SAR Evaluation Report

DUT Information	
Manufacturer	Ascom Sweden AB
Brand Name	DH8
Model Under Test	DH8-ACAA
FCC ID	BXZDH8
IC Number	3742B-DH8
DUT Type	handset
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.
Prepared for	
Manufacturer	Ascom Sweden AB Grimbodalen 2 SE-41749 Goteborg Sweden
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	6210225
Issue Date	May 7, 2021
Revision Date	August 08, 2021
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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1 Subject of Investigation and Test Results

The tested DH8-ACAA is a new handset from Ascom Sweden AB operating in DECT and BT standards with three integrated antennas. Two DECT antennas are working in diversity mode and one BT antenna is capable of working in simultaneous transmission in combination with DECT mode.

The objective of the measurements performed by IMST is the dosimetric assessment of DECT and BT on one device in the intended use positions. Simultaneous transmission consideration has been taken in the worst case configurations of the model.

1.1 Technical Data of DUT

Product Specifications		
Manufacturer	Ascom Sweden AB	
Model Under Test	DH8-ACAA (refer to chapter 1.2)	
SN / IMST DUT No.	radiated sample: T26107D4ZB; conducted sample: T26107D3NL, HW Type: 904750; HW rev.: PD	
Software	SW Type: SW000650, SW ver.:1.0.8	
Integrated Transmitter	Dialog SC14445	Cypress CYW20721
Operation Mode	DECT	BT/BLE
Frequency Range	1921.536 – 1928.448 MHz	2402 - 2480 MHz
Modulation	GFSK	GFSK
Maximum Duty Cycle	4.17 %	77 %
Antenna Type	2x internal (IFA)	1x internal (IFA)
Maximum Output Power	refer chapter 7.3	
Power Supply	internal Li-polymer battery DC 3.8V	
Used Accessory	belt clip, headset	
DUT Stage	☒ production unit	☐ identical prototype
Notes:		

1.2 Product Family / Model Variants

As declared by the manufacturer, there are different model variants of DH8-xxxx available. All variants have identical PCB, RF design and antennas with the tested variant DH8-ACAA. The differences are as follows:

Product Family		
Model	**Marketing Name**	**Applicable parts**
DH8-AAAA	Ascom d83 Talker	All basics. Dual colour LED
DH8-ABAA	Ascom d83 Messenger	All basics and IR, IF location. Multi colour LED
DH8-ACAA	Ascom d83 Protector	All basics, IR, IF location, Accelerometer and alarm button, pull cord. Multi colour LED
DH8-ABAB	Ascom d83 Messenger EX	All basics, IR, IF location and current limitation
DH8-ACAB	Ascom d83 Protector EX	All basics, IR, IF location, Accelerometer, alarm button, pull cord and current limitation. Multi colour LED
DH8-CEAA	Avaya DECT 3755 Handset	All basics, Accelerometer and alarm button, pull cord. Multi colour LED
DH8-CEAB	Avaya DECT 3759 Handset	All basics, Accelerometer, alarm button, pull cord and current limitation. Multi colour LED
DH8-DDAA	Mitel 5617	All basics. Multi colour LED
DH8-DEAB	Mitel 5619	All basics, Accelerometer, alarm button, pull cord and current limitation. Multi colour LED
Notes:		

Table 1: Product family of DH8 handset.

The assessed DH8-ACAA represents the worst case and therefore covers all test requirements and grant compliance also for all other variants. All model variants have the same PCB and RF interface but only mounting differencies. There are no differences in shape/appearance, other than the features above shown in the table.

The model name after the main model name is based on the following pattern - first letter after is stating the brand, second letter is stating modell type Talker, Messenger or Protector, fourth letter is stating EX version or standard version.

1.3 Antenna Configuration

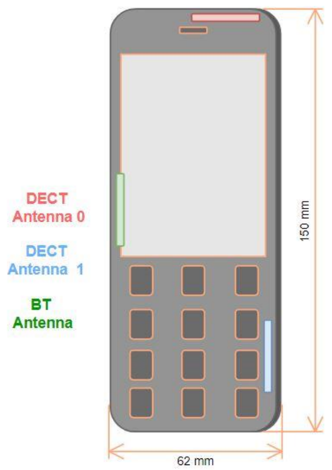


Fig. 1: Sketch of DUT and 2xDECT and 1xBT antenna locations.

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
☒	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)	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

1.5 Attestation of Test Results

Highest Reported SAR [W/kg]						
Exposure Configuration / Position of DUT		**Equipment Class**			**Limit SAR_{1g}**	**Verdict**
		PUE (DECT)	**DSS** (BT)	**DTS** (BLE)		
Standalone TX	Head	0.048	0.130*	0.130*	1.6	PASS
	Body	0.061	0.130*	0.130*	1.6	PASS
Simultaneous TX	Head	0.178			1.6	PASS
	Body	0.191			1.6	PASS

Notes: *Estimated SAR values.
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 19.

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.

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

Dessislava Patrishkova
Test Engineer

Alexander Rahn
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 2: 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 3: 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:

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

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. 9
- 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

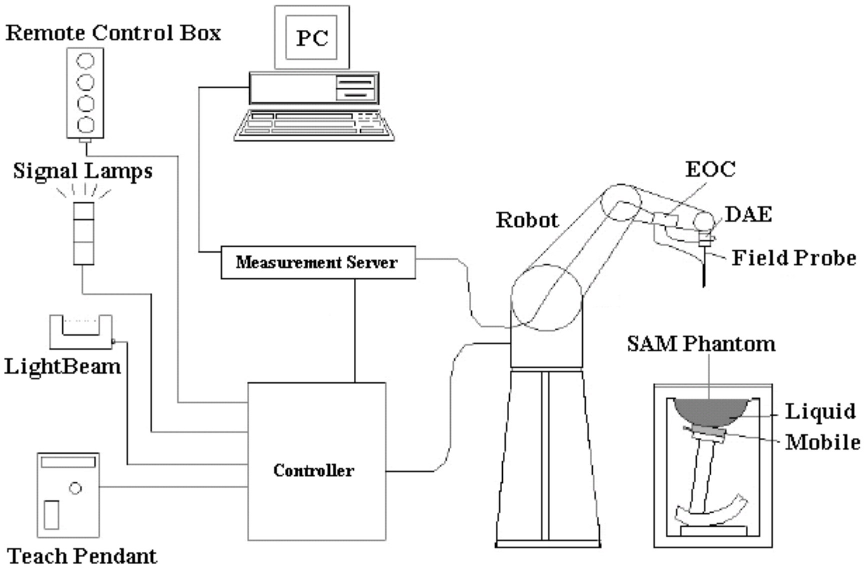


Fig. 2: The DASY4 measurement system.

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 defined in IEEE 1528 and IEC 62209-1 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. 10 on page 37.
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 38.
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 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.

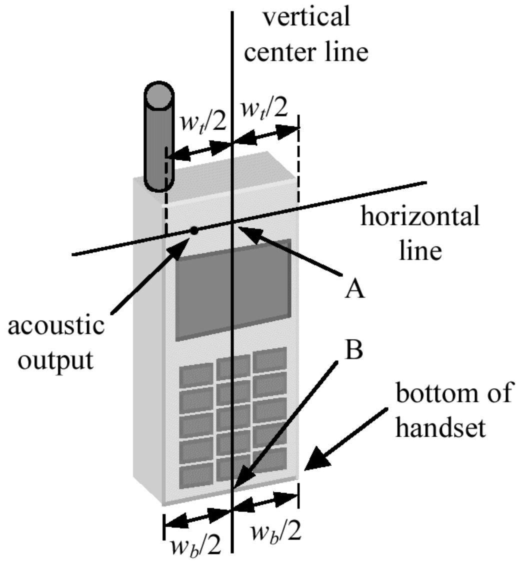
5.2 Test Position of DUT operating next to the Human Ear

5.2.1 Phantom Requirements

The phantom is a simplified representation of the human anatomy and comprised of material with electrical properties similar to the corresponding tissues. The physical characteristics of the phantom model shall resemble the head and the neck of a user since the shape is a dominant parameter for exposure.

5.2.2 Reference Points

As it cannot be expected that the user will hold the mobile phone exactly in one well defined position, different operational conditions shall be tested. The standards require two test positions. For an exact description helpful geometrical definitions are introduced and shown in Fig. 4 - 6. There are two imaginary lines on the mobile, the vertical centerline and the horizontal line. The vertical centerline passes through two points on the front side of the handset: the midpoint of the width w_t of the handset at the level of the acoustic output (point A on Fig. 4 and 6), and the midpoint of the width w_b of the bottom of the handset (point B). The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output (see Fig. 4). The horizontal line is also tangential to the face of the handset at point A. The two lines intersect at point A.



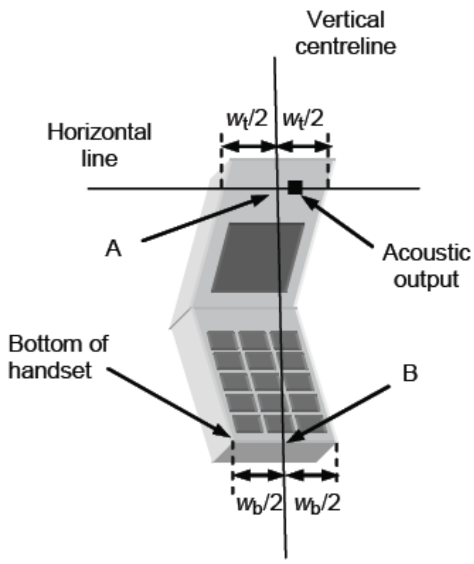


Fig. 4: Geometrical definitions on the telephone (bar phone).

Fig. 5: Geometrical definitions on the telephone (clam shell or flip).

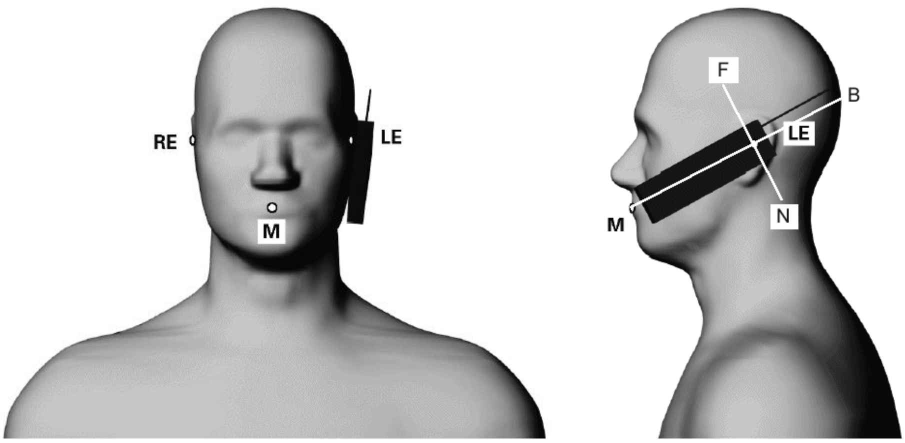


Fig. 6: Phantom reference points.

According to Fig. 6 the human head position is given by means of the following three reference points: auditory canal opening of both ears (RE and LE) and the center of the closed mouth (M). The ear reference points are 15 - 17 mm above the entrance to the ear canal along the BM line (back-mouth), as shown in Fig. 6. The plane passing through the two ear canals and M is defined as the reference plane. The line NF (Neck-Front) perpendicular to the reference plane and passing through the RE (or LE) is called the reference pivoting line. Line BM is perpendicular to the NF line. With this definitions the test positions are given by

5.2.3 Cheek Position:

Position the handset close to the surface of the phantom such that point A is on the (virtual) extension of the line passing through points RE and LE on the phantom (see Fig. 6), such that the plane defined by the vertical center line and the horizontal line of the phone is approximately parallel to the sagittal plane of the phantom. Translate the handset towards the phantom along the line passing through RE and LE until the handset touches the ear. While maintaining the handset in this plane, rotate it around the LE-RE line until the vertical centerline is in the plane normal to MB-NF including the line MB (called the reference plane). Rotate the phone around the vertical centerline until the phone (horizontal line) is symmetrical with respect to the line NF. While maintaining the vertical centerline in the reference plane, keeping point A on the line passing through RE and LE, and maintaining the phone contact with the ear, rotate the handset about the line NF until any point on the handset is in contact with a phantom point below the ear.

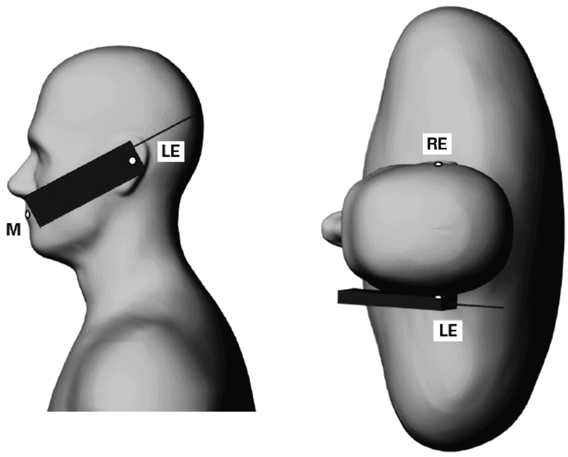


Fig. 7: The cheek position.

5.2.4 Tilted Position:

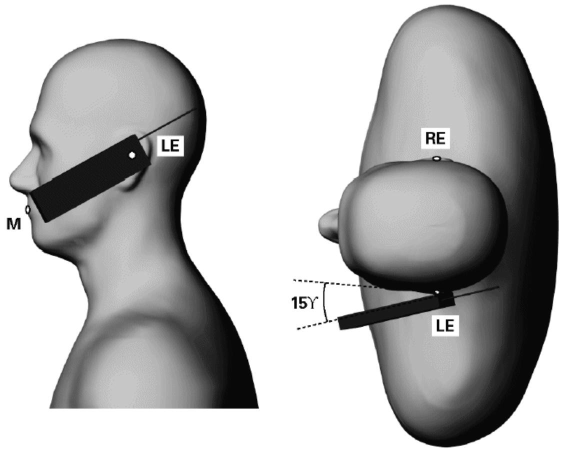


Fig. 8: The tilted position.

While maintaining the orientation of the phone retract the phone parallel to the reference plane far enough to enable a rotation of the phone by 15°. Rotate the phone around the horizontal line by 15°. While maintaining the orientation of the phone, move the phone parallel to the reference plane until any part of the phone touches the head. In this position, point A will be located on the line RE-LE.

5.2.5 Test to be Performed

The SAR test shall be performed with both phone positions described above, on the left and right side of the phantom. The device shall be measured for all modes operating when the device is next to the ear, even if the different modes operate in the same frequency band.

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 for each test configuration is at least 3.0 dB lower than the SAR limit, testing at the high and low channels is optional.

5.3 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.

Other separation distances may be used, but they shall not exceed 2.5 cm.

5.3.1 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.

5.4 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 *4*.
- 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	$\frac{1}{2}\cdot\delta\cdot\ln(2) \pm 0.5$ 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	$\frac{1}{2}\cdot\delta \ln(2)$ [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 4: Parameters for SAR scan procedures.

6 System Verification and Test Conditions

6.1 Date of Testing

Date of Testing				
Band	**Test Position**	**Frequency [MHz]**	**Date of System Check**	**Date of SAR Measurement**
DECT	Head	1900	April 23, 2021	April 23, 2021
		1900	April 26, 2021	April 26, 2021
	Body	1900	April 26, 2021	April 26-27, 2021

Table 5: 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 6: 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 7: 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 Parameters										
Ambient Temperature(C) : 22.0 ± 2				Liquid Temperature(C) : 22.0 ± 2			Humidity(%) : 40.0 ± 5			
Band	**Date**	**Frequency**	**Channel**	**Permittivity**			**Conductivity**			
				Measured	**Target**	**Delta**	**Measured**	**Target**	**Delta**	
		[MHz]		**ε'**	**ε'**	**+/- 5 [%]**	**σ [S/m]**	**σ [S/m]**	**+/- 5 [%]**	
DECT 1900 MHz	April 23, 2021	*1900.0*	*System Check*	*38.8*	*40.0*	*-3.1*	*1.37*	*1.40*	*-2.1*	
		1921.536	4	38.7	40.0	-3.2	1.39	1.40	-0.8	
		1924.992	2	38.7	40.0	-3.2	1.39	1.40	-0.5	
		1928.448	0	38.7	40.0	-3.3	1.40	1.40	-0.1	
DECT 1900 MHz	April 26, 2021	*1900.0*	*System Check*	*38.8*	*40.0*	*-3.0*	*1.37*	*1.40*	*-2.0*	
		1921.536	4	38.7	40.0	-3.2	1.39	1.40	-0.8	
		1924.992	2	38.7	40.0	-3.2	1.39	1.40	-0.4	
		1928.448	0	38.7	40.0	-3.3	1.40	1.40	-0.1	

Table 8: 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 9 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**	
1900	D1900V2 #535	9.26	4.98	37.04	19.92	39.20	20.50	-5.51	-2.83	April 23, 2021
1900	D1900V2 #535	9.06	4.83	36.24	19.32	39.20	20.50	-7.55	-5.76	April 26, 2021

Table 9: Dipole target and measured results.

7 SAR Measurement Conditions and Results

7.1 Test Conditions

Test Conditions				
Band	**TX Range [MHz]**	**Used Channels**	**Crest Factor**	**Phantom**
DECT	1921.536 - 1928.448	04, 02, 00	24	SAM Twin Phantom V4.0
Notes:				

Table 10: Used channels and crest factors during the test.

7.2 Tune-Up Information

Tune-Up Output Power			
Band	**Frequency [MHz]**	**CH**	**Max. Tune-Up Limit [dBm]**
DECT	1921.536 - 1928.448	00 - 04	20.4
BT EDR	2402 – 2480	0 - 78	5.0
BLE	2412 – 2480	0 – 39	5.0
Notes: According to the manufacturer both DECT antennas have the same tune-up output values.			

Table 11: Maximum transmitting output power values declared by the manufacturer.

7.3 Measured Output Power

Maximum Output Power				
Antenna	**Mode**	**Frequency [MHz]**	**CH**	**Measured Output Power [dBm]**
DECT Ant. 0	GFSK	1921.536	04	19.6
		1924.992	02	19.5
		1928.448	00	19.3
DECT Ant. 1	GFSK	1921.536	04	19.6
		1924.992	02	19.5
		1928.448	00	19.3
BT EDR	GFSK	2402 – 2480	0 – 78	NR[1]
BLE	GFSK	2412 – 2480	0 – 39	NR[1]
Notes: - According to the manufacturer both antennas have the same tune-up output values. NR: Not required and excluded from testing.				

Table 12: Conducted output power values.

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 (peak		Maximum Duty Cycle	Output Power (average)		Threshold Comparison Value	Exclusion Threshold SAR 1g	SAR Testing Exclusio	Estimated SAR Values	SAR Testing Required
	[MHz]	[mm]	[dBm]	[mW]	[%]	[dBm]	[mW]					
DECT	1925	5	20.40	109.65	4.17	6.60	4.57	1.3	≤ 3.0	YES	measured	NO
BT	2440	5	5.00	3.16	77.00	3.86	2.43	0.8	≤ 3.0	YES	0.13	NO
BLE	2440	5	5.00	3.16	77.00	3.86	2.43	0.8	≤ 3.0	YES	0.13	NO
Notes:												

Table 13: 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 (peak)		Maximum Duty Cycle	Output Power (average)		Exemption Limit for SAR 1g [mW]	SAR Testing Exclusion	SAR Testing Required
	[MHz]	[mm]	[dBm]	[mW]	[%]	[dBm]	[mW]			
DECT	1925	5	20.40	109.65	4.17	6.60	4.57	6.8	YES	NO
BT	2440	5	5.00	3.16	77.00	3.86	2.43	4.0	YES	NO
BLE	2440	5	5.00	3.16	77.00	3.86	2.43	4.0	YES	NO
Notes:										

Table 14: 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 Table 11.

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 for DECT

SAR Measurement Results in Head Configuration (DECT)												
Band / Antenna	**Freq. [MHz]**	**CH**	**DUT* Position**	**Gap [mm]**	**Pic. No.**	**Measured SAR1g [W/kg]**	**Power Drift [dB]**	**Power [dBm]**		**Tune-Up SF**	**Reported SAR1g [W/kg]**	**Plot No.**
								Measured	**Limit**			
DECT Ant 0	1924.99	2	Left Cheek	0	5	0.039	-0.033	19.5	20.4	1.230	0.048	-
			Left Tilted	0	6	0.029	0.031	19.5		1.230	0.036	-
			Right Cheek	0	7	0.036	-0.017	19.5		1.230	0.044	-
			Right Tilted	0	8	0.029	0.078	19.5		1.230	0.036	-
	1921.54	4	Left Cheek	0	7	0.040	-0.057	19.6		1.202	0.048	1
	1928.45	0	Left Cheek	0	7	0.037	0.020	19.3		1.288	0.048	-
DECT Ant 1	1924.99	2	Left Cheek	0	5	0.006	0.009	19.5		1.230	0.008	-
			Left Tilted	0	6	0.004	-0.14	19.5		1.230	0.005	-
			Right Cheek	0	7	0.011	-0.04	19.5		1.230	0.014	-
			Right Tilted	0	8	0.004	-0.05	19.5		1.230	0.005	-
	1921.54	4	Right Cheek	0	5	0.011	0.15	19.6		1.202	0.013	-
	1928.45	0	Right Cheek	0	5	0.011	-0.04	19.3		1.288	0.014	2
Notes:												

Table 15: SAR measurement results in head configuration.

SAR Measurement Results in Body Worn Configurations (DECT)												
Band / Antenna	**Freq. [MHz]**	**CH**	**DUT* Position**	**Gap [mm]**	**Pic. No.**	**Measured SAR1g [W/kg]**	**Power Drift [dB]**	**Power [dBm]**		**Tune-Up SF**	**Reported SAR1g [W/kg]**	**Plot No.**
								Measured	**Limit**			
DECT Ant 0	1924.99	2	Front	0	9	0.045	-0.121	19.5	20.4	1.230	0.055	-
			Rear	0	10	0.009	-0.181	19.5		1.230	0.012	-
	1921.54	4	Front	0	9	0.031	-0.179	19.6		1.202	0.037	-
	1928.45	0	Front	0	9	0.047	0.046	19.3		1.288	0.061	3
DECT Ant 1	1924.99	2	Front	0	9	0.039	-0.045	19.5		1.230	0.048	-
			Rear	0	10	0.031	-0.072	19.5		1.230	0.038	-
	1921.54	4	Front	0	9	0.039	0.112	19.6		1.202	0.047	-
	1928.45	0	Front	0	9	0.038	0.106	19.3		1.288	0.049	4
Notes:												

Table 16: SAR measurement results in body worn configuration.

7.7 Simultaneous Transmission Consideration

Simultaneous Transmission Capabilities of DUT		
ANT0 DECT	**ANT1 DECT**	**ANT2 BT / BLE**
V	X	V
X	V	V
Notes: Simultaneous Transmission can be performed only in combination of Ant0 + Ant 2, or Ant1 + Ant 2.		

Table 17: Simultaneous transmission capabilities.

For the following simultaneous transmission analysis the worst case SAR results shown in chapter 7.6.1 and in the following Table 18 are taken to introduce the highest reported SAR results for standalone transmission at BT/BLE antenna.

Highest Reported SAR for Standalone Transmission [W/kg]				
Exposure Position of DUT		**DECT**	**BT**	**BLE**
		PUE	**DSS**	**DTS**
Head	Left Cheek	0.048	0.13*	0.13*
	Left Tilted	0.036	0.13*	0.13*
	Right Cheek	0.048	0.13*	0.13*
	Right Tilted	0.036	0.13*	0.13*
Body	Front	0.061	0.13*	0.13*
	Rear	0.038	0.13*	0.13*
Notes: *Estimated SAR values according to Table 13				

Table 18: Reported SAR for standalone transmission for WLAN/BT.

According to KDB 447498, the following table gives an overview about the ∑SAR for simultaneous transmitting modes. When ∑SAR > 1.6 W/kg. a SAR test exclusion is determined by the SAR to peak location separation ratio. The ratio is determined by $(SAR1 + SAR2)^{1.5}/Ri$ rounded to two decimal digits and must be ≤ 0.04 for all antenna pairs in the configuration to qualify for 1-g SAR test exclusion. Where Ri is the separation distance between the peak SAR locations for the antenna pair in mm. When SAR is measured for both antennas in a pair the peak location separation distance is computed by the square root of $[(x1-x2)^2 + (y1-y2)^2 + (z1-z2)^2]$ where (x1, y1, z1) and (x2, y2, z2) are the coordinates of the area scans or extrapolated peak SAR locations in the zoom scans as appropriate.

Highest Reported SAR for Simultaneous Transmission [W/kg]							
Exposure Configuration / Position of DUT		**DECT**	**BT**	**BLE**	**Σ SAR_{1g}**	**Limit SAR_{1g}**	**SPLSR Analysis**
		PUE	**DSS**	**DTS**			
Simultaneous TX	Head Cheek	0.048	0.130	/	**0.178**	1.6	NO
		0.048	/	0.130	**0.178**	1.6	NO
	Body Front	0.061	0.130	/	**0.191**	1.6	NO
		0.061	/	0.130	**0.191**	1.6	NO
Notes: According to simultaneous transmission capabilities shown in Table 17							

Table 19: SAR for simultaneous transmission scenario.

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	02/2020	02/2022
☒ Dosimetric E-Field Probe	SPEAG	ET3DV6R	1669	03/2021	03/2023
☐ Dosimetric E-Field Probe	SPEAG	EX3DV4	3536	08/2020	08/2022
☐ Dosimetric E-Field Probe	SPEAG	EX3DV4	3860	10/2019	10/2021
☒ Data Acquisition Electronics	SPEAG	DAE 3	335	03/2021	03/2022
☐ Data Acquisition Electronics	SPEAG	DAE 4	631	08/2020	08/2021
☐ 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 Dipole	SPEAG	D450V2	1014	03/2021	03/2024
☐ System Validation Dipole	SPEAG	D835V2	470	03/2021	03/2024
☐ System Validation Dipole	SPEAG	D1640V2	311	09/2018	09/2021
☐ 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	11/2018	11/2021
☐ System Validation Dipole	SPEAG	D2600V2	1019	11/2018	11/2021
☐ System Validation Dipole	SPEAG	D5GHzV2	1028	04/2020	04/2023
Material Measurement					
☒ Network Analyzer	Agilent	E5071C	MY46103220	08/2019	08/2021
☒ Dielectric Probe Kit	SPEAG	DAK-3.5	1234	02/2020	02/2022
☒ Thermometer	LKMelectronic	DTM3000	3511	02/2020	02/2022
Power Meters and Sensors					
☒ Power Meter	Anritsu	ML2487A	6K00002319	07/2020	07/2022
☒ Power Sensor	Anritsu	MA2472A	990365	07/2020	07/2022
☒ Power Meter	Anritsu	ML2488A	6K00002078	07/2020	07/2022
☒ Power Sensor	Anritsu	MA2472A	002122	07/2020	07/2022
☒ Spectrum Analyzer	Rohde & Schwarz	FSP7	100433	01/2021	01/2023
RF Sources					
☒ Network Analyzer	Agilent	E5071C	MY46103220	08/2019	08/2021
☐ 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	06/2020	06/2022
☐ Radio Communication Tester	Anritsu	MT8820C	6200918336	05/2020	05/2022
Notes: Used test equipment for measurement is checked above.					

Table 20: 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 [± %]**	**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 21: Uncertainty budget for SAR measurements.

9 Report History

Revision History				
Revision	**Description of Revision**	**Date**	**Revised Page**	**Revised By**
/	Initial Release	May 7, 2021	-	-
1	Added a detailed description of the differences between models in the product family	July 22, 2021	3	DP
2	References to IEC/IEEE 62209-1528:2020 updated	August 09, 2021	1, 4, 9, 22, 24	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