown in Appendix B - SAR Distribution Plots.

7.6.1 SAR Measurement Results

SAR Measurement Results for Extremity Exposure Configuration [W/kg]													
Band	Mode IEEE 802.11	Frequency [MHz]	CH	Exposure Position of DUT	Gap [mm]	Measured	Power Drift [dB]	Power [dBm]		Tune-Up SF	Reported	Plot No.	Note No.
						SAR10g		Meas.	Limit		SAR10g		
WLAN 2.4 DSSS	b 1Mbps	2437	6	Front (1)	0	0.088	0.036	15.7	16.65	1.245	0.110		
				Front (2)	0	0.112	0.034	15.7	16.65	1.245	0.139		
				Rear	0	0.050	-0.138	15.7	16.65	1.245	0.062		
				Left	0	0.023	0.060	15.7	16.65	1.245	0.029		
				Right	0	0.049	-0.142	15.7	16.65	1.245	0.061		
				Top (1)	0	0.223	-0.195	15.7	16.65	1.245	0.278		
				Top (2)	0	0.353	0.061	15.7	16.65	1.245	**0.439**	1	
		2412	1	Top (2)	0	0.250	0.041	14.7	16.65	1.567	0.392		
		2462	11	Top (2)	0	0.263	-0.020	14.7	16.65	1.567	0.412		
Notes: Tune-up limits for IEEE 802.11 g/n are significantly lower than for IEEE 802.11 b and have been therefore excluded from testing.													

Table 14: SAR measurement results for IEEE 802.11 b in extremity exposure configuration.

To control the output power stability during the SAR test the used DASY4 system calculates the power drift by measuring the e-field at the same location at the beginning and at the end of the measurement for each test position. These drift values can be found in the above tables labeled as: (Power Drift [dB]). This ensures that the power drift during one measurement is within 5%.

8 Administrative Measurement Data

8.1 Calibration of Test Equipment

Test Equipment Overview					
Test Equipment	**Manufacturer**	**Model**	**Serial Number**	**Last Calibration**	**Next Calibration**
DASY System Components					
☒ Software Versions DASY4	SPEAG	V4.7	N/A	N/A	N/A
☒ Software Versions SEMCAD	SPEAG	V1.8	N/A	N/A	N/A
☐ Dosimetric E-Field Probe	SPEAG	ET3DV6R	1579	02/2022	02/2024
☐ Dosimetric E-Field Probe	SPEAG	ET3DV6R	1669	03/2021	03/2023
☒ Dosimetric E-Field Probe	SPEAG	EX3DV4	3536	10/2022	10/2024
☐ Dosimetric E-Field Probe	SPEAG	EX3DV4	3860	10/2021	10/2023
☐ Data Acquisition Electronics	SPEAG	DAE 3	335	02/2022	02/2023
☐ Data Acquisition Electronics	SPEAG	DAE 4	631	10/2022	10/2023
☐ Phantom	SPEAG	SAM	1059	N/A	N/A
☐ Phantom	SPEAG	SAM	1176	N/A	N/A
☐ Phantom	SPEAG	SAM	1340	N/A	N/A
☒ Phantom	SPEAG	SAM	1341	N/A	N/A
☐ Phantom	SPEAG	ELI4	1004	N/A	N/A
Dipoles					
☐ System Validation Loop Antenna	SPEAG	CLA150	4029	02/2022	02/2025
☐ System Validation Dipole	SPEAG	D450V2	1014	03/2021	03/2024
☐ System Validation Dipole	IMST	diSARA750	0702103	05/2020	05/2023
☐ System Validation Dipole	SPEAG	D835V2	470	03/2021	03/2024
☐ System Validation Dipole	SPEAG	D1640V2	311	09/2018	/
☐ System Validation Dipole	SPEAG	D1750V2	1005	03/2021	03/2024
☐ System Validation Dipole	SPEAG	D1900V2	535	03/2021	03/2024
☒ System Validation Dipole	SPEAG	D2450V2	709	10/2021	10/2024
☐ System Validation Dipole	SPEAG	D2600V2	1019	10/2021	10/2024
☐ System Validation Dipole	SPEAG	D5GHzV2	1028	05/2020	05/2023
Material Measurement					
☒ Network Analyzer	Agilent	E5071C	MY46103220	10/2021	10/2023
☒ Dielectric Probe Kit	SPEAG	DAK-3.5	1234	02/2022	02/2024
☐ Dielectric Probe Kit	SPEAG	DAK-12	1151	02/2022	02/2024
☒ Thermometer	LKMelectronic	DTM3000	3511	02/2022	02/2024
Power Meters and Sensors					
☒ Power Meter	Anritsu	ML2487A	6K00002319	08/2022	08/2024
☒ Power Sensor	Anritsu	MA2472A	990365	08/2022	08/2024
☒ Power Meter	Anritsu	ML2488A	6K00002078	08/2022	08/2024
☒ Power Sensor	Anritsu	MA2472A	002122	08/2022	08/2024
☐ Spectrum Analyzer	Rohde & Schwarz	FSP7	100433	01/2021	01/2023
RF Sources					
☒ Network Analyzer	Agilent	E5071C	MY46103220	10/2021	10/2023
☐ RF Generator	Rohde & Schwarz	SM300	100142	N/A	N/A
Amplifiers					
☒ Amplifier 10 MHz – 4200 MHz	Mini Circuits	ZHL-42-42W	D080504-1	N/A	N/A
☐ Amplifier 2 GHz – 6 GHz	Ciao Wireless	CA26-451	37452	N/A	N/A
Radio Tester					
☐ Radio Communication Tester	Anritsu	MT8815B	6200576536	06/2022	06/2024
☐ Radio Communication Tester	Anritsu	MT8820C	6200918336	06/2022	06/2024
Notes: Used test equipment for measurement is checked above.					

Table 15: Calibration of test equipment.

8.2 Uncertainty Assessment

The following tables include the uncertainty budgets suggested by IEC/IEEE 62209-1528. The requirements for the validity and the certificate of conformity can be found in Appendix D – Certificates of Conformity.

Uncertainty Budget for SAR Measurements according to IEC/IEEE 62209-1528 (300 MHz - 6 GHz)								
Error Sources	**Uncertainty Value [± %]**	**Probability Distribution**	**Divisor**	**c_i**	**c_i**	**Standard Uncertainty [± %]**		**v_i^2 or v_{eff}**
Measurement System				1g	10g	1g	10g	
Probe calibration	6.3	Normal (k=2)	1	1	1	6.3	6.3	∞
Probe linearity	0.3	Rectangular	√3	1	1	0.2	0.2	∞
Probe isotropy axial	0.3	Rectangular	√3	√0.5	√0.5	0.1	0.1	∞
Probe isotropy spherical	1.3	Rectangular	√3	√0.5	√0.5	0.5	0.5	∞
Boundary effects	1.0	Rectangular	√3	1	1	0.6	0.6	∞
System detection limit	1.0	Rectangular	√3	1	1	0.6	0.6	∞
Modulation response	4.0	Rectangular	√3	1	1	2.3	2.3	∞
Readout electronics	0.3	Normal	1	1	1	0.3	0.3	∞
Response time	0.8	Rectangular	√3	1	1	0.5	0.5	∞
Integration time	1.4	Rectangular	√3	1	1	0.8	0.8	∞
RF ambient conditions - noise	3.0	Rectangular	√3	1	1	1.7	1.7	∞
RF ambient conditions - refl.	3.0	Rectangular	√3	1	1	1.7	1.7	∞
Probe positioner mech. tol.	0.4	Rectangular	√3	1	1	0.2	0.2	∞
Probe positioning	2.9	Rectangular	√3	1	1	1.7	1.7	∞
Data processing errors	4.0	Rectangular	√3	1	1	2.3	2.3	∞
Phantom and set-up errors								
Measurement of phantom conductivity	5.0	Normal	1	1	1	5.0	5.0	∞
Liquid conductivity temp. unc.	2.9	Rectangular	√3	0.78	0.71	1.3	1.2	∞
Liquid permittivity temp. unc.	1.8	Rectangular	√3	0.23	0.26	0.2	0.3	∞
Phantom shell permittivity	4.0	Rectangular	√3	1	1	2.3	2.3	∞
Distance between DUT and medium	1.0	Normal	1	2	2	2.0	1.0	∞
Repeatability of positioning the DUT	2.9	Normal	1	1	1	2.9	2.9	145
Device holder uncertainty	3.6	Normal	1	1	1	3.6	3.6	5
Effect of operation mode	7.0	Rectangular	√3	1	1	4.0	4.0	∞
Time-average SAR	5.0	Rectangular	√3	1	1	2.9	2.9	∞
SAR drift measurement (< 0.2 dB)	4.7	Rectangular	√3	1	1	2.7	2.7	∞
Corrections to the SAR result								
Phantom deviation from target (ε',σ)	1.2	Normal	1	1	0.8	1.2	1.0	∞
SAR scaling	2.0	Rectangular	√3	1	1	1.2	1.2	∞
Combined Standard Uncertainty						12.4	12.2	
Coverage Factor for 95%						kp=2		
Expanded Standard Uncertainty						**24.8**	**24.5**	
Notes: *Worst case probe calibration uncertainty has been applied for all available probes and frequencies.*								

Table 16: Uncertainty budget for SAR measurement.

9 Report History

Revision History				
Revision	**Description of Revision**	**Date**	**Revised Page**	**Revised By**
/	Initial Release	December 27, 2022	-	-
1	Changes: FCC ID and IC (Page 1 and 20); Added RSS-102 reference to IEEE 95.3 (Page 4); E-field probe selection corrected (Page 17); Date and temperatures added to SAR plots (Page 30 and 31)	June 1, 2023	1, 4, 17, 20, 30 and 31	JL
2	Changes: Measuring dates corrected underneath SAR plots	August 31, 2023	30 and 31	JL

END OF THE SAR REPORT

Please refer to separated appendix file for the following data:

- Appendix A - Pictures
- Appendix B - SAR Distribution Plots
- Appendix C - System Verification Plots
- Appendix D – Certificates of Conformity
- Appendix E – Calibration Certificates for DAEs
- Appendix F – Calibration Certificates for E-Field Probes
- Appendix G – Calibration Certificates for Dipoles

Appendixes for Report SAR_FCC_ISED_6220619_MWS

DUT Information				
Manufacturer	Märklin			
Model Name	Mobile Station WLAN			
FCC ID	2A532WGM160P			
IC Number	29966-WGM160P			
Type / Category	hand-held wireless controller for model railroad			
Intended Use	☒ < 20 cm to human body (portable device)		☐ > 20 cm to human body (mobile/fixed device)	
	☐ -	☐ next to the ear	☐ body-worn	☐ limb-worn
	☒ hand-held	☐ front-of-face	☐ body supported	☐ clothing-integrated

Prepared by	
Testing Laboratory	IMST GmbH, Test Center Carl-Friedrich-Gauß-Str. 2 – 4 47475 Kamp-Lintfort Germany

Prepared for	
Applicant	Gebr. Märklin & Cie GmbH Stuttgarter Str. 55-57 73033 Göppingen Germany

Test Specification		
Applied Standard / Rule	FCC CFR 47 § 2.1093; IEC/IEEE 62209-1528; RSS-102 Issue 5	
Exposure Category	☒ general public / uncontrolled exposure	☐ occupational / controlled exposure
Test Result	☒ PASS	☐ FAIL

Report Information	
Data Stored	6220619
Issue Date	December 27, 2022
Revision Date	August 31, 2023
Revision Number*	2
	***A new revision replaces all previous revisions and thus, become invalid herewith.**
Appendixes	Appendix A - Pictures Appendix B - SAR Distribution Plots Appendix C - System Verification Plots Appendix D – Certificates of Conformity Appendix E – Calibration Certificates for DAEs Appendix F – Calibration Certificates for E-Field Probes Appendix G – Calibration Certificates for Dipoles

Appendix A - Pictures

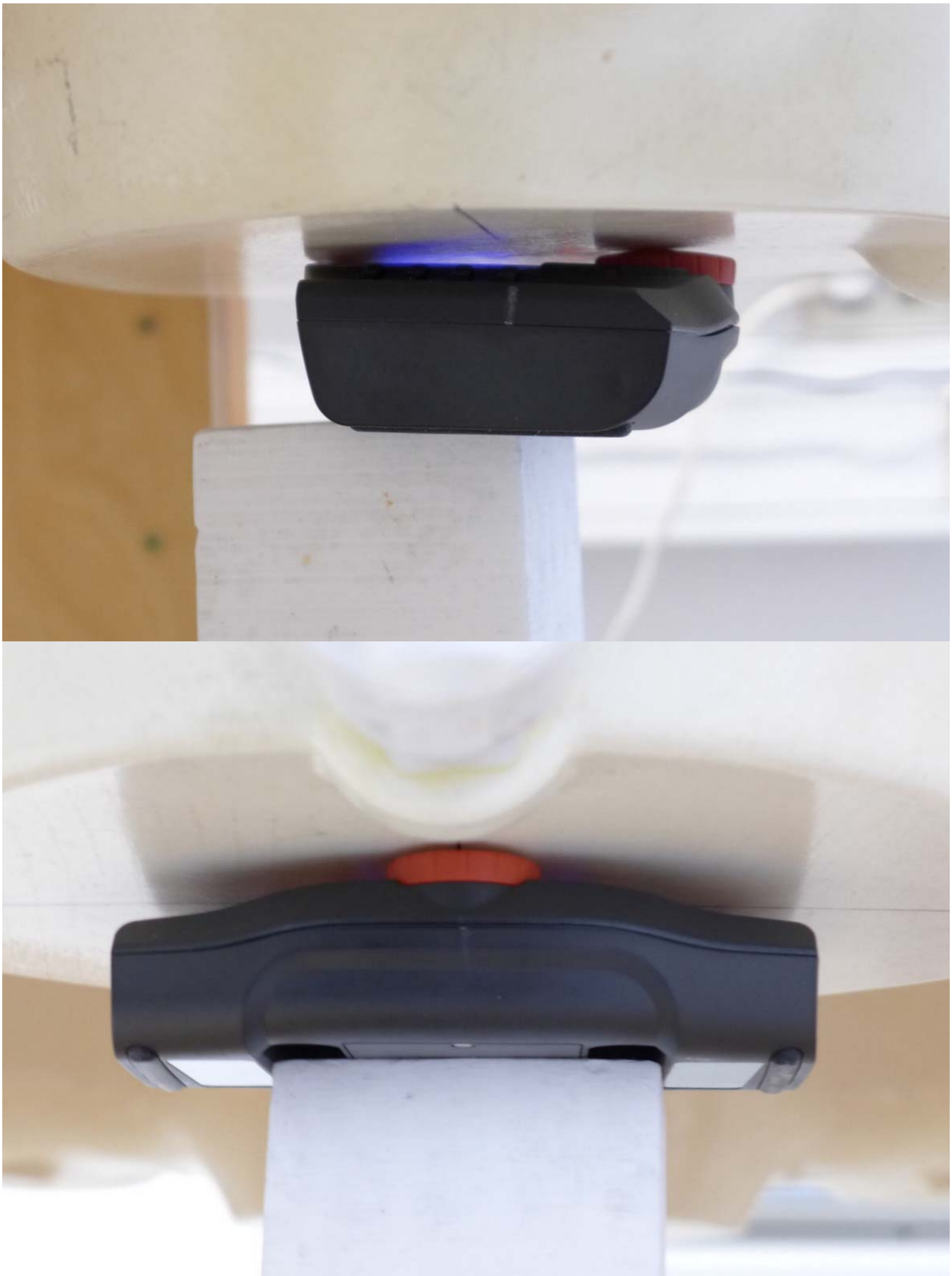
Pictures of the DUT

Pic.1: *Front and right side views of the DUT.*

Pic. 2: *Rear and left side views of the DUT.*

Pic. 3: *Front top/left and rear top/right side views of the DUT.*

Pictures of Test Positions of the DUT



Pic. 4: Test position front side (1) of DUT towards the phantom, 0 mm gap.

Pic. 5: Test position right part of the front side (2) of DUT towards the phantom, 0 mm gap.

Pic. 6: Test position rear side of DUT towards the phantom, 0 mm gap.

Pic. 7: Test position left side of DUT towards the phantom, 0 mm gap.

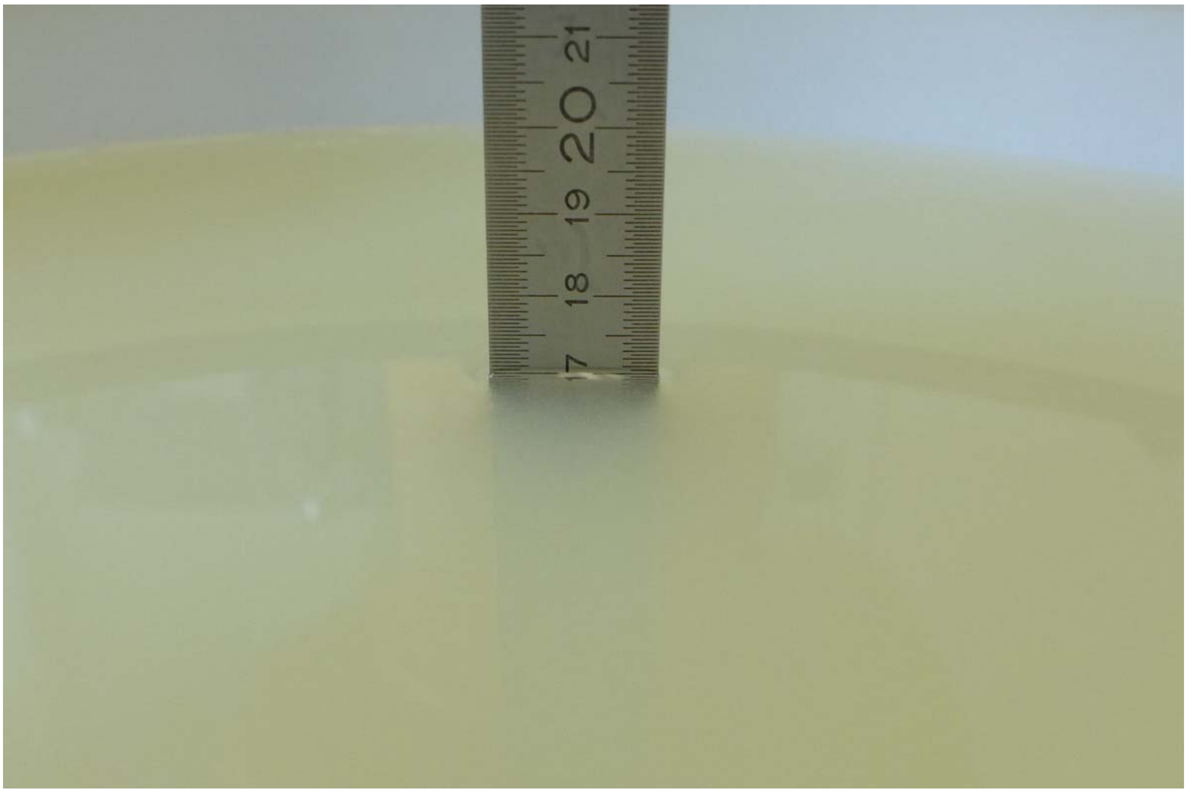
Pic. 8: Test position right side of DUT towards the phantom, 0 mm gap.

Pic. 9: Test position top side (1) of DUT towards the phantom, 0 mm gap.

Pic. 10: Test position top side (2) of DUT towards the phantom, 0 mm gap.

Pictures of Liquid Depth

Picture 11 shows the liquid depth in the used SAM phantom.



Pic. 11: Liquid depth for 2.4 GHz measurements.

Appendix B - SAR Distribution Plots

Worst Case SAR Measurement Plots

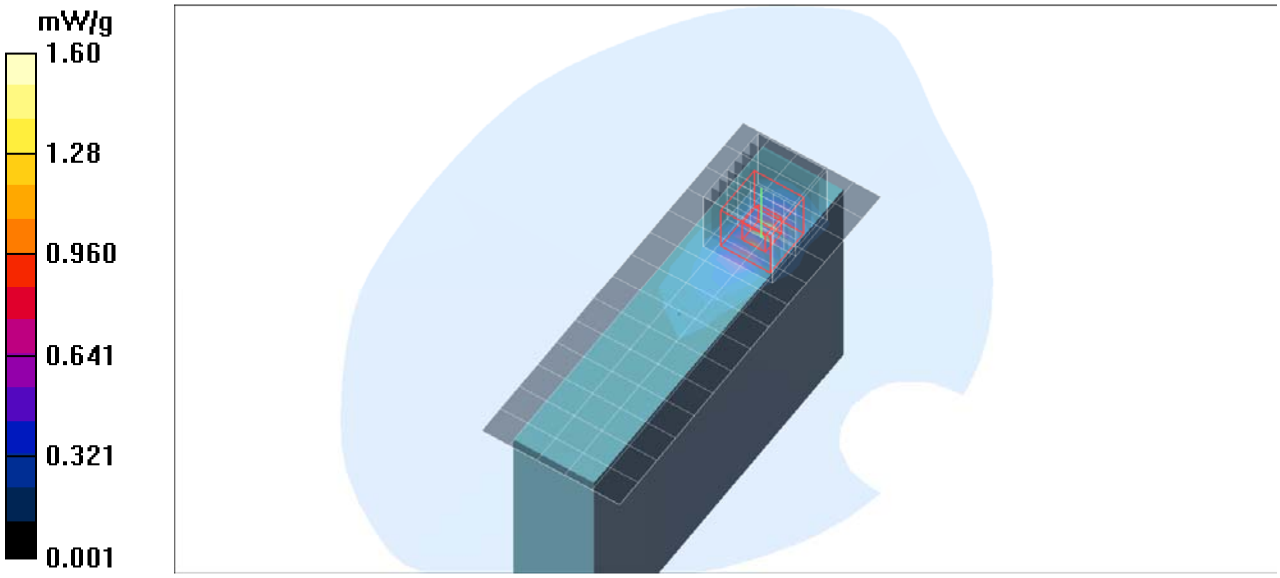
Test Laboratory: IMST GmbH, DASY Yellow (II);
File Name: MS_2Dy_WLAN_CH6_top2_0mm.da4

DUT: m ¦ rklin; Type: mobile station; Serial: SAR01
Program Name: IEEE 802.11b 1Mbit/s

Communication System: WLAN 2450; Frequency: 2437 MHz;Duty Cycle: 1:1
Medium parameters used (interpolated): f = 2437 MHz; σ = 1.83 mho/m; ε_r = 40.4; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3536; ConvF(7.61, 7.61, 7.61); Calibrated: 10/26/2022
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn631; Calibrated: 10/26/2022
- Phantom: SAM 1341; Type: QD 000 P40 CB; Serial: TP-1341
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Flat/Area Scan (6x15x1): Measurement grid: dx=12mm, dy=12mm
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.56 mW/g
Flat/Zoom Scan (7x8x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 9.59 V/m; Power Drift = 0.061 dB
Peak SAR (extrapolated) = 2.32 W/kg
SAR(1 g) = 0.937 mW/g; SAR(10 g) = 0.353 mW/g
Info: Interpolated medium parameters used for SAR evaluation.
Maximum value of SAR (measured) = 1.60 mW/g
Smallest distance from peak to all points 3 dB below = 7.1 mm
Ratio of SAR are M2 to SAR at M1 = 44.60 %



Plot. 1: SAR distribution plot for IEEE 802.11 b, channel 6, top side (2) of DUT. Ambient and liquid temperature = 21.5°C (date of measurement 30 November, 2022)

Appendix C - System Verification Plots

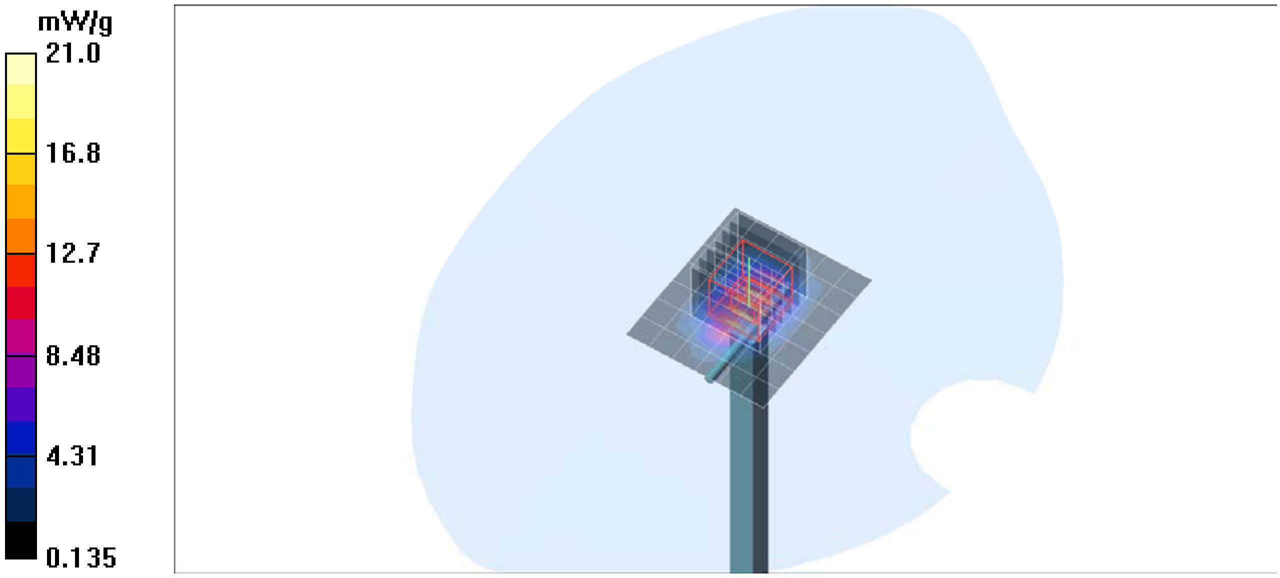
Test Laboratory: IMST GmbH, DASY Yellow (II);
File Name: 2022-11-30_2Dy_2450h_3536_631.da4

DUT: Dipole D2450V2; Serial: 709
Program Name: System Performance Check at 2450 MHz

Communication System: CW; Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 1.84 mho/m; ε_r = 40.3; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: EX3DV4 - SN3536; ConvF(7.61, 7.61, 7.61); Calibrated: 10/26/2022
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn631; Calibrated: 10/26/2022
- Phantom: SAM 1341; Type: QD 000 P40 CB; Serial: TP-1341
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

d=10mm, Pin=250mW/Area Scan (7x8x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 19.9 mW/g
d=10mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 108.7 V/m; Power Drift = -0.037 dB
Peak SAR (extrapolated) = 28.0 W/kg
SAR(1 g) = 13.6 mW/g; SAR(10 g) = 6.33 mW/g
Maximum value of SAR (measured) = 21.0 mW/g



Plot. 2: SAR Verification Measurement 2450 MHz. Ambient and liquid temperature = 21.5°C (date of measurement 30 November, 2022)

Appendix D – Certificates of Conformity

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Certificate of conformity

Item	Dosimetric Assessment System DASY4
Type No	SD 000 401A, SD 000 402A
Software Version No	DASY 4.7
Manufacturer / Origin	Schmid & Partner Engineering AG Zeughausstrasse 43, CH-8004 Zürich, Switzerland

References

[1] IEEE 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
[2] IEC 62209 – 1, "Specific Absorption Rate (SAR) in the frequency range of 300 MHz to 3 GHz – Measurement Procedure, Part 1: Hand-held mobile wireless communication devices", February 2005
[3] IEC 62209 – 2, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation and Procedures, Part 2: Procedure to determine the Specific Absorption Rate (SAR) for ... including accessories and multiple transmitters", March 2010
[4] KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"
[5] ANSI-C63.19-2011, "American National Standard for Methods of Measurement of Compatibility between Wireless Communication Devices and Hearing Aids", May 2011

Conformity

We certify that this **system is designed to be fully compliant** with the standards [1 – 5] for RF emission tests of wireless devices.

Uncertainty

The uncertainty of the measurements with this system was evaluated according to the above standards and is documented in the applicable chapters of the DASY4 system handbook and in Chapter 27 of the DASY5 system handbook.

The uncertainty values represent current state of methodology and are subject to changes. They are applicable to all laboratories using DASY4 provided the following requirements are met (responsibility of the system end user):

1) the system is used by an experienced engineer who follows the manual and the guidelines taught during the training provided by SPEAG,
2) the probe and validation dipoles have been calibrated for the relevant frequency bands and media within the requested period,
3) the DAE has been calibrated within the requested period,
4) the "minimum distance" between probe sensor and inner phantom shell and the radiation source is selected properly,
5) the system performance check has been successful,
6) the operational mode of the DUT is CW, CDMA, FDMA or TDMA (GSM, DCS, PCS, IS136, PDC) and the measurement/integration time per point is ≥ 500 ms,
7) if applicable, the probe modulation factor is evaluated and applied according to field level, modulation and frequency,
8) the dielectric parameters of the liquid are conform with the standard requirement,
9) the DUT has been positioned as described in the manual.
10) the uncertainty values from the calibration certificates, and the laboratory and measurement equipment dependent uncertainties, are updated by end user accordingly.

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Date 19.09.2016 **Signature / Stamp**

Doc No 880 – SD00040XA-Standards_1609 – G KP/FB Page 1 (1)

Fig. 4: Certificate of conformity for the used DASY4 system:

Schmid & Partner Engineering AG

speag

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Certificate of Conformity / First Article Inspection

Item	SAM Twin Phantom V4.0 and V5.0
Type No	QD 000 P40 C
Series No	TP-1150 and higher
Manufacturer	Untersee Composites Knebelstrasse 8, CH-8268 Mannenbach, Switzerland

Tests

Complete tests were made on the pre-series QD 000 P40 A, # TP-1001, on the series first article QD 000 P40 B # TP-1006. Certain parameters are retested on series items.

Test	Requirement	Details	Units tested
Dimensions	Compliant with the geometry according to the CAD model.	IT'IS CAD File *	First article, Samples
Material thickness of shell	2mm +/- 0.2mm in flat section, other locations: +/- 0.2mm with respect to CAD file	in flat section, in the cheek area	First article, Samples, TP-1314 ff.
Material thickness at ERP	6mm +/- 0.2mm at ERP		First article, All items
Material parameters	rel. permittivity 2 – 5, loss tangent ≤ 0.05, at f ≤ 6 GHz	rel. permittivity 3.5 +/- 0.5 loss tangent ≤ 0.05	Material samples
Material resistivity	Compatibility with tissue simulating liquids .	Compatible with SPEAG liquids. **	Phantoms, Material sample
Sagging	Sagging of the flat section in tolerance when filled with tissue simulating liquid.	< 1% for filling height up to 155 mm	Prototypes, Sample testing

* The IT'IS CAD file is derived from [2] and is also within the tolerance requirements of the shapes of the other documents.

** Note: Compatibility restrictions apply certain liquid components mentioned in the standard, containing e.g. DGBE, DGMHE or Triton X-100. Observe technical note on material compatibility.

Standards

[1] OET Bulletin 65, Supplement C, "Evaluating Compliance with FCC Guidelines for Human Exposure to Radiofrequency Electromagnetic Fields", Edition 01-01

[2] IEEE 1528-2003, "Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques, December 2003

[3] IEC 62209–1 ed1.0, "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 1: Procedure to determine the specific absorption rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", 2005-02-18

[4] IEC 62209–2 ed1.0, "Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz)", 2010-03-30

Conformity

Based on the sample tests above, we certify that this item is in compliance with the uncertainty requirements of **hand-held** SAR measurements and system performance checks as specified in [1 – 4] and further standards.

Date 25.07.2011

Signature / Stamp

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Doc No 881 – QD 000 P40 C – H Page 1 (1)

Fig. 5: Certificate of conformity for the used SAM phantom.

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Certificate of Conformity / First Article Inspection

Item	Oval Flat Phantom ELI 4.0
Type No	QD OVA 001 B
Series No	1003 and higher
Manufacturer	SPEAG Zeughausstrasse 43 CH-8004 Zürich Switzerland

Tests
Complete tests were made on the prototype units QD OVA 001 AA 1001, QD OVA 001 AB 1002, pre-series units QD OVA 001 BA 1003-1005 as well as on the series units QD OVA 001 BB, 1006 ff.

Test	Requirement	Details	Units tested
Dimensions	Compliant with the standard IEC 62209 – 2 [1] requirements	Dimensions of bottom for 300 MHz – 6 GHz: longitudinal = 600 mm (max. dimension) width= 400 mm (min dimension) depth= 190 mm Shape: ellipse	Prototypes, Samples
Material thickness	Compliant with the standard IEC 62209 – 2 [1] requirements	Bottom plate: 2.0mm +/- 0.2mm	Prototypes, All items
Material parameters	Dielectric parameters for required frequencies	300 MHz – 6 GHz Rel. permittivity = 4 +/-1, Loss tangent ≤ 0.05	Material sample
Material resistivity	The material has been tested to be compatible with the liquids defined in the standards if handled and cleaned according to the instructions. Observe Technical Note for material compatibility.	DEGMBE based simulating liquids	Equivalent phantoms, Material sample
Sagging	Compliant with the requirements according to the standard. Sagging of the flat section when filled with tissue simulating liquid	< 1% typical < 0.8% if filled with 155mm of HSL900 and without DUT below	Prototypes, Sample testing

Standards

[1] IEC 62209 – 2, Draft Version 0.9, "Evaluation of Human Exposure to Radio Frequency Fields from Handheld and Body-Mounted Wireless Communication Devices in the Frequency Range of 30 MHz to 6 GHz: Human models, Instrumentation and Procedures
Part 2: Procedure to determine the Specific Absorption Rate (SAR) for ... including accessories and multiple transmitters", December 2004

Conformity
Based on the sample tests above, we certify that this item is in compliance with the standard [1].

Date 07.07.2005

Signature / Stamp

s p e a g
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Fig. 11: Certificate of conformity for the ELI phantom.