

SAR Evaluation Report			
EUT Information			
Manufacturer	Hellberg Safety AB		
Model Name	Hellberg Secure Local		
FCC ID	QF9LOCALUS		
IC Number	5808A-LOCALUS		
Type / Category	headband with integrated communication radio (FRS)		
Intended Use	<input checked="" type="checkbox"/> portable <input type="checkbox"/> mixed mobile/portable <input type="checkbox"/> - <input checked="" type="checkbox"/> next to the ear <input type="checkbox"/> body-worn <input type="checkbox"/> limb-worn <input type="checkbox"/> hand-held <input type="checkbox"/> front-of-face <input type="checkbox"/> body supported <input type="checkbox"/> clothing-integrated		
Prepared by			
Testing Laboratory	IMST GmbH, Test Center Carl-Friedrich-Gauß-Str. 2 – 4 47475 Kamp-Lintfort Germany		
Laboratory Accreditation	 	<p>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.</p> <p>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.</p>	
Prepared for			
Applicant / Manufacturer	Hellberg Safety AB Stakebergsvägen 2 44361 Stenkullen Sweden		
Test Specification			
Applied Rules/Standards	FCC CFR 47 § 2.1093; IEC/IEEE 62209-1528; RSS-102 Issue 5		
Exposure Category	<input checked="" type="checkbox"/> general public / uncontrolled exposure <input type="checkbox"/> occupational / controlled exposure		
Test Result	<input checked="" type="checkbox"/> PASS <input type="checkbox"/> FAIL		
Report Information			
Data Stored	6210505		
Issue Date	June 30, 2021		
Revision Date	October 05, 2021		
Revision Number	1 A new revision replaces all previous revisions and thus, become invalid herewith.		
Remarks	<p>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.</p> <p>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.</p>		

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1 Subject of Investigation and Test Results

The Hellberg Secure Local is a new hearing protection headband from Hellberg Safety AB operating in the FRS radio standard. The headband has one antenna.

The objective of the measurements done by IMST was the dosimetric assessment of one device in direct contact to the left and right cheeks of the SAM phantom as well as below the flat part of the phantom using head tissue simulating liquid.

1.1 Technical Data of EUT

Product Specifications	
Model Name	Hellberg Secure Local (refer to chapter 1.2)
SN No.	FCC31
Operation Mode	UHF (FRS)
Frequency Range	462.55000 - 467.71250
Modulation	FM
Number of Channels	22
Maximum Duty Cycle	100 % (CW)
Type of Antenna	1x external
Maximum Output Power	refer chapter 7.3
Power Supply	2x AA batteries
Used Accessory	-
EUT Stage	<input type="checkbox"/> production unit <input checked="" type="checkbox"/> identical prototype
Notes:	

1.2 Product Family / Model Variants

As declared by the manufacturer, there are two different model variants of the device available. Both variants have identical PCB, RF design and antennas with the tested variant Hellberg Secure Local. The difference between the two model variants is the mechanical attachment to the earcups. The assessed model is delivered with the earcups mounted on a headband. The alternative variant is delivered with mechanical attachment suitable to mount on protective helmet as shown below.



Fig. 1: Headband model (tested)

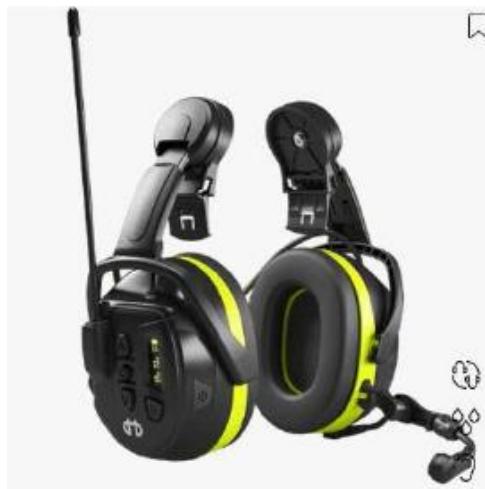


Fig. 2: Helmet mount

1.3 Antenna Configuration



Fig. 3: Antenna location on the right earpiece of the DUT.

1.4 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
<input checked="" type="checkbox"/> 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
<input type="checkbox"/> FCC CFR 47 § 2.1091	Code of Federal Regulations; Title 47. Radiofrequency radiation exposure evaluation: Mobile Devices .	October 01, 2010
<input checked="" type="checkbox"/> FCC CFR 47 § 2.1093	Code of Federal Regulations; Title 47. Radiofrequency radiation exposure evaluation: Portable Devices .	October 01, 2010
<input checked="" type="checkbox"/> RSS-102, Issue 5	Radio Frequency (RF) Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands)	March, 2015
Measurement Methodology KDB		
<input checked="" type="checkbox"/> KDB 865664 D01 v01r04	SAR measurement 100 MHz to 6 GHz	August 07, 2015
<input checked="" type="checkbox"/> KDB 865664 D02 v01r02	Exposure Reporting	October 23, 2015
Product KDB		
<input checked="" type="checkbox"/> KDB 447498 D01 v06	General RF Exposure Guidance	October 23, 2015

1.5 Attestation of Test Results

Highest Reported SAR _{1g} [W/kg]									
Band	Equipment Class	Frequency [MHz]	CH	Test Side of DUT	Gap [mm]	Pic. No.	Highest Reported SAR1g [W/kg]	SAR1g Limit [W/kg]	
UHF / FRS	FRE	462.5625	1	right side	0	7	0.112	1.6	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 7.6 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 DIN EN ISO IEC 17025-2017.

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Reviewed by:



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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:

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

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: 4. Additionally, Fig: 5 shows the equipment, similar to the installations in other laboratories.

- Fully compliant with all current measurement standards as stated in Fig. 6
- 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

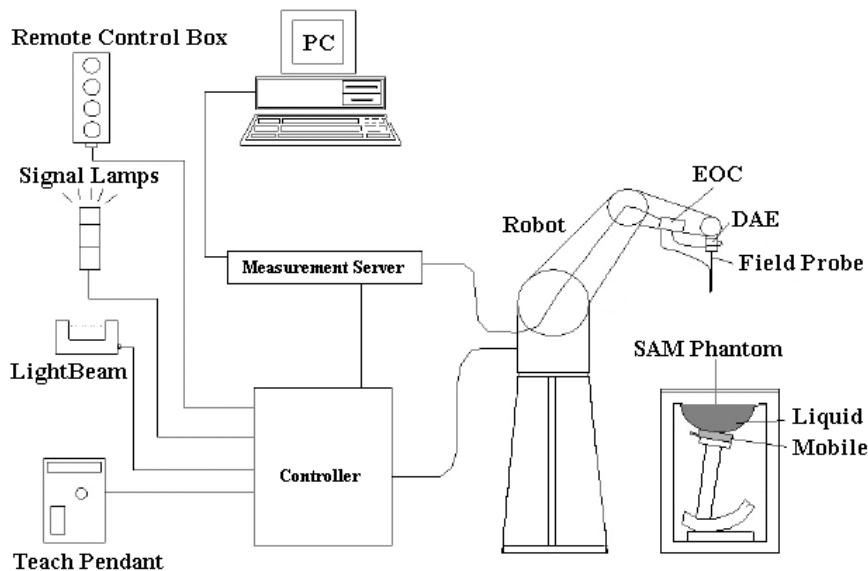


Fig. 4: The DASY4 measurement system.



Fig. 5: The measurement set-up with a DASY system and phantoms containing tissue simulating liquid.

The EUT 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 defined in IEC/IEEE 62209-1528 and 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. 7.
Shell Thickness	$2 \pm 0.2 \text{ mm}$ ($6 \pm 0.2 \text{ mm}$ at ear point)
Dimensions	Length: 1000 mm; Width: 500 mm Height: adjustable feet
Filling Volume	approx. 25 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 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 μ W/g to > 100 mW/g; Linearity: ± 0.2 dB
Calibration Range	450 MHz / 750 MHz / 900 MHz / 1750 MHz / 1900 MHz for head and body simulating liquid

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 μ W/g to > 100 mW/g Linearity: ± 0.2 dB (noise: typically < 1 μ W/g)
Calibration Range	2450 MHz / 2600 MHz / 5250 MHz / 5600 MHz / 5800 MHz for head and body simulating liquid

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 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 $\pm 0.21\text{dB}$.

Area Scan		
Parameter	$f \leq 3 \text{ GHz}$	$3 \text{ GHz} < f \leq 10 \text{ GHz}$
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	$5 \pm 1 \text{ mm}$	$\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5 \text{ mm}$
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	$5^\circ \pm 1^\circ$ (flat phantom) $30^\circ \pm 1^\circ$ (other phantoms)	$5^\circ \pm 1^\circ$ (flat phantom) $20^\circ \pm 1^\circ$ (other phantoms)
Zoom Scan		
Maximum distance between the closest measured points and the phantom surface	5 mm	$\frac{1}{2} \cdot \delta \cdot \ln(2)$ ^a
Maximum angle between the probe axis and the phantom surface	$5^\circ \pm 1^\circ$ (flat phantom) $30^\circ \pm 1^\circ$ (other phantoms)	$5^\circ \pm 1^\circ$ (flat phantom) $20^\circ \pm 1^\circ$ (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.

5.3 Measurement Variability

According KDB 865664 repeated measurements are required only when the measured SAR is ≥ 0.80 W/kg. If the measured SAR value of the initial repeated measurement is < 1.45 W/kg with $\leq 20\%$ variation, only one repeated measurement is required to reaffirm that the results are not expected to have substantial variations, which may introduce significant compliance concerns. A second repeated measurement is required only if the measured result for the initial repeated measurement is within 10% of the SAR limit and vary by more than 20%, which are often related to device and measurement setup difficulties. The following procedures are applied to determine if repeated measurements are required.

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

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	
			SAM cheek	SAM flat
UHF	450	June 22, 2021	June 22 - 23, 2021	
	450	June 24, 2021		June 24 - 25, 2021

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 [MHz]	Water [%]	Sugar [%]	Cellulose [%]	Salt [%]	Preventol [%]	DGBE [%]	Triton X/100 [%]	TWEEN 80 [%]	GERMABEN [%]
Head Tissue									
<input type="checkbox"/>	300	37.1	56.1	0.9	5.8	0.2	-	-	-
<input checked="" type="checkbox"/>	450	38.9	56.9	0.3	3.8	0.1	-	-	-
<input type="checkbox"/>	835	40.3	57.9	0.2	1.4	0.2	-	-	-
<input type="checkbox"/>	900	40.3	57.9	0.2	1.4	0.2	-	-	-
<input type="checkbox"/>	1800	55.2	-	-	0.3	-	44.5	-	-
<input type="checkbox"/>	1900	55.4	-	-	0.1	-	44.5	-	-
<input type="checkbox"/>	2450	55.0	-	-	-	-	45.0	-	-
<input type="checkbox"/>	2600	54.8	-	-	0.1	-	45.1	-	-
<input type="checkbox"/>	5000 - 6000	65.5	-	-	-	-	17.2	17.25	-
Notes: Used liquid for measurement is checked above.									

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.

Tissue Simulating Liquids										
Ambient Temperature(C) : 22.0 ± 2			Liquid Temperature(C) : 23.1			Humidity (%) : 40.0 ± 10			Date	
Band	Frequency	Channel	Permittivity			Conductivity				
	[MHz]		Measured	Target	Delta	Measured	Target	Delta		
UHF	450.0	System Check	45.2	43.5	4.0	0.871	0.870	0.1	June 22, 2021	
	462.5625	1	45.1	43.4	3.8	0.88	0.87	1.0		
	462.7125	7	45.1	43.4	3.8	0.88	0.87	1.0		
	467.5625	8	45.0	43.4	3.8	0.88	0.87	1.3		
	467.7125	14	45.0	43.4	3.8	0.88	0.87	1.3		
	462.5500	15	45.1	43.4	3.8	0.88	0.87	1.0		
	462.7250	22	45.1	43.4	3.8	0.88	0.87	1.0		
Ambient Temperature(C) : 22.0 ± 2			Liquid Temperature(C) : 23.2			Humidity (%) : 40.0 ± 10			Date	
Band	Frequency	Channel	Permittivity			Conductivity				
	[MHz]		Measured	Target	Delta	Measured	Target	Delta		
UHF	450.0	System Check	43.9	43.5	1.0	0.889	0.870	2.1	June 24, 2021	
	462.6	1	43.8	43.4	1.0	0.90	0.87	2.8		
	462.7	7	43.8	43.4	1.0	0.90	0.87	2.8		
	467.6	8	43.8	43.4	1.0	0.90	0.87	3.0		
	467.7	14	43.8	43.4	1.0	0.90	0.87	3.0		
	462.6	15	43.8	43.4	1.0	0.90	0.87	2.8		
	462.7	22	43.8	43.4	1.0	0.90	0.87	2.8		

Notes: Liquid depth is at least 15 cm for all frequency ranged measurements.

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]	Tissue	Dipole #SN	SAR Values with Head TSL [W/kg]						Date		
			Measured			Target		Delta			
			with 250 mW		scaled to 1 W		normalized to 1 W				
			1g	10g	1g	10g	1g	10g			
450	Head	D450V2 #1014	1.170	0.784	4.68	3.14	4.88	3.23	-4.10	-2.91	June 22, 2021
			1.200	0.800	4.80	3.20	4.88	3.23	-1.64	-0.93	

Table 8: Dipole target and measured results.

7 SAR Measurement Conditions and Results

7.1 Test Conditions

Test Conditions					
Band	TX Range [MHz]	RX Range [MHz]	Used Channels	Crest Factor	Phantom
UHF / FRS	462.55000 - 467.71250	462.55000 - 467.71250	1, 7, 8, 14, 15, 22	1	SAM Twin Phantom V4.0
Notes: -					

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

7.2 Tune-Up Information

Tune-Up Information				
Mode	Frequency [MHz]	Target Output Power [dBm]	Tolerance [± dB]	Tune -Up Tolerance Limit [dBm]
UHF / FRS	462.55000 - 467.71250	21.8	1.2	23.0
Notes:				

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

7.3 Measured Output Power

Conducted Output Power [dBm]			
Band	Frequency [MHz]	CH	Measured Output Power [dBm]
			CW
UHF / FRS	462.5625	1	22.5
	462.7125	7	22.5
	467.5625	8	22.3
	467.7125	14	22.3
	462.5500	15	22.5
	462.7250	22	22.5
Notes:			

Table 11: Conducted output power values.

7.4 Standalone SAR Test Exclusion according to KDB 447498

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

$$[(\text{max power of channel, incl. tune-up tolerance, mW}) / (\text{min test separation distance, mm})] * [\sqrt{f(\text{GHz})}]$$

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

- $f(\text{GHz})$ 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)							
Band	Freq.	Distance	Output Power (avg)		Threshold Comparison Value	SAR Testing Exclusion Threshold Value	SAR Testing Exclusion
	[MHz]	[mm]	[dBm]	[mW]		HEAD/BODY	HEAD/BODY
UHF	462.0	5	23.0	199.53	27.1	≤ 3.0	NO
UHF	467.0	5	23.0	199.53	27.3	≤ 3.0	NO

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:

- $(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm}) * [\sqrt{f(\text{GHz})}/x] \text{ W/kg}$ 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)							
Band	Freq.	Distance	Output Power (avg)		SAR Testing Exclusion Threshold Value [mW]	SAR Testing Exclusion	SAR Testing Required
	[MHz]	[mm]	[dBm]	[mW]		HEAD/BODY	HEAD/BODY
UHF	462.0	5	23.0	199.53	52.0	NO	YES
UHF	467.0	5	23.0	199.53	52.0	NO	YES

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

7.6 SAR Results

The tables below contain the measured SAR values averaged over a mass of 1g. SAR assessment was conducted in the worst case configuration with output power values according to Table 10. According to KDB 447498 D01, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.

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

SAR Measurement Results [W/kg]														
Band	Frequency [MHz]	CH	Exposure Position of DUT		Pic. No.	Gap [mm]	Measured SAR1g	Power Drift [dB]	Power [dBm]	Meas.	Limit	Tune-Up SF	Reported SAR1g	Plot No.
UHF (CW)	462.5625	1	SAM Cheek	Right Side of DUT	5	0	0.069	-0.100	22.5	23.0	1.122	0.077		
	462.7125	7				0	0.069	0.078	22.5	23.0	1.122	0.077		
	467.5625	8				0	0.065	-0.180	22.3	23.0	1.175	0.076		
	467.7125	14				0	0.070	0.159	22.3	23.0	1.175	0.082		
	462.5500	15				0	0.073	-0.092	22.5	23.0	1.122	0.082	1	
	462.7250	22				0	0.072	0.053	22.5	23.0	1.122	0.081		
	462.5625	1	SAM Flat Part	Left Side of DUT	6	0	0.029	-0.003	22.5	23.0	1.122	0.033	2	
	467.5625	8				0	0.024	-0.014	22.3	23.0	1.175	0.028		
	462.7250	22				0	0.028	0.004	22.5	23.0	1.122	0.031		
	462.5625	1	SAM Flat Part	Right Side of DUT	7	0	0.100	-0.032	22.5	23.0	1.122	0.112	3	
	462.7125	7				0	0.095	0.011	22.5	23.0	1.122	0.107		
	467.5625	8				0	0.083	0.000	22.3	23.0	1.175	0.098		
	467.7125	14				0	0.083	-0.019	22.3	23.0	1.175	0.098		
	462.5500	15				0	0.094	-0.032	22.5	23.0	1.122	0.105		
	462.7250	22				0	0.094	-0.013	22.5	23.0	1.122	0.105		
	462.5625	1	SAM Flat Part	Left Side of DUT	8	0	0.007	-0.027	22.5	23.0	1.122	0.008	4	
	467.5625	8				0	0.006	0.095	22.3	23.0	1.175	0.007		
	462.7250	22				0	0.004	-0.161	22.5	23.0	1.122	0.004		

Notes: Antenna is installed on the right side of DUT

Table 14: SAR measurement results.

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					
<input checked="" type="checkbox"/> Software Versions DASY4	SPEAG	V4.7	N/A	N/A	N/A
<input checked="" type="checkbox"/> Software Versions SEMCAD	SPEAG	V1.8	N/A	N/A	N/A
<input checked="" type="checkbox"/> Dosimetric E-Field Probe	SPEAG	ET3DV6R	1579	02/2020	02/2022
<input type="checkbox"/> Dosimetric E-Field Probe	SPEAG	ET3DV6R	1669	03/2021	03/2023
<input type="checkbox"/> Dosimetric E-Field Probe	SPEAG	EX3DV4	3536	08/2020	08/2022
<input type="checkbox"/> Dosimetric E-Field Probe	SPEAG	EX3DV4	3860	10/2019	10/2021
<input checked="" type="checkbox"/> Data Acquisition Electronics	SPEAG	DAE 3	335	03/2021	03/2022
<input type="checkbox"/> Data Acquisition Electronics	SPEAG	DAE 4	631	08/2020	08/2021
<input type="checkbox"/> Phantom	SPEAG	SAM	1059	N/A	N/A
<input checked="" type="checkbox"/> Phantom	SPEAG	SAM	1176	N/A	N/A
<input type="checkbox"/> Phantom	SPEAG	SAM	1340	N/A	N/A
<input type="checkbox"/> Phantom	SPEAG	SAM	1341	N/A	N/A
<input type="checkbox"/> Phantom	SPEAG	ELI4	1004	N/A	N/A
Dipoles					
<input type="checkbox"/> System Validation Loop Antenna	SPEAG	CLA150	4029	02/2020	02/2022
<input checked="" type="checkbox"/> System Validation Dipole	SPEAG	D450V2	1014	03/2021	03/2024
<input type="checkbox"/> System Validation Dipole	SPEAG	D835V2	470	03/2021	03/2024
<input type="checkbox"/> System Validation Dipole	SPEAG	D1640V2	311	09/2018	/
<input type="checkbox"/> System Validation Dipole	SPEAG	D1750V2	1005	03/2021	03/2024
<input type="checkbox"/> System Validation Dipole	SPEAG	D1900V2	535	03/2021	03/2024
<input type="checkbox"/> System Validation Dipole	SPEAG	D2450V2	709	11/2018	11/2021
<input type="checkbox"/> System Validation Dipole	SPEAG	D2600V2	1019	11/2018	11/2021
<input type="checkbox"/> System Validation Dipole	SPEAG	D5GHzV2	1028	05/2020	05/2023
Material Measurement					
<input checked="" type="checkbox"/> Network Analyzer	Agilent	E5071C	MY46103220	08/2019	08/2021
<input checked="" type="checkbox"/> Dielectric Probe Kit	SPEAG	DAK-3.5	1234	02/2020	02/2022
<input type="checkbox"/> Dielectric Probe Kit	SPEAG	DAK-12	1151	02/2020	02/2022
<input checked="" type="checkbox"/> Thermometer	LKMelectronic	DTM3000	3511	02/2020	02/2022
Power Meters and Sensors					
<input checked="" type="checkbox"/> Power Meter	Anritsu	ML2487A	6K00002319	06/2020	07/2022
<input checked="" type="checkbox"/> Power Sensor	Anritsu	MA2472A	990365	06/2020	07/2022
<input checked="" type="checkbox"/> Power Meter	Anritsu	ML2488A	6K00002078	06/2020	07/2022
<input checked="" type="checkbox"/> Power Sensor	Anritsu	MA2472A	002122	06/2020	07/2022
<input type="checkbox"/> Spectrum Analyzer	Rohde & Schwarz	FSP7	100433	12/2018	12/2020
RF Sources					
<input checked="" type="checkbox"/> Network Analyzer	Agilent	E5071C	MY46103220	08/2019	08/2021
<input type="checkbox"/> RF Generator	Rohde & Schwarz	SM300	100142	N/A	N/A
Amplifiers					
<input checked="" type="checkbox"/> Amplifier 10 MHz – 4200 MHz	Mini Circuits	ZHL-42-42W	D080504-1	N/A	N/A
<input type="checkbox"/> Amplifier 2 GHz – 6 GHz	Ciao Wireless	CA26-451	37452	N/A	N/A
Radio Tester					
<input type="checkbox"/> Radio Communication Tester	Anritsu	MT8815B	6200576536	06/2020	06/2022
<input type="checkbox"/> Radio Communication Tester	Anritsu	MT8820C	6200918336	05/2020	05/2022
Notes: Used test equipment for measurement is checked above.					

Table 15: Calibration of test equipment.

8.2 Uncertainty Assessment

Uncertainty Budget for SAR Measurements according to IEC/IEEE 62209-1528 (300 MHz - 6 GHz)								
Error Sources	Uncertainty Value [\pm %]	Probability Distribution	Divisor	c_i	c_i	Standard Uncertainty [\pm %]		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	$\sqrt{3}$	1	1	0.2	0.2	∞
Probe isotropy axial	0.3	Rectangular	$\sqrt{3}$	$\sqrt{0.5}$	$\sqrt{0.5}$	0.1	0.1	∞
Probe isotropy spherical	1.3	Rectangular	$\sqrt{3}$	$\sqrt{0.5}$	$\sqrt{0.5}$	0.5	0.5	∞
Boundary effects	1.0	Rectangular	$\sqrt{3}$	1	1	0.6	0.6	∞
System detection limit	1.0	Rectangular	$\sqrt{3}$	1	1	0.6	0.6	∞
Modulation response	4.0	Rectangular	$\sqrt{3}$	1	1	2.3	2.3	∞
Readout electronics	0.3	Normal	1	1	1	0.3	0.3	∞
Response time	0.8	Rectangular	$\sqrt{3}$	1	1	0.5	0.5	∞
Integration time	1.4	Rectangular	$\sqrt{3}$	1	1	0.8	0.8	∞
RF ambient conditions - noise	3.0	Rectangular	$\sqrt{3}$	1	1	1.7	1.7	∞
RF ambient conditions - refl.	3.0	Rectangular	$\sqrt{3}$	1	1	1.7	1.7	∞
Probe positioner mech. tol.	0.4	Rectangular	$\sqrt{3}$	1	1	0.2	0.2	∞
Probe positioning	2.9	Rectangular	$\sqrt{3}$	1	1	1.7	1.7	∞
Data processing errors	4.0	Rectangular	$\sqrt{3}$	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	$\sqrt{3}$	0.78	0.71	1.3	1.2	∞
Liquid permittivity temp. unc.	1.8	Rectangular	$\sqrt{3}$	0.23	0.26	0.2	0.3	∞
Phantom shell permittivity	4.0	Rectangular	$\sqrt{3}$	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	$\sqrt{3}$	1	1	4.0	4.0	∞
Time-average SAR	5.0	Rectangular	$\sqrt{3}$	1	1	2.9	2.9	∞
SAR drift measurement (< 0.2 dB)	4.7	Rectangular	$\sqrt{3}$	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	$\sqrt{3}$	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 measurements.

9 Report History

Revision History				
Revision	Description of Revision	Date	Revised Page	Revised By
/	Initial Release	June 30, 2021	-	-
1	Added a detailed description of the differences between models in the product family. References to IEC/IEEE 62209-1528:2020 updated	October 05, 2021	1, 3, 5, 10, 18	AR

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