SAR Evaluation Report

DUT Information

Manufacturer	Panasonic Entertainment & Communication Co., Ltd.
Brand Name	KX-TGDA86
Model Under Test	KX-TGDA86
FCC ID	ACJ96NKX-TGDA51A
IC Number	216A-KXTGDA59A
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	DAkkS Deutsche Akkreditierungsstelle D-PL-12139-01-01 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. Bundesnetzagentur BNetzA-CAB-16/21-14 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

	Applicant	Manufacturer
Applicant / Manufacturer	Panasonic Corporation of North America Two Riverfront Plaza, 9th Floor Newark, 07102-5490, NJ USA	Panasonic Entertainment & Communication Co., Ltd. 1-10-12 Yagumo-higashi-machi, Moriguchi City, Osaka 570-0021, Japan

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	6220567
Issue Date	December 28, 2022
Revision Date	February 16, 2023
Revision Number*	1
	***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.

Table of Contents

1 Subject of Investigation and Test Results

The tested KX-TGDA86 is a new handset from Panasonic Entertainment & Communication Co., Ltd. operating in DECT standard with one integrated antenna. The objective of the measurements performed by IMST is the dosimetric assessment of DECT on one device in the intended use positions.

1.1 Technical Data of DUT

Product Specifications		
Manufacturer	Panasonic Entertainment & Communication Co., Ltd.	
Model Under Test	KX-TGDA86 (refer to chapter 1.2)	
SN / IMST DUT No.	N/A / SAR 01	
Operation Mode	DECT	
Frequency Range	1921.536 – 1928.448 MHz	
Modulation	GFSK	
Maximum Duty Cycle	4.17 %	
Antenna Type	1x internal (IFA)	
Maximum Output Power	refer chapter 7.3	
Power Supply	2x NiMH 1.2 V (DC 2.4V)	
Used Accessory	belt clip	
DUT Stage	☐ production unit	☒ identical prototype
Notes:		

1.2 Product Family / Model Variants

As declared by the manufacturer, there are different model variants available. All following model name variants have identical RF design and antennas with the tested variant KX-TGDA86.

Model Variants	
Manufacturer	Panasonic Entertainment & Communication Co., Ltd.
Model Under Test	KX-TGDA86
Identical Model Variants	KX-TGDA83; KX-TGDA50; KX-TGDA51; KX-TGDA52; KX-TGFA85 KX-TGDA87AC; KX-TGDA85AC; KX-TGDA59AC; KX-TGDA58AC, KX-TGDA57AC, KX-TGFA87AC

1.3 Antenna Configuration

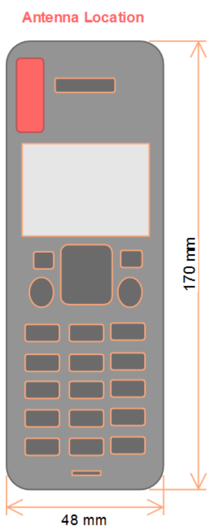


Fig. 1: Sketch of DUT and antenna location.

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** **PUE** (DECT)	**Limit SAR_{1g}**	**Verdict**
Standalone TX	Head	0.057	1.6	PASS
Standalone TX	Body	0.053	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 18.

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

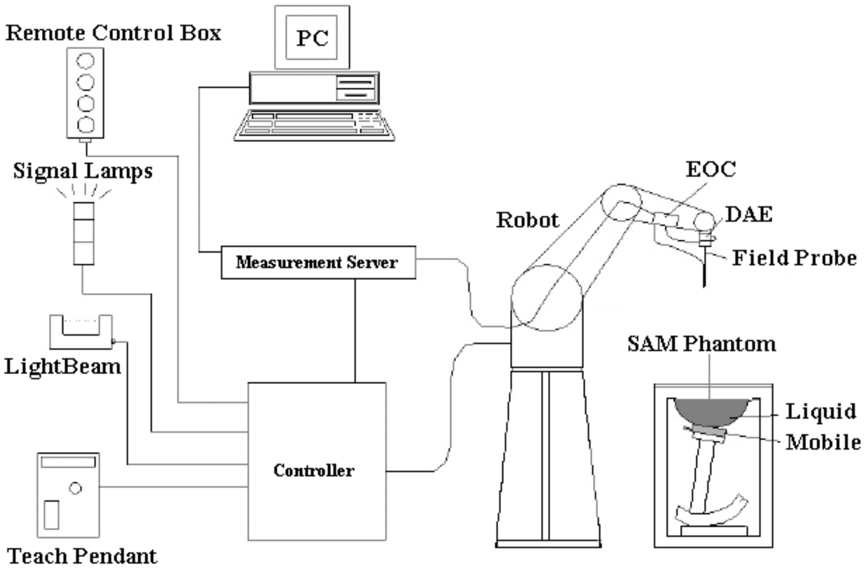


Fig. 2: The DASY4 measurement system.

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 31.
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 32.
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	150 MHz / 300 MHz / 450 MHz / 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 - 5. 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) and the midpoint of the width w_b of the bottom of the handset (point B) on Fig. 4 and 5. The horizontal line is perpendicular to the vertical centerline and passes through the center of the acoustic output. The horizontal line is also tangential to the face of the handset at point A. The two lines intersect at point A.

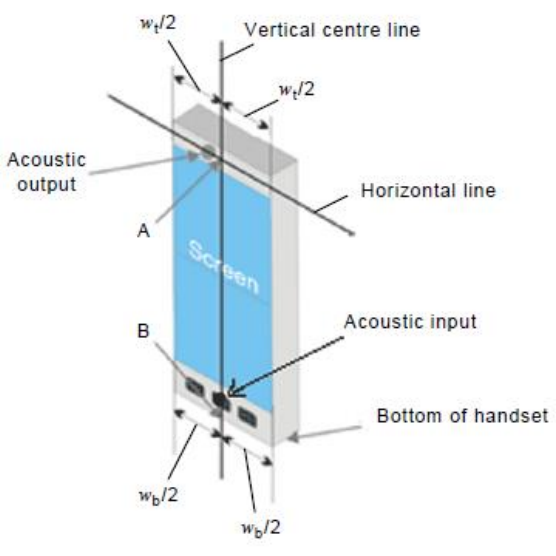


Fig. 4: Reference lines on a full touch screen smart phone.

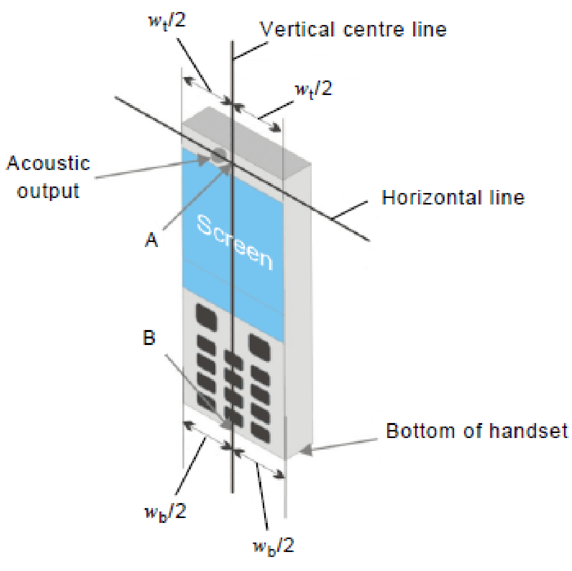


Fig. 5: Reference lines on a keyboard handset.

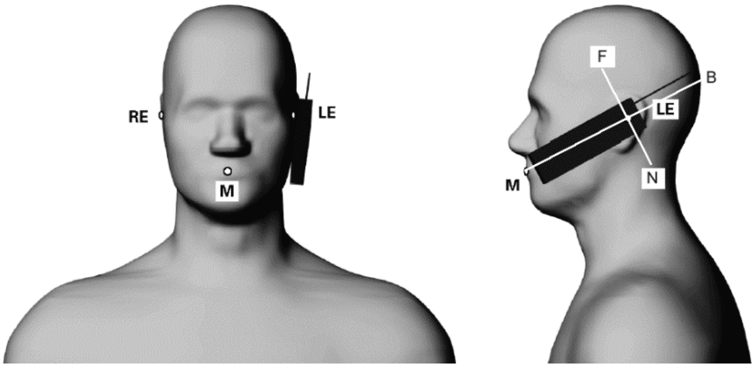


Fig. 6: Phantom reference points.

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 cheek and tilted position.

5.2.3 Cheek Position

1. The NF line is the plane defined by the handset vertical and horizontal line
2. The vertical centreline from the handset is in the reference plane
3. Position the handset close to the surface of the phantom such that point A meets the line through the reference points (RE) and (LE) (see Fig. 7)
4. Move the handset towards the phantom along the line through RE and LE until point A touches the pinna at RE or LE
5. While keeping point A on the line through LE and RE and maintaining the handset in contact with the pinna, rotate it about the NF line until any point on the handset is in contact with the phantom below the pinna

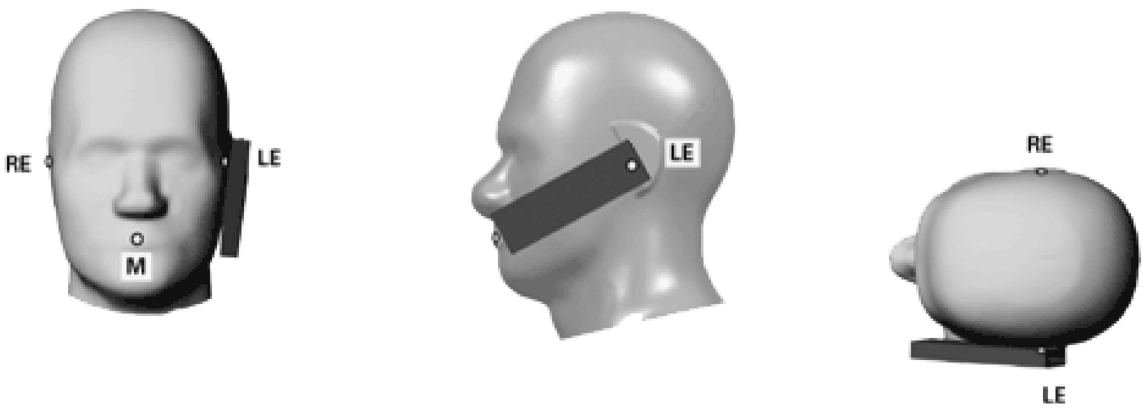


Fig. 7: The cheek position.

5.2.4 Tilted Position:

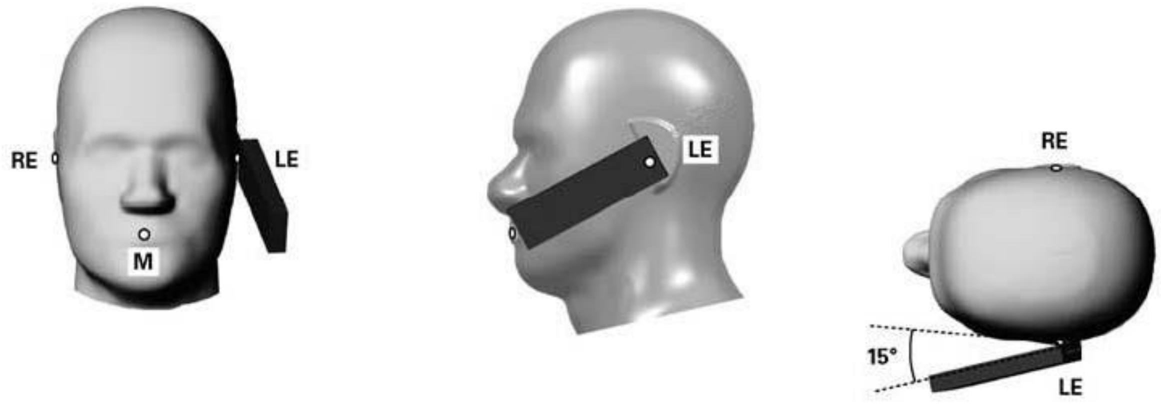


Fig. 8: The tilted position.

1. Repeat the above steps for the cheek position
2. While maintaining the orientation of the handset, remove the handset from the pinna along the RE - LE line until a free rotation of the handset around the horizontal line is possible
3. Rotate the handset by 15° and move it back along the RE- LE line until any part touches the ear
4. For the case that contact occurs at any position other than the pinna, the rotation should be reduced so that the device has contact with the ear and any additional point of the phantom

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.

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 *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.

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	November 23, 2022	November 23, 2022
	Body	1900	November 23, 2022	November 24, 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 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	November 23, 2022	*1900.0*	*System Check*	*40.2*	*40.0*	*0.6*	*1.43*	*1.40*	*2.1*
		1921.536	4	40.2	40.0	0.4	1.45	1.40	3.7
		1924.992	2	40.2	40.0	0.4	1.46	1.40	4.0
		1928.448	0	40.1	40.0	0.3	1.46	1.40	4.3

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 PlotsThe 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	9.32	4.91	37.28	19.64	39.20	20.50	-4.90	-4.20	November 23, 2022

Table 8: 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 9: 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	20.0
Notes:			

Table 10: 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	GFSK	1921.536	04	18.6
		1924.992	02	18.7
		1928.448	00	18.5
Notes: -				

Table 11: Conducted output power values.

7.4 Standalone SAR Test Exclusion according to KDB 447498

SAR test exclusion is determined for the 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 Exclusion**	**Estimated SAR Values**	**SAR Testing Required**
	[MHz]	**[mm]**	**[dBm]**	**[mW]**	**[%]**	**[dBm]**	**[mW]**					
DECT	1925	5	20.0	100.00	4.17	6.20	4.17	1.1	≤ 3.0	YES	measured	NO
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 (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	20.0	100.0	4.17	6.2	4.17	7.0	YES	NO
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 Table 10.

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

Measured and Reported SAR [W/kg]													
Band	Freq. [MHz]	CH	Phantom	Test Position	Gap [mm]	Pic. No.	Measured SAR1g	Drift [dBm]	Power [dBm]		Tune-Up SF	Reported SAR1g	Plot No.
									Meas.	Limit			
DECT	1924.99	2	head left	cheek	0	3	0.042	-0.121	18.7	20.0	1.349	0.057	1
	1924.99	2		tilted	0	4	0.019	-0.095	18.7	20.0	1.349	0.026	
	1924.99	2	head right	cheek	0	5	0.028	0.018	18.7	20.0	1.349	0.038	
	1924.99	2		tilted	0	6	0.017	-0.059	18.7	20.0	1.349	0.023	
	1921.54	4	head left	cheek	0	3	0.039	0.102	18.6	20.0	1.380	0.054	1
	1928.45	0			0	3	0.038	-0.026	18.5	20.0	1.413	0.054	
	1924.99	2	body-worn	front	0	7	0.039	0.047	18.7	20.0	1.349	0.053	2
	1924.99	2		rear	0	8	0.022	0.129	18.7	20.0	1.349	0.030	
	1921.54	4		front	0	7	0.034	-0.061	18.6	20.0	1.380	0.047	
	1928.45	0			0	7	0.035	0.078	18.5	20.0	1.413	0.049	
Notes:													

Table 14: SAR measurement results (head/body).

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	08/2020	08/2022
☐	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	10/2021	10/2022
☐	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	02/2020	02/2023
☐	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	/
☐	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	3848	02/2022	02/2024
Power Meters and Sensors						
☒	Power Meter	Anritsu	ML2487A	6K00002319	06/2020	07/2022
☒	Power Sensor	Anritsu	MA2472A	990365	06/2020	07/2022
☒	Power Meter	Anritsu	ML2488A	6K00002078	06/2020	07/2022
☒	Power Sensor	Anritsu	MA2472A	002122	06/2020	07/2022
☐	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	06/2020	06/2022
☐	Radio Communication Tester	Anritsu	MT8820C	6200918336	05/2020	05/2022
Notes: Used test equipment for measurement is checked above.						

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 15: Uncertainty budget for SAR measurements.

9 Report History

Revision History				
Revision	**Description of Revision**	**Date**	**Revised Page**	**Revised By**
/	Initial Release	December 28, 2022	-	-
1	1st Revision – Manufacturer contact corrected	February 16, 2023	1 & 22	Jens Lerner

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_6220567

DUT Information				
Manufacturer	Panasonic Entertainment & Communication Co., Ltd.			
Brand Name	KX-TGDA86			
Model Under Test	KX-TGDA86			
FCC ID	ACJ96NKX-TGDA51A			
IC Number	216A-KXTGDA59A			
Type / Category	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

Prepared for		
	Applicant	**Manufacturer**
Applicant / Manufacturer	Panasonic Corporation of North America Two Riverfront Plaza, 9th Floor Newark, 07102-5490, NJ USA	Panasonic Entertainment & Communication Co., Ltd. 1-10-12 Yagumo-higashi-machi, Moriguchi City, Osaka 570-0021, Japan

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	6220567
Issue Date	December 28, 2022
Revision Date	February 16, 2023
Revision Number*	1
	***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 side views of the device under test.

Pic. 2: Rear side views of the device under test.

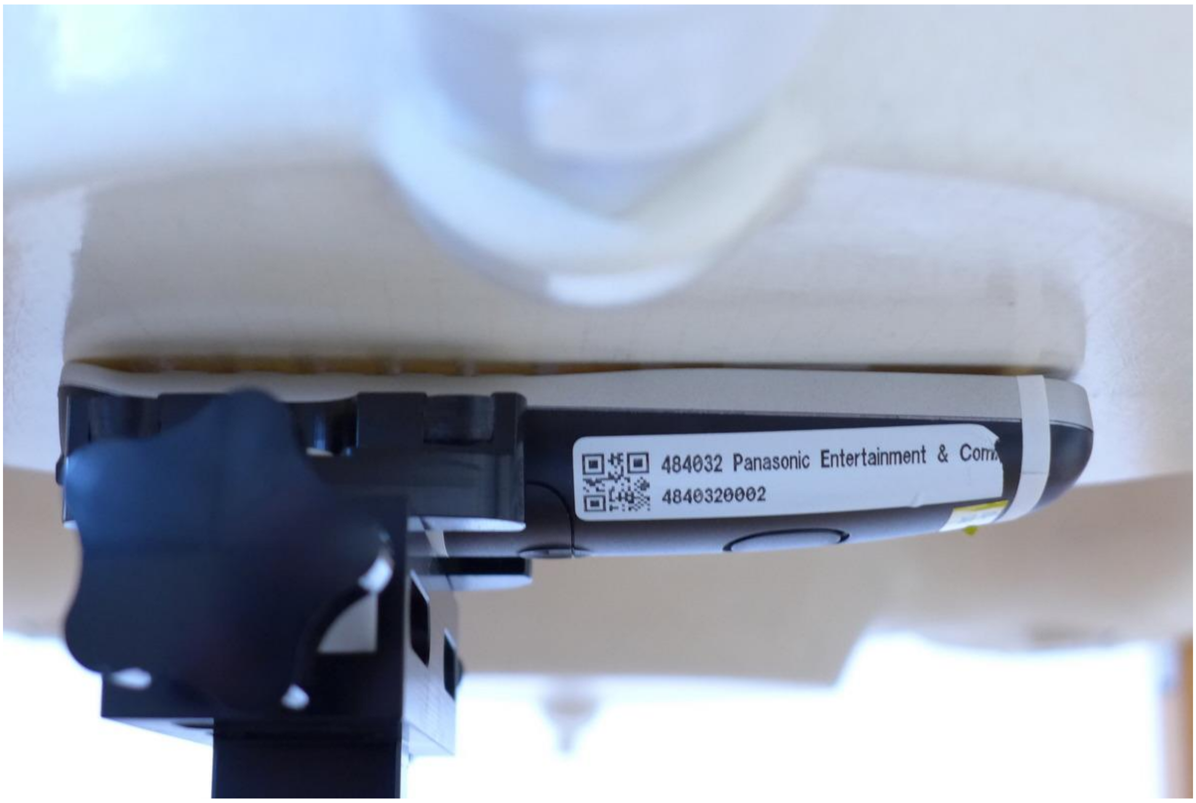
Pictures of Test Positions of the DUT

Pic. 3: *Cheek position, left side.*

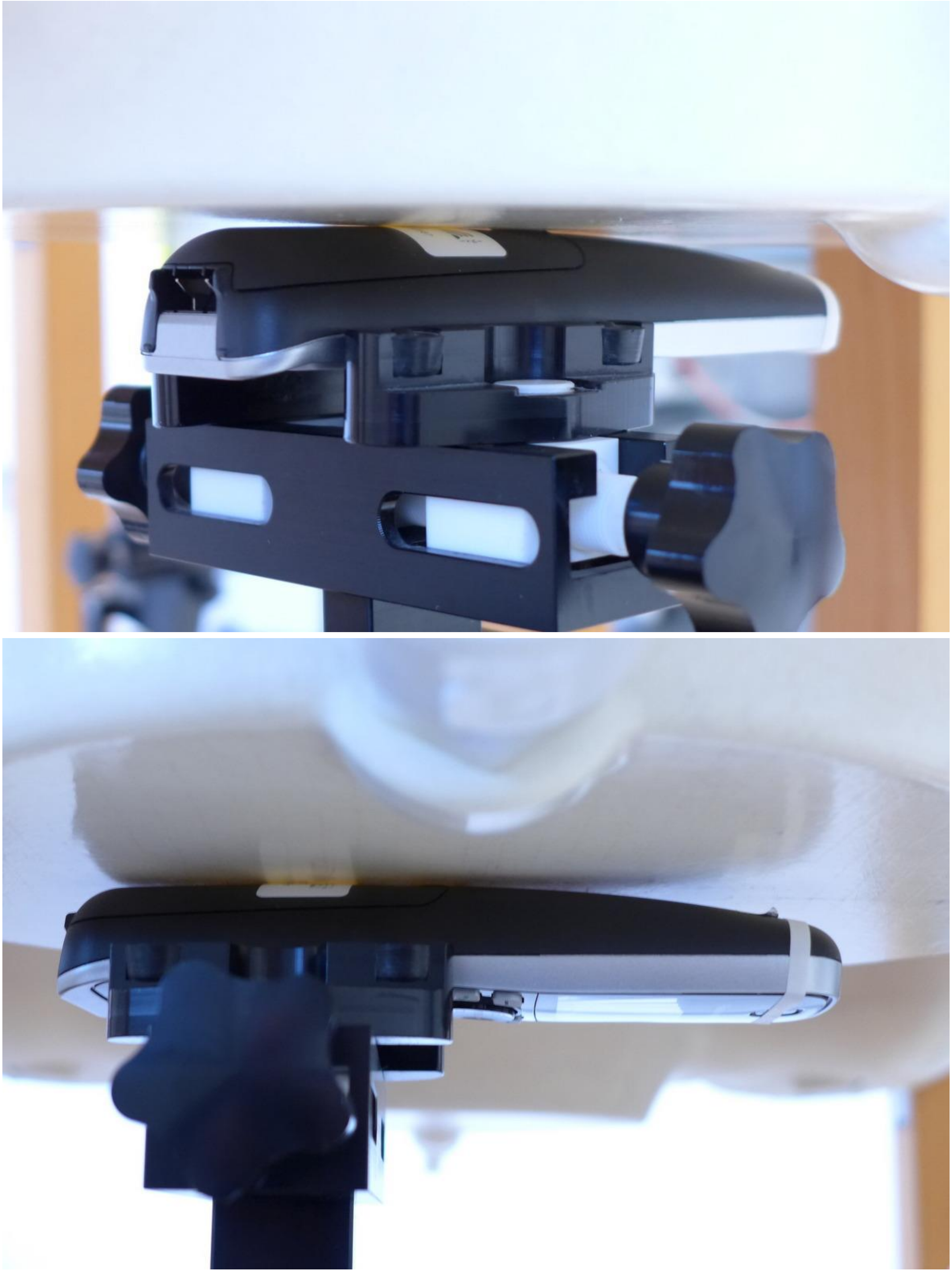
Pic. 4: *Tilted position, left side.*

Pic. 5: *Cheek position, right side.*

Pic. 6: *Tilted position, right side.*



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



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

Appendix B - SAR Distribution Plots

Worst Case SAR Measurement Plots for Head and Body Worn Configuration

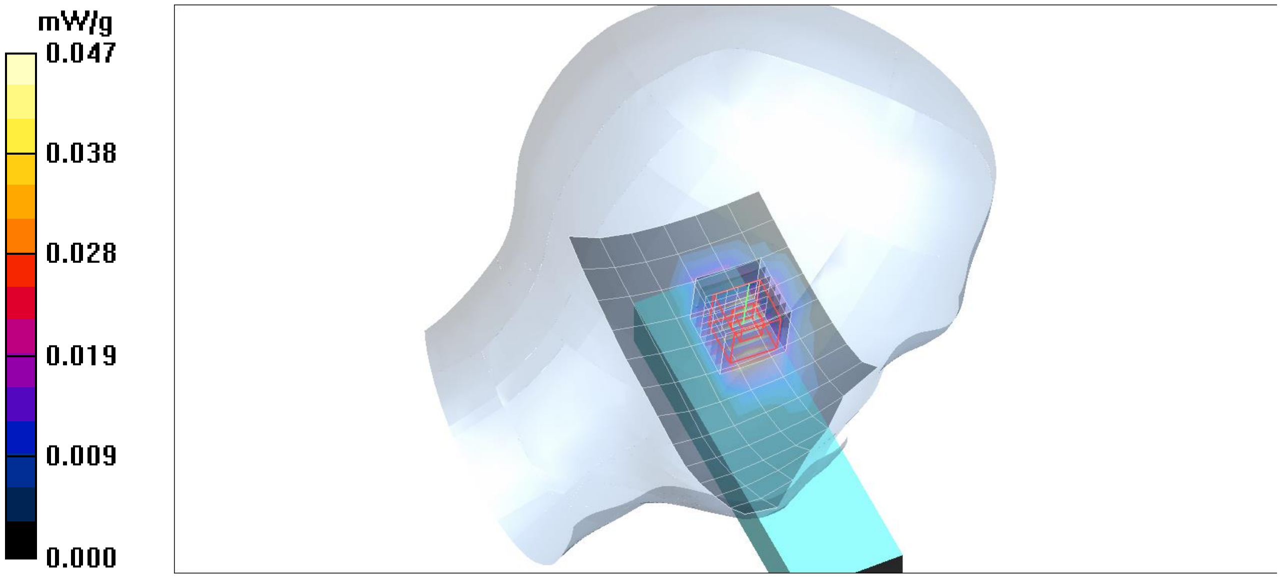
Test Laboratory: IMST GmbH, DASY Yellow (II);
File Name: KX-TGDA86_2Dy_DECT_CH2_lm_1.da4

DUT: Panasonic; Type: KX-TGDA86; Serial: 01
Program Name: DECT US

Communication System: DECT US; Frequency: 1924.99 MHz;Duty Cycle: 1:24
Medium parameters used: f = 1925 MHz; σ = 1.46 mho/m; ε_r = 40.2; ρ = 1000 kg/m^3
Phantom section: Left Section

DASY4 Configuration:
- Probe: ET3DV6R - SN1579; ConvF(5.46, 5.46, 5.46); Calibrated: 2/25/2022
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn335; Calibrated: 2/17/2022
- Phantom: SAM 1340; Type: QD 000 P40 CB; Serial: TP-1340
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Cheek Left/Area Scan (7x13x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 0.045 mW/g
Cheek Left/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 3.99 V/m; Power Drift = -0.121 dB
Peak SAR (extrapolated) = 0.079 W/kg
SAR(1 g) = 0.042 mW/g; SAR(10 g) = 0.022 mW/g
Maximum value of SAR (measured) = 0.047 mW/g
Minimum distance from peak to all points 3 dB below in M1 = 18.2 mm
Ratio of SAR at M2 to SAR at M1 = 54.43 %



Plot. 1: SAR distribution plot for DECT, channel 2, head configuration, left cheek.

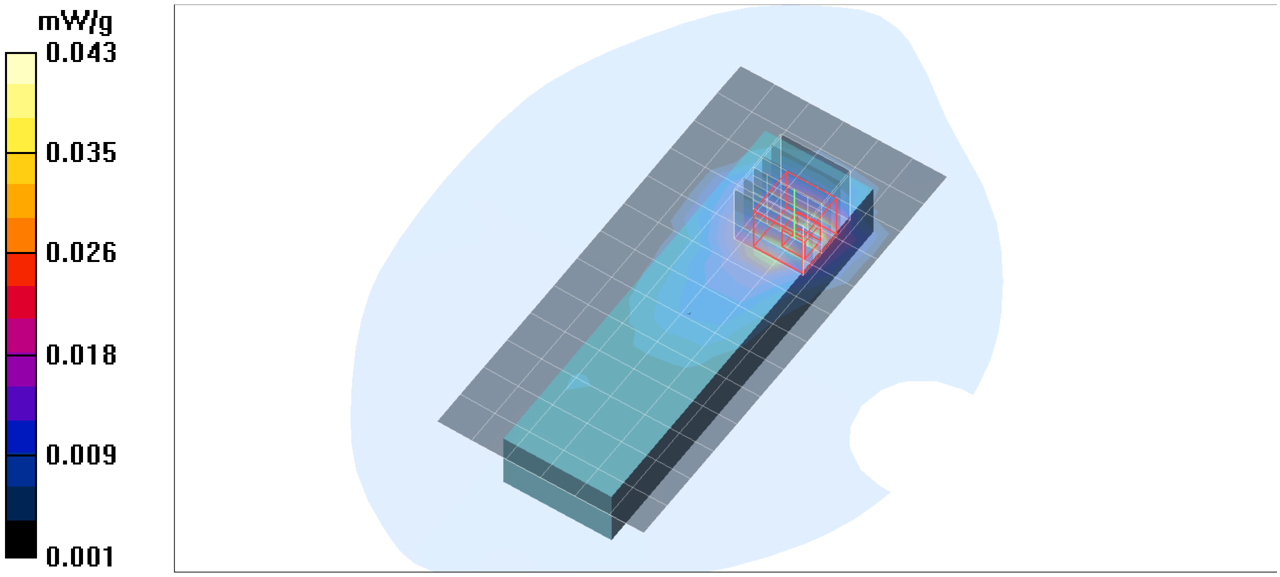
Test Laboratory: IMST GmbH, DASY Yellow (II);
File Name: KX-TGDA86_2Dy_DECT_CH2_front.da4

DUT: Panasonic; Type: KX-TGDA86; Serial: 01
Program Name: DECT US

Communication System: DECT US; Frequency: 1924.99 MHz;Duty Cycle: 1:24
Medium parameters used: f = 1925 MHz; σ = 1.46 mho/m; ε_r = 40.2; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6R - SN1579; ConvF(5.46, 5.46, 5.46); Calibrated: 2/25/2022
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn335; Calibrated: 2/17/2022
- Phantom: SAM 1340; Type: QD 000 P40 CB; Serial: TP-1340
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

Body Worn/Area Scan (7x14x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 0.038 mW/g
Body Worn/Zoom Scan (6x6x7)/Cube 0: Measurement grid: dx=6mm, dy=6mm, dz=5mm
Reference Value = 2.90 V/m; Power Drift = 0.047 dB
Peak SAR (extrapolated) = 0.074 W/kg
SAR(1 g) = 0.039 mW/g; SAR(10 g) = 0.020 mW/g
Maximum value of SAR (measured) = 0.043 mW/g
Minimum distance from peak to all points 3 dB below in M1 = 12.0 mm
Ratio of SAR at M2 to SAR at M1 = 53.85 %



Plot. 2: SAR distribution plot for DECT, channel 2, body-worn configuration, front side, 0mm gap.

Appendix C - System Verification Plots

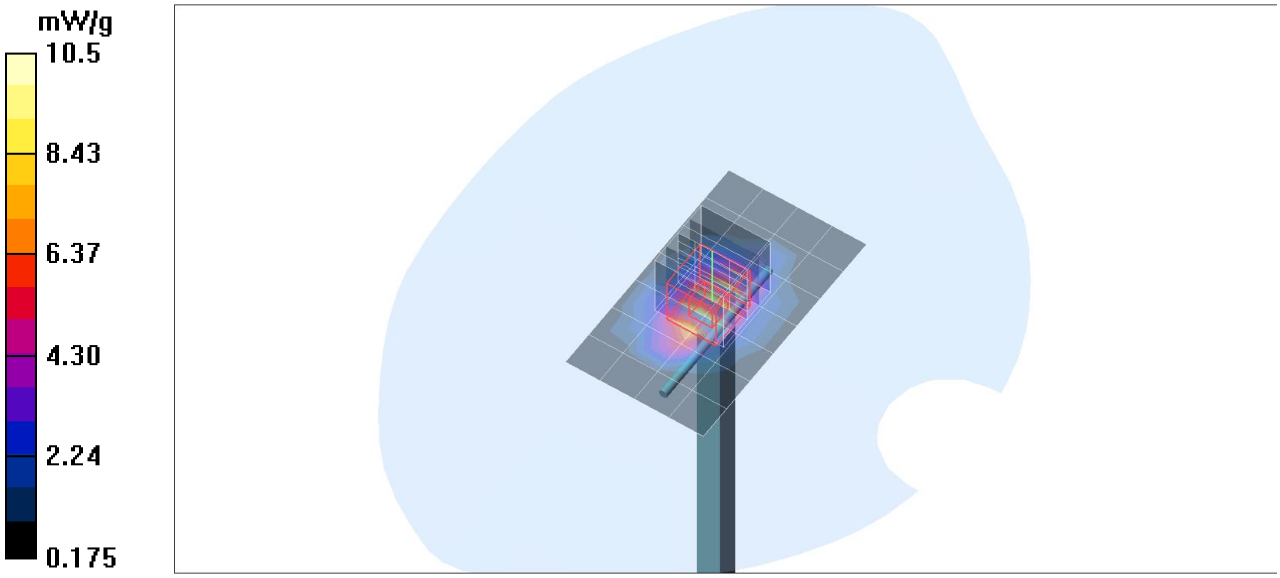
Test Laboratory: IMST GmbH, DASY Yellow (II);
File Name: 2022-11-23_1900h_2Dy_1579_335.da4

DUT: D1900V2 - SN535; Type: D1900V2; Serial: SN535
Program Name: System Performance Check at 1900 MHz

Communication System: CW; Frequency: 1900 MHz;Duty Cycle: 1:1
Medium parameters used: f = 1900 MHz; σ = 1.43 mho/m; ε_r = 40.2; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY4 Configuration:
- Probe: ET3DV6R - SN1579; ConvF(5.46, 5.46, 5.46); Calibrated: 2/25/2022
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE3 Sn335; Calibrated: 2/17/2022
- Phantom: SAM 1340; Type: QD 000 P40 CB; Serial: TP-1340
- Measurement SW: DASY4, V4.7 Build 80; Postprocessing SW: SEMCAD, V1.8 Build 186

d=10mm, Pin=250mW/Area Scan (5x8x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 10.1 mW/g
d=10mm, Pin=250mW/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=7.5mm, dy=7.5mm, dz=5mm
Reference Value = 90.4 V/m; Power Drift = 0.032 dB
Peak SAR (extrapolated) = 15.8 W/kg
SAR(1 g) = 9.32 mW/g; SAR(10 g) = 4.91 mW/g
Maximum value of SAR (measured) = 10.5 mW/g



Plot. 3: SAR Verification Measurement 1900 MHz.

Appendix D – Certificates of Conformity

Schmid & Partner Engineering AG **s p e a g**

Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

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.

s p e a g
Schmid & Partner Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

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

s p e a g

Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
info@speag.com, http://www.speag.com

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

s p e a g
Schmid & Partner Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland
Phone +41 44 245 9700, Fax +41 44 245 9779
http://www.speag.com

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

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

Schmid & Partner Engineering AG

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info@speag.com, http://www.speag.com

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

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Phone +41 1 245 9700, Fax +41 1 245 9779
info@speag.com, http://www.speag.com

Doc No 881 – QD OVA 001 B - C Page 1 (1)

Fig. 11: Certificate of conformity for the ELI phantom.

Appendix E – Calibration Certificates for DAEs

DAE 3 – SN: 335

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

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Swiss Calibration Service

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The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: SCS 0108

Client **IMST**

Certificate No: DAE3-335_Feb22

CALIBRATION CERTIFICATE

Object	DAE3 - SD 000 D03 AA - SN: 335
Calibration procedure(s)	QA CAL-06.v30 Calibration procedure for the data acquisition electronics (DAE)
Calibration date:	February 17, 2022

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Keithley Multimeter Type 2001	SN: 0810278	31-Aug-21 (No:31368)	Aug-22
Secondary Standards	**ID #**	**Check Date (in house)**	**Scheduled Check**
Auto DAE Calibration Unit	SE UWS 053 AA 1001	24-Jan-22 (in house check)	In house check: Jan-23
Calibrator Box V2.1	SE UMS 006 AA 1002	24-Jan-22 (in house check)	In house check: Jan-23

	Name	Function	Signature
Calibrated by:	Adrian Gehring	Laboratory Technician	
Approved by:	Sven Kühn	Deputy Manager	

Issued: February 17, 2022

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

Certificate No: DAE3-335_Feb22 Page 1 of 5

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Accreditation No.: SCS 0108

Glossary

DAE	data acquisition electronics
Connector angle	information used in DASY system to align probe sensor X to the robot coordinate system.

Methods Applied and Interpretation of Parameters

- *DC Voltage Measurement:* Calibration Factor assessed for use in DASY system by comparison with a calibrated instrument traceable to national standards. The figure given corresponds to the full scale range of the voltmeter in the respective range.
- *Connector angle*: The angle of the connector is assessed measuring the angle mechanically by a tool inserted. Uncertainty is not required.
- The following parameters as documented in the Appendix contain technical information as a result from the performance test and require no uncertainty.
  - *DC Voltage Measurement Linearity:* Verification of the Linearity at +10% and -10% of the nominal calibration voltage. Influence of offset voltage is included in this measurement.
  - *Common mode sensitivity:* Influence of a positive or negative common mode voltage on the differential measurement.
  - *Channel separation:* Influence of a voltage on the neighbor channels not subject to an input voltage.
  - *AD Converter Values with inputs shorted:* Values on the internal AD converter corresponding to zero input voltage
  - *Input Offset Measurement*: Output voltage and statistical results over a large number of zero voltage measurements.
  - *Input Offset Current:* Typical value for information; Maximum channel input offset current, not considering the input resistance.
  - *Input resistance:* Typical value for information: DAE input resistance at the connector, during internal auto-zeroing and during measurement.
  - *Low Battery Alarm Voltage:* Typical value for information. Below this voltage, a battery alarm signal is generated.
  - *Power consumption:* Typical value for information. Supply currents in various operating modes.

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = 6.1μV , full range = -100...+300 mV

Low Range: 1LSB = 61nV , full range = -1.......+3mV

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	403.985 ± 0.02% (k=2)	404.552 ± 0.02% (k=2)	403.663 ± 0.02% (k=2)
Low Range	3.95814 ± 1.50% (k=2)	3.96994 ± 1.50% (k=2)	3.96254 ± 1.50% (k=2)

Connector Angle

Connector Angle to be used in DASY system	345.5 ° ± 1 °

Appendix (Additional assessments outside the scope of SCS0108)

1. DC Voltage Linearity

High Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	200031.34	-4.57	-0.00
Channel X	+ Input	20008.70	2.68	0.01
Channel X	- Input	-20000.84	4.95	-0.02
Channel Y	+ Input	200031.97	-3.25	-0.00
Channel Y	+ Input	20006.37	0.42	0.00
Channel Y	- Input	-20003.32	2.63	-0.01
Channel Z	+ Input	200032.84	-2.50	-0.00
Channel Z	+ Input	20006.62	0.62	0.00
Channel Z	- Input	-20004.90	1.04	-0.01

Low Range		Reading (μV)	Difference (μV)	Error (%)
Channel X	+ Input	2001.82	0.36	0.02
Channel X	+ Input	201.38	-0.02	-0.01
Channel X	- Input	-198.22	0.40	-0.20
Channel Y	+ Input	2001.02	-0.25	-0.01
Channel Y	+ Input	200.55	-0.71	-0.35
Channel Y	- Input	-199.80	-1.10	0.56
Channel Z	+ Input	2001.69	0.42	0.02
Channel Z	+ Input	200.67	-0.59	-0.29
Channel Z	- Input	-199.44	-0.70	0.35

2. Common mode sensitivity

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Common mode Input Voltage (mV)	High Range Average Reading (μV)	Low Range Average Reading (μV)
Channel X	200	-10.71	-12.54
	- 200	13.42	11.85
Channel Y	200	-10.64	-11.18
	- 200	9.84	9.39
Channel Z	200	3.00	3.07
	- 200	-4.27	-4.36

3. Channel separation

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	Input Voltage (mV)	Channel X (μV)	Channel Y (μV)	Channel Z (μV)
Channel X	200	-	-1.39	-0.99
Channel Y	200	9.81	-	0.16
Channel Z	200	3.98	7.68	-

4. AD-Converter Values with inputs shorted

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

	High Range (LSB)	Low Range (LSB)
Channel X	16185	16716
Channel Y	16094	17413
Channel Z	16104	15830

5. Input Offset Measurement

DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec
Input 10MΩ

	Average (μV)	min. Offset (μV)	max. Offset (μV)	Std. Deviation (μV)
Channel X	0.51	-0.53	1.37	0.41
Channel Y	0.77	-0.48	2.55	0.65
Channel Z	0.86	-0.36	2.52	0.63

6. Input Offset Current

Nominal Input circuitry offset current on all channels: <25fA

7. Input Resistance (Typical values for information)

	Zeroing (kOhm)	Measuring (MOhm)
Channel X	200	200
Channel Y	200	200
Channel Z	200	200

8. Low Battery Alarm Voltage (Typical values for information)

Typical values	Alarm Level (VDC)
Supply (+ Vcc)	+7.9
Supply (- Vcc)	-7.6

9. Power Consumption (Typical values for information)

Typical values	Switched off (mA)	Stand by (mA)	Transmitting (mA)
Supply (+ Vcc)	+0.01	+6	+14
Supply (- Vcc)	–0.01	-8	-9

Appendix F – Calibration Certificates for E-Field Probes

Probe ET3DV6R – SN1579

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

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

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The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **IMST**

Certificate No: **ET3-1579_Feb22**

CALIBRATION CERTIFICATE

Object: ET3DV6R - SN:1579

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

Calibration date: February 28, 2022

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

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

Calibration Equipment used (M&TE critical for calibration)

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

	Name	Function	Signature
Calibrated by:	Joanna Lleshaj	Laboratory Technician	
Approved by:	Niels Kuster	Quality Manager	

Issued: February 28, 2022

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Certificate No: ET3-1579_Feb22 Page 1 of 9

Calibration Laboratory of
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Accreditation No.: SCS 0108

Glossary:

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

Calibration is Performed According to the Following Standards:

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

b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

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

DASY/EASY - Parameters of Probe: ET3DV6R - SN:1579

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	1.79	1.82	1.56	± 10.1 %
DCP (mV)[B]	100.0	99.0	101.0	

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Max dev.	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	245.6	±3.3 %	± 4.7 %
		Y	0.0	0.0	1.0		257.5		
		Z	0.0	0.0	1.0		265.5		

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

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

DASY/EASY - Parameters of Probe: ET3DV6R - SN:1579

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-105.2
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disabled
Probe Overall Length	337 mm
Probe Body Diameter	10 mm
Tip Length	10 mm
Tip Diameter	6.8 mm
Probe Tip to Sensor X Calibration Point	2.7 mm
Probe Tip to Sensor Y Calibration Point	2.7 mm
Probe Tip to Sensor Z Calibration Point	2.7 mm
Recommended Measurement Distance from Surface	4 mm

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

DASY/EASY - Parameters of Probe: ET3DV6R - SN:1579

Calibration Parameter Determined in Head Tissue Simulating Media

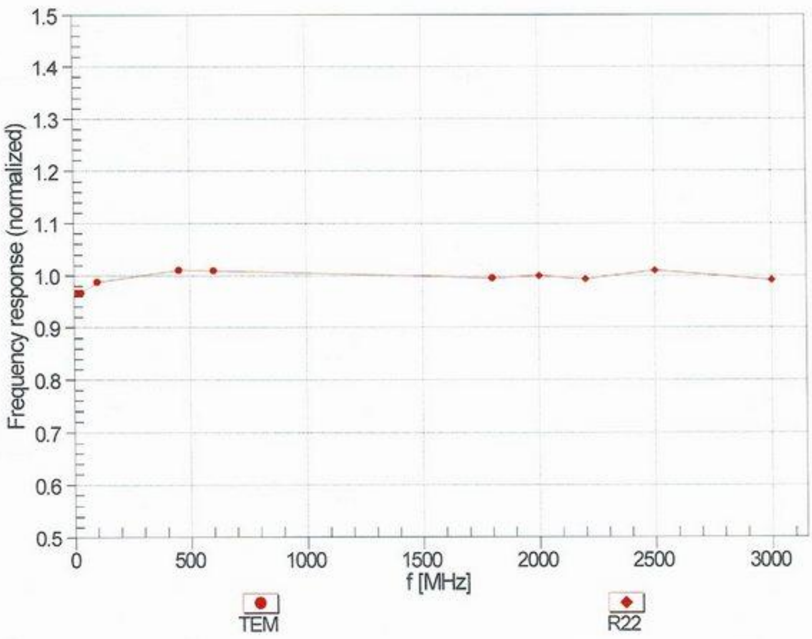
f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unc (k=2)
750	41.9	0.89	7.42	7.42	7.42	0.60	1.84	± 12.0 %
900	41.5	0.97	6.93	6.93	6.93	0.52	2.04	± 12.0 %
1750	40.1	1.37	5.56	5.56	5.56	0.80	2.00	± 12.0 %
1900	40.0	1.40	5.46	5.46	5.46	0.79	2.05	± 12.0 %

[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz is ± 10, 25, 40, 50 and 70 MHz for ConvF assessments at 30, 64, 128, 150 and 220 MHz respectively. Validity of ConvF assessed at 6 MHz is 4-9 MHz, and ConvF assessed at 13 MHz is 9-19 MHz. Above 5 GHz frequency validity can be extended to ± 110 MHz.
[F] At frequencies below 3 GHz, the validity of tissue parameters (ε and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ε and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty for indicated target tissue parameters.
[G] Alpha/Depth are determined during calibration. SPEAG warrants that the remaining deviation due to the boundary effect after compensation is always less than ± 1% for frequencies below 3 GHz and below ± 2% for frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

ET3DV6R– SN:1579 February 28, 2022

Frequency Response of E-Field

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

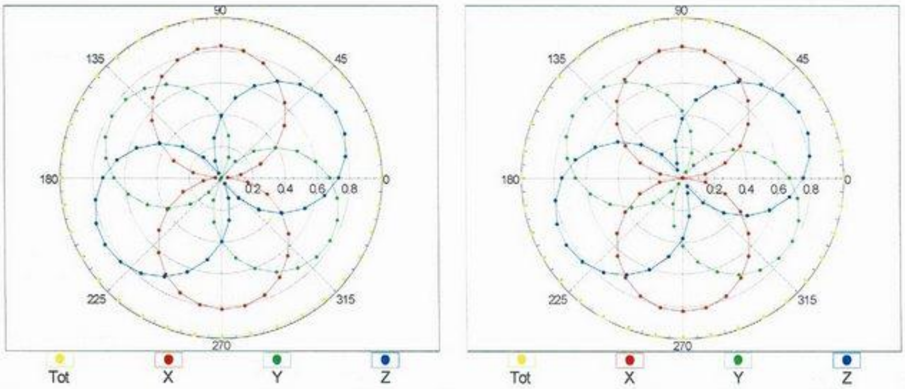


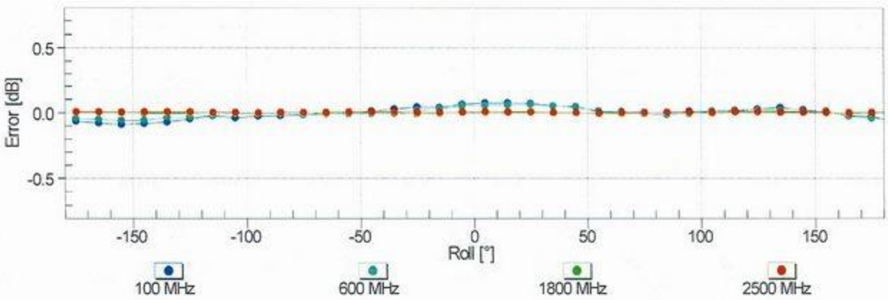
Uncertainty of Frequency Response of E-field: ± 6.3% (k=2)

Certificate No: ET3-1579_Feb22 Page 6 of 9

Receiving Pattern (ϕ), ϑ = 0°

f=600 MHz,TEM f=1800 MHz,R22





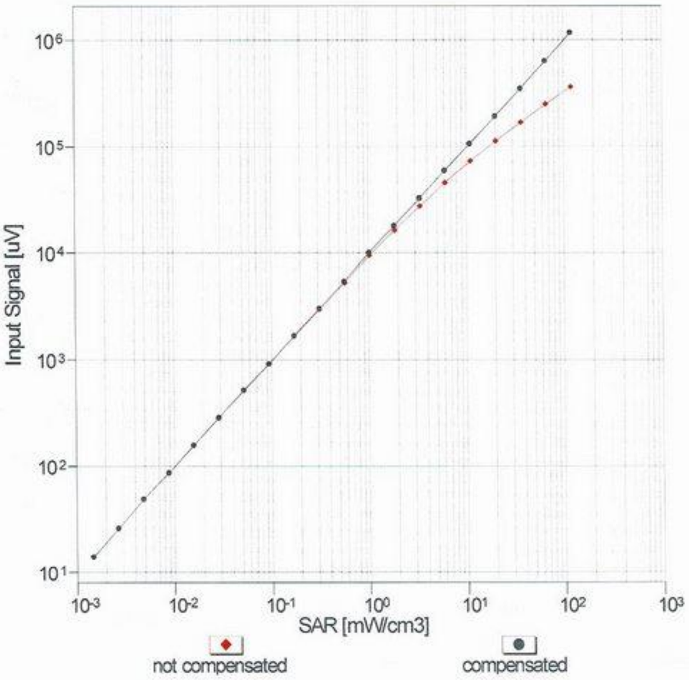
Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

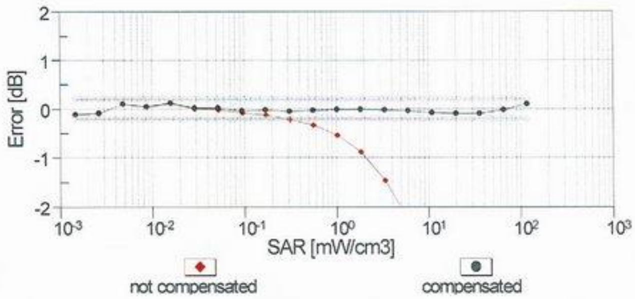
ET3DV6R– SN:1579

February 28, 2022

Dynamic Range f(SAR$_{head}$)

(TEM cell , f$_{eval}$= 1900 MHz)



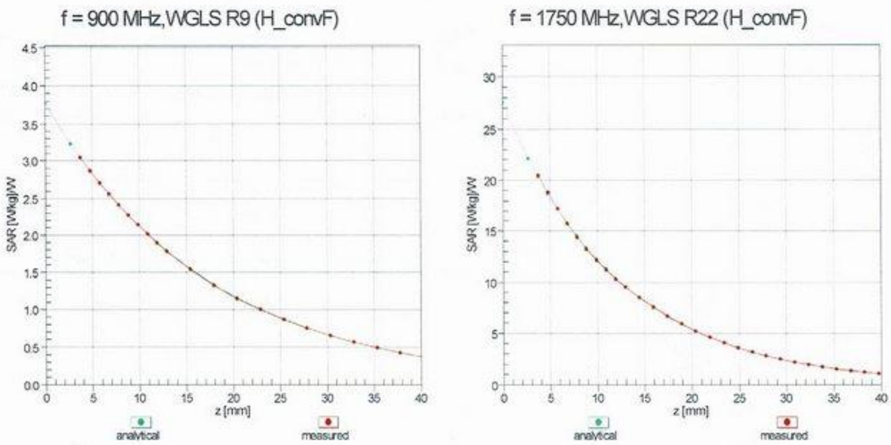


Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Certificate No: ET3-1579_Feb22 Page 8 of 9

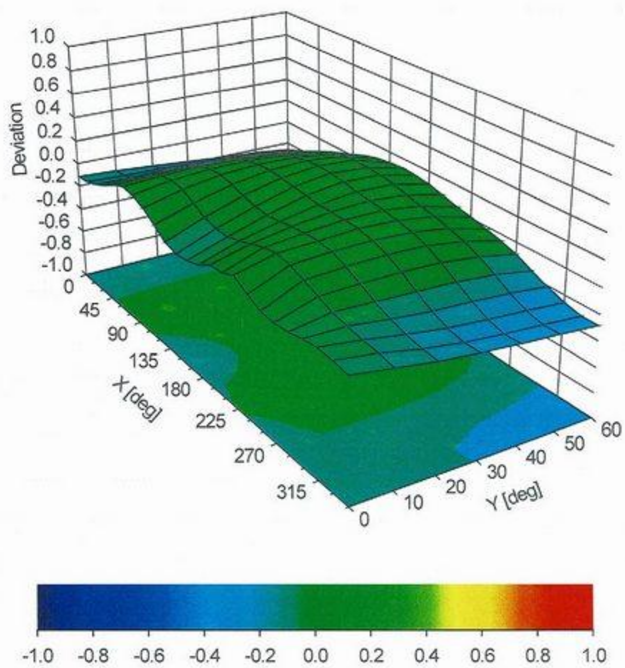
ET3DV6R– SN:1579 February 28, 2022

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



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

Certificate No: ET3-1579_Feb22 Page 9 of 9

Appendix G – Calibration Certificates for Dipoles

Dipole 1900 MHz – SN535

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

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Accreditation No.: **SCS 0108**

Client **IMST** Certificate No: **D1900V2-535_Mar21**

CALIBRATION CERTIFICATE

Object	D1900V2 - SN:535
Calibration procedure(s)	QA CAL-05.v11 Calibration Procedure for SAR Validation Sources between 0.7-3 GHz
Calibration date:	March 09, 2021

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP	SN: 104778	01-Apr-20 (No. 217-03100/03101)	Apr-21
Power sensor NRP-Z91	SN: 103244	01-Apr-20 (No. 217-03100)	Apr-21
Power sensor NRP-Z91	SN: 103245	01-Apr-20 (No. 217-03101)	Apr-21
Reference 20 dB Attenuator	SN: BH9394 (20k)	31-Mar-20 (No. 217-03106)	Apr-21
Type-N mismatch combination	SN: 310982 / 06327	31-Mar-20 (No. 217-03104)	Apr-21
Reference Probe EX3DV4	SN: 7349	28-Dec-20 (No. EX3-7349_Dec20)	Dec-21
DAE4	SN: 601	02-Nov-20 (No. DAE4-601_Nov20)	Nov-21

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB39512475	30-Oct-14 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: US37292783	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
Power sensor HP 8481A	SN: MY41092317	07-Oct-15 (in house check Oct-20)	In house check: Oct-22
RF generator R&S SMT-06	SN: 100972	15-Jun-15 (in house check Oct-20)	In house check: Oct-22
Network Analyzer Agilent E8358A	SN: US41080477	31-Mar-14 (in house check Oct-20)	In house check: Oct-21

	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	M.Weber
Approved by:	Katja Pokovic	Technical Manager	

Issued: March 9, 2021

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

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

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

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

Accreditation No.: **SCS 0108**

Glossary:

TSL	tissue simulating liquid
ConvF	sensitivity in TSL / NORM x,y,z
N/A	not applicable or not measured

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013
b) IEC 62209-1, "Measurement procedure for the assessment of Specific Absorption Rate (SAR) from hand-held and body-mounted devices used next to the ear (frequency range of 300 MHz to 6 GHz)", July 2016
c) IEC 62209-2, "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)", March 2010
d) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

e) DASY4/5 System Handbook

Methods Applied and Interpretation of Parameters:

- *Measurement Conditions:* Further details are available from the Validation Report at the end of the certificate. All figures stated in the certificate are valid at the frequency indicated.
- *Antenna Parameters with TSL:* The dipole is mounted with the spacer to position its feed point exactly below the center marking of the flat phantom section, with the arms oriented parallel to the body axis.
- *Feed Point Impedance and Return Loss:* These parameters are measured with the dipole positioned under the liquid filled phantom. The impedance stated is transformed from the measurement at the SMA connector to the feed point. The Return Loss ensures low reflected power. No uncertainty required.
- *Electrical Delay:* One-way delay between the SMA connector and the antenna feed point. No uncertainty required.
- *SAR measured:* SAR measured at the stated antenna input power.
- *SAR normalized:* SAR as measured, normalized to an input power of 1 W at the antenna connector.
- *SAR for nominal TSL parameters:* The measured TSL parameters are used to calculate the nominal SAR result.

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

Measurement Conditions

DASY system configuration, as far as not given on page 1.

DASY Version	DASY5	V52.10.4
Extrapolation	Advanced Extrapolation	
Phantom	Modular Flat Phantom	
Distance Dipole Center - TSL	10 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	1900 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	**Permittivity**	**Conductivity**
Nominal Head TSL parameters	22.0 °C	40.0	1.40 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	41.1 ± 6 %	1.39 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm^3 (1 g) of Head TSL	Condition	
SAR measured	250 mW input power	9.71 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**39.2 W/kg ± 17.0 % (k=2)**

SAR averaged over 10 cm^3 (10 g) of Head TSL	condition	
SAR measured	250 mW input power	5.08 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**20.5 W/kg ± 16.5 % (k=2)**

Appendix (Additional assessments outside the scope of SCS 0108)

Antenna Parameters with Head TSL

Impedance, transformed to feed point	53.5 Ω + 6.2 jΩ
Return Loss	- 23.3 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.186 ns

After long term use with 100W radiated power, only a slight warming of the dipole near the feedpoint can be measured.

The dipole is made of standard semirigid coaxial cable. The center conductor of the feeding line is directly connected to the second arm of the dipole. The antenna is therefore short-circuited for DC-signals. On some of the dipoles, small end caps are added to the dipole arms in order to improve matching when loaded according to the position as explained in the "Measurement Conditions" paragraph. The SAR data are not affected by this change. The overall dipole length is still according to the Standard.
No excessive force must be applied to the dipole arms, because they might bend or the soldered connections near the feedpoint may be damaged.

Additional EUT Data

Manufactured by	SPEAG

DASY5 Validation Report for Head TSL

Date: 09.03.2021

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 1900 MHz; Type: D1900V2; Serial: D1900V2 - SN:535

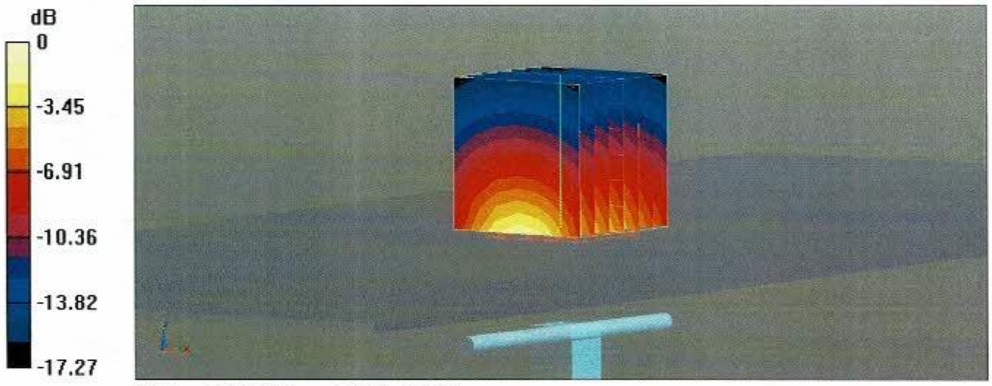
Communication System: UID 0 - CW; Frequency: 1900 MHz
Medium parameters used: f = 1900 MHz; σ = 1.39 S/m; ε_r = 41.1; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: EX3DV4 - SN7349; ConvF(8.43, 8.43, 8.43) @ 1900 MHz; Calibrated: 28.12.2020
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn601; Calibrated: 02.11.2020
- Phantom: Flat Phantom 5.0 (front); Type: QD 000 P50 AA; Serial: 1001
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Dipole Calibration for Head Tissue/Pin=250 mW, d=10mm/Zoom Scan (7x7x7)/Cube 0:

Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 108.8 V/m; Power Drift = 0.00 dB
Peak SAR (extrapolated) = 17.9 W/kg
SAR(1 g) = 9.71 W/kg; SAR(10 g) = 5.08 W/kg
Smallest distance from peaks to all points 3 dB below = 9.5 mm
Ratio of SAR at M2 to SAR at M1 = 54.9%
Maximum value of SAR (measured) = 15.0 W/kg



0 dB = 15.0 W/kg = 11.76 dBW/kg

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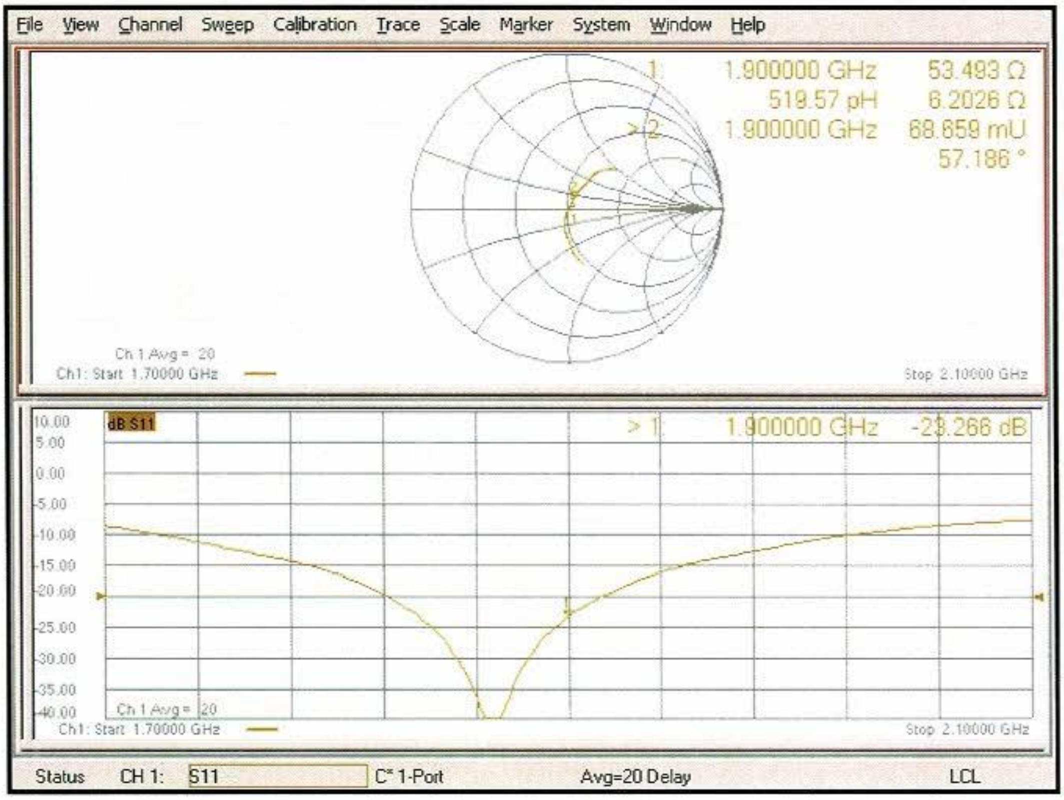
Impedance Measurement Plot for Head TSL



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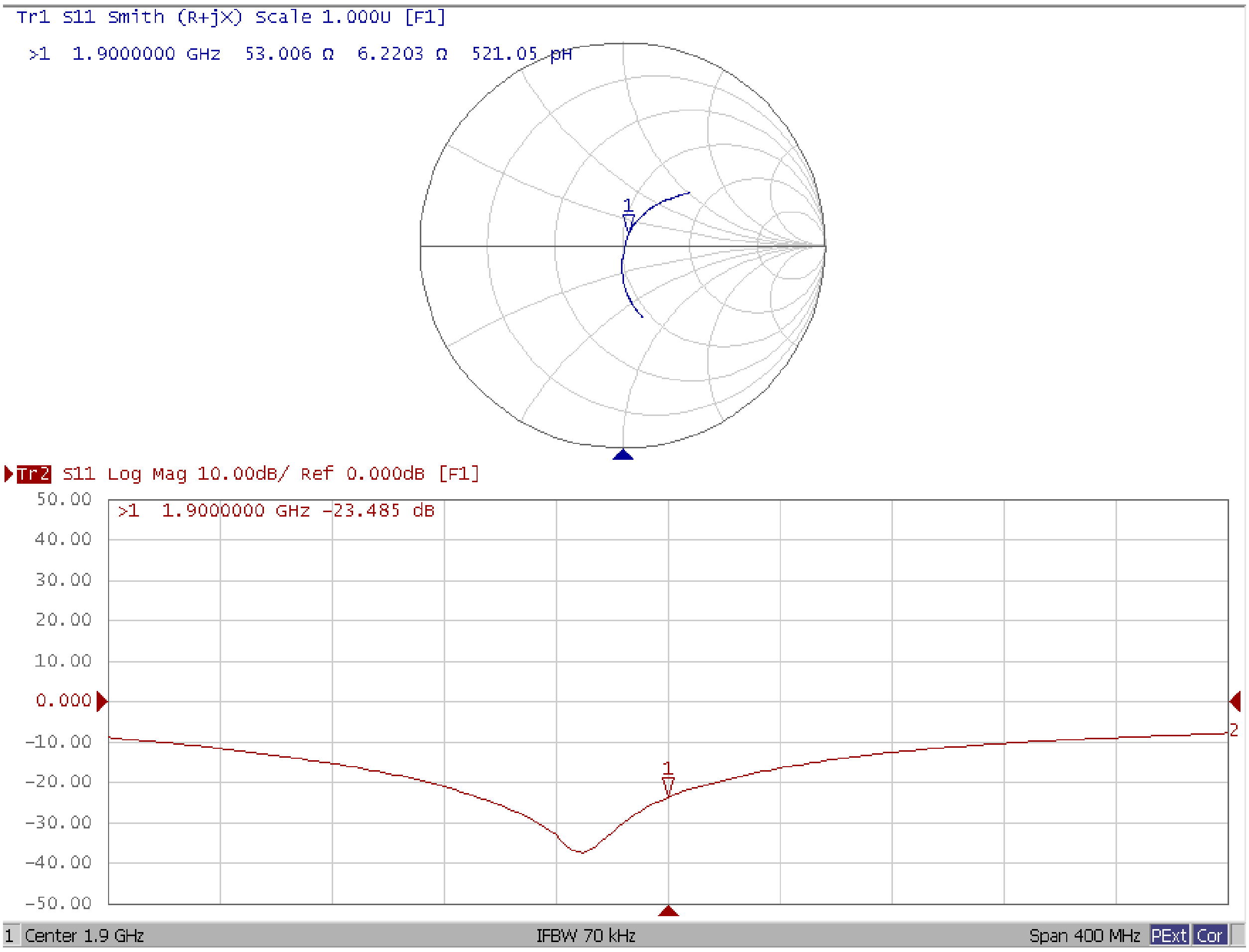
Extended Dipole Calibration Verification for the D1900V2, SN: 535

Referring to section 3.2.2 of KDB 865664 D01, the tables below contain the measurement results for the impedance and return loss of the dipole.

Justification of the Extended Calibration						
1900 HEAD TSL	**Calibration**		**Verification**			
	March 09, 2021		March 10, 2022			
Impedance transformed to feed point	Target		Measured		Delta	
	R [Ω]	X [jΩ]	R [Ω]	X [jΩ]	R [Ω]	X [jΩ]
	53.5	6.2	53.0	6.22	**-0.5**	**0.0**
Return Loss	Target [dB]		Measured [dB]		Delta [%]	
	-23.3		**-23.5**		**0.8**	

Measurement Plot for Head TSL



The impedance is within 5 ohm of prior calibration.
The return loss is <-20 dB and within 20% of prior calibration.

Therefore the verification result supports extended dipole calibration.