Certificate # 2861.01

GRGTEST

TEST REPORT

Verified Code: 061325

Report No.:	E202012093384-3-G1	**Application No.:**	E202012093384
Client:	Realme Chongqing Mobile Telecommunications Corp., Ltd.		
Address:	No.178 Yulong Avenue, Yufengshan, Yubei District, Chongqing， China.		
Sample Description:	realme Buds Q2		
Model:	RMA2010		
Test Specification:	IEEE Std. 1528:2013 47 CFR FCC Part 2.1093:2013 IEEE Std. C95.1:2019		
Receipt Date:	2020-12-11		
Test Date:	2021-01-12 to 2021-01-12		
Issue Date:	2021-01-22		
Test Result:	Pass		

Prepared By: Test Engineer Wang Zhicheng	**Reviewed By:** Technical Manager Jiang Tao	**Approved By:** Manager Wu Chengrong

Other Aspects:

Note: This report instead the report E202012093384-3, and from the date of issuance of this report, the report which being replaced become invalid.

Abbreviations: *ok / P = passed; fail / F = failed; n.a. / N = not applicable;*

DIRECTIONS OF TEST

1. **This station carries out test task according to the national regulation of verifications which can be traced to National Primary Standards and BIPM.**

2. **The test report merely corresponds to the test sample. It is not permitted to copy extracts of these test result without the written permission of the test laboratory.**

3. **If there is any objection concerning the test, the client should inform the laboratory within 15 days from the date of receiving the test report.**

TABLE OF CONTENTS

1. GENERAL INFORMATION

Equipment	realme Buds Q2
Brand Name	realme
Model Name	RMA2010
Model difference(s)	/
Sample No.:	0006,0007
Manufacturer	Realme Chongqing Mobile Telecommunications Corp., Ltd
Address	No.178 Yulong Avenue, Yufengshan, Yubei District, Chongqing，China.
Factory	/
Address	/
Standard(s)	**IEEE Std 1528-2013** Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques **47 CFR FCC Part 2.1093:2013** Radio frequency radiation exposure evaluation: portable devices **ANSI Std C95.1-2019** Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz - 300 GHz. **KDB447498 D01** v06 General RF Exposure Guidance **KDB865664 D01** v01r04 SAR measurement 100 MHz to 6 GHz **KDB865664 D02** v01r02 RF Exposure Reporting

2. GENERAL INFORMATION OF EUT
2.1 STATEMENT OF COMPLIANCE

Frequency Band	Highest Reported 1g-SAR(W/Kg)		SAR Test Limit (W/Kg)
Bluetooth	Left Ear	0.07056	1.6
	Right Ear	0.04884	
Test Result	PASS		

Note：

This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6 W/kg) specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-2019, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013 and IEC 62209-2:2019.

2.2 GENERAL DESCRIPTION

Equipment	realme Buds Q2		
Brand Name	realme		
Model Name	RMA2010		
Series Model	/		
Model Difference	/		
Device Type	Portable device		
HW Version	V4		
SW Version	V1.1.09		
Frequency Range	Band	TX (MHz)	RX (MHz)
	Bluetooth	2402-2480	
Device class	Class B		
Type of Modulation:	FHSS (GFSK for 1Mbps, π/4-DQPSK for 2Mbps,8DPSK for 3Mbps)		
Antenna Specification:	Left earphone: Intenna antenna -3.12dBi Right earphone: Intenna antenna -4.07dBi		
Test Channels (low-mid-high):	0-39-78 (BT)		
Operating Mode:	Maximum continuous output		
Other Information			
Power Supply:	DC5V power supplied by charging case DC 3.7V power supplied by the earphone battery or charging case battery		
Earphone Battery Specification:	ZWD541112 3.7V, 40mAh, 0.15Wh		
Charging Case Battery Specification:	ZWD802028 3.7V, 400mAh, 1.48Wh		
Sample submitting way:	■Provided by customer □Sampling		
Note:	/		

2.3 LABORATORY ENVIRONMENT

Temperature	Min. = 18 ℃, Max. = 25 ℃
Relative humidity	Min. = 30%, Max. = 70%
Ground system resistance	< 0.5Ω
Ambient noise is checked and found very low and in compliance with requirement of standards. Reflection of surrounding objects is minimized and in compliance with requirement of standards.	

3. LABORATORY AND ACCREDITATIONS

3.1 LABORATORY

The tests & measurements refer to this report were performed by Shenzhen EMC Laboratory of Guangzhou GRG Metrology & Test Co,. Ltd.	
Add.:	No.1301 Guanguang Road Xinlan Community, Guanlan Street, Longhua District Shenzhen, 518110, People's Republic of China.
P.C.:	518000
Tel :	0755-61180008
Fax:	0755-61180008

3.2 ACCREDITATIONS

Our laboratories are accredited and approved by the following approval agencies according to GB/T 27025(ISO/IEC 17025:2017)

USA	A2LA(Certificate #:2861.01)

The measuring facility of laboratories has been authorized or registered by the following approval agencies.

Canada	Industry Canada
USA	FCC

Copies of granted accreditation certificates are available for downloading from our web site, http://www.grgtest.com

3.3 MEASUREMENT UNCERTAINTY

Per KDB865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval. The equivalent ratio (1.5/1.6) is applied to extremity and occupational exposure conditions.

4. SAR MEASUREMENTS SYSTEM

4.1 DEFINITION OF SPECIFIC ABSORPTION RATE (SAR)

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and general population/uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.

The SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density (ρ). The equation description is as below:

$$\mathrm{SAR} = \frac{d}{dt}\left(\frac{dW}{dm}\right) = \frac{d}{dt}\left(\frac{dW}{\rho dv}\right)$$

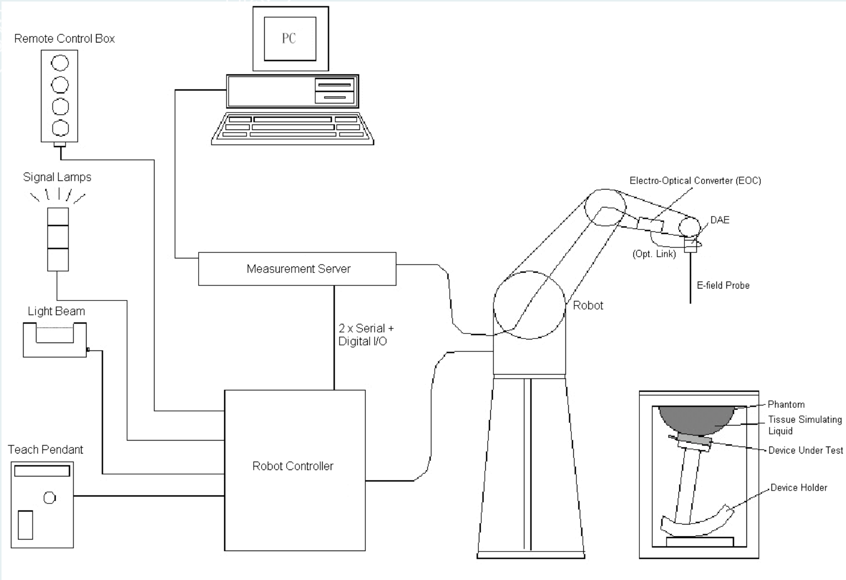
SAR is expressed in units of Watts per kilogram (W/kg) SAR measurement can be related to the electrical field in the tissue by

$$\mathrm{SAR} = \frac{\sigma E^2}{\rho}$$

Where: σ is the conductivity of the tissue;

ρ is the mass density of the tissue and E is the RMS electrical field strength.

4.2 SAR SYSTEM



DASY System Configurations

The DASY system for performance compliance tests is illustrated above graphically. This system consists of the following items:

- A standard high precision 6-axis robot with controller, a teach pendant and software
- A data acquisition electronic (DAE) attached to the robot arm extension
- A dosimetric probe equipped with an optical surface detector system
- The electro-optical converter (EOC) performs the conversion between optical and electrical signals
- A measurement server performs the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the accuracy of the probe positioning
- A computer operating Windows XP
- DASY software
- Remove control with teach pendant and additional circuitry for robot safety such as warming lamps, etc.
- The SAM twin phantom
- A device holder
- Tissue simulating liquid
- Dipole for evaluating the proper functioning of the system

Components are described in details in the following sub-sections.

4.3 E-FIELD PROBE

The SAR measurement is conducted with the dosimetric probe (manufactured by SPEAG).The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency. This probe has a built in optical surface detection system to prevent from collision with phantom.

- **E-Field Probe Specification**

<EX3DV4 Probe>

Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	 **Photo of EX3DV4**
Frequency	10 MHz to 6 GHz; Linearity: ±0.2 dB	
Directivity	±0.3 dB in HSL (rotation around probe axis) ±0.5 dB in tissue material (rotation normal to probe axis)	
Dynamic Range	10 μW/g to 100 mW/g; Linearity: ±0.2 dB (noise: typically < 1 μW/g)	
Dimensions	Overall length: 330 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm	

- **E-Field Probe Calibration**

Each probe needs to be calibrated according to a dosimetric assessment procedure with accuracy better than ±10%. The spherical isotropy shall be evaluated and within ±0.25dB. The sensitivity parameters (NormX, NormY, and NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested. The calibration data can be referred to appendix C of this report.

4.4 DATA ACQUISITION ELECTRONICS (DAE)

The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock.

The input impedance of the DAE is 200MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80dB.

Photo of DAE

4.5 ROBOT

The SPEAG DASY system uses the high precision robots (DASY5: TX60XL) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY5: CS8c) from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability ±0.035 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)

Photo of DASY5

4.6 MEASUREMENT SERVER

The measurement server is based on a PC/104 CPU board with CPU (DASY5: 400 MHz, Intel Celeron), chip disk (DASY5: 128 MB), RAM (DASY5: 128 MB). The necessary circuits for communication with the DAE electronic box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DASY I/O board, which is directly connected to the PC/104 bus of the CPU board.

The measurement server performs all the real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operations.

Photo of Server for DASY5

4.7 PHANTOM

<SAM Twin Phantom>

Shell Thickness	2 ±0.2 mm; Center ear point: 6 ±0.2 mm
Filling Volume	Approx. 25 liters
Dimensions	Length: 1000 mm; Width: 500 mm; Height: adjustable feet
Measurement Areas	Left Hand, Right Hand, Flat Phantom

Photo of SAM Phantom

The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. A white cover is provided to tap the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. On the phantom top, three reference markers are provided to identify the phantom position with respect to the robot.

4.8 DEVICE HOLDER

The SAR in the phantom is approximately inversely proportional to the square of the distance between the source and the liquid surface. For a source at 5 mm distance, a positioning uncertainty of ±0.5mm would produce a SAR uncertainty of ± 20%. Accurate device positioning is therefore crucial for accurate and repeatable measurements. The positions in which the devices must be measured are defined by the standards.

The DASY device holder is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear reference points). The rotation center for both scales is the ear reference point (ERP).Thus the device needs no repositioning when changing the angles.

The DASY device holder is constructed of low-loss POM material having the following dielectric parameters: relative permittivity ε = 3 and loss tangent δ = 0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

Device Holder

4.9 DATA STORAGE AND EVALUATION

➢ **Data Storage**

The DASY software stores the assessed data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all the necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files. The post-processing software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of erroneous parameter settings. For example, if a measurement has been performed with an incorrect crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be reevaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type (e.g., [V/m], [A/m], [mW/g]). Some of these units are not available in certain situations or give meaningless results, e.g., a SAR-output in a non-lose media, will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

➢ **Data Evaluation**

The DASY post-processing software (SEMCAD) automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software：

Probe parameters:	- Sensitivity	$Norm_i$, a_{i0}, a_{i1}, a_{i2}
	- Conversion factor	$ConvF_i$
	- Diode compression point	dcp_i
Device parameters:	- Frequency	f
	- Crest factor	cf
Media parameters:	- Conductivity	σ
	- Density	ρ

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY components. In the direct measuring mode of the multi-meter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics. If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power.

The formula for each channel can be given as：

$$\mathbf{V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}}$$

with V_i= compensated signal of channel i, (i = x, y, z)
U_i = input signal of channel i, (i = x, y, z)
cf = crest factor of exciting field (DASY parameter)
dcp_i = diode compression point (DASY parameter)

From the compensated input signals, the primary field data for each channel can be evaluated：

E-field Probes： $\mathbf{E_i = \sqrt{\frac{V_i}{Norm_i \cdot ConvF}}}$

H-field Probes： $\mathbf{H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1} f + a_{i2} f^2}{f}}$

with V_i = compensated signal of channel i,(i = x, y, z)
$Norm_i$= sensor sensitivity of channel i, (i = x, y, z), $\mu V/(V/m)^2$ for E-field Probes
ConvF= sensitivity enhancement in solution
a_{ij}= sensor sensitivity factors for H-field probes
f = carrier frequency [GHz]
E_i= electric field strength of channel i in V/m
H_i= magnetic field strength of channel i in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$\mathbf{E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}}$$

The primary field data are used to calculate the derived field units.

$$\mathbf{SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1000}}$$

with SAR = local specific absorption rate in mW/g
E_{tot}= total field strength in V/m
σ = conductivity in [mho/m] or [Siemens/m]
ρ = equivalent tissue density in g/cm^3
Note that the density is set to 1, to account for actual head tissue density rather than the density of the tissue simulating liquid.

5. TEST EQUIPMENT LIST

Kind of Equipment	Manufacturer	Type No.	Serial No.	Last Calibration	Calibrated Until
2450MHz Dipole	SPEAG	D2450V2	903	2019.10.15	2022.10.14
Dosimetric E-Field Probe	SPEAG	EX3DV4	SN 7514	2020.09.01	2021.08.31
Data Acquisition Electronics	SPEAG	DAE4	SN 796	2020.05.06	2021.05.05
ENA Series Network Analyzer	Keysight	85032F	MY53202597	2020.09.25	2021.09.24
DAK	SPEAG	DAK-3.5	1056	N/A	N/A
Twin SAM Phantom1	SPEAG	QD000P40CD	1743	N/A	N/A
SAM Twin Phantom2	SPEAG	QD000P40CD	1745	N/A	N/A
2mm Triple Flat Phantom	SPEAG	QD000P51CA	1134/3	N/A	N/A
Power Meter	Anritsu	ML2495A	1204003	2020.04.14	2021.04.13
Power Sensor	Anritsu	MA2411B	1126150	2020.04.14	2021.04.13
Spectrum Analyzer	Keysight	N9010A	MY55370330	2020.12.16	2021.12.15
Signal generator	R&S	SMA100A	100434	2020.10.09	2021.10.08

Remark:

1. “N/A” denotes no model name, serial No. or calibration specified.
2. * These test equipments have been recalibrated between the test periods. All these test equipments were within the valid period when the tests were performed.
3. Per KDB865664 D01 requirements for dipole calibration, the test laboratory has adopted three-year extended calibration interval. Each measured dipole is expected to evaluate with the following criteria at least on annual interval in Appendix C.
   a) There is no physical damage on the dipole;
   b) System check with specific dipole is within 10% of calibrated value;
   c) The most recent return-loss result , measured at least annually, deviates by no more than 20% from the previous measurement;
   d) The most recent measurement of the real or imaginary parts of the impedance, measured at least annually is within 5Ω from the previous measurement.

6. SYSTEM VERIFICATION PROCEDURE

6.1 TISSUE VERIFICATION

For the measurement of the field distribution inside the SAM phantom with DASY, the phantom must be filled with around 25 liters of homogeneous body tissue simulating liquid. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm, which is shown in Fig. 6.1. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm, which is shown as followed:

Photo of 2450HSL Liquid Height for Head SAR

Frequency (MHz)	**Water (%)**	**Sugar (%)**	**Cellulose (%)**	**Salt (%)**	**Preventol (%)**	**DGBE (%)**	**Conductivity (σ)**	**Permittivity (εr)**
For Head								
2450	55.0	0	0	0	0	45.0	1.80	39.2

The following table shows the measuring results for simulating liquid.

Tissue Type	Measured Frequency (MHz)	Target Value (±10%)		Measured Value		Tissue temperature (℃)	Measured Date
		εr	σ(S/M)	εr	σ(S/M)		
2450 HSL	2450	39.20 (35.28~43.12)	1.80 (1.62~1.98)	39.62	1.83	19.1	Jan. 12, 2021

Note:
1) The dielectric parameters of the tissue-equivalent liquid should be measured under similar ambient conditions and within 2 ℃ of the conditions expected during the SAR evaluation to satisfy protocol requirements.
2) KDB 865664 was ensured to be applied for probe calibration frequencies greater than or equal to 50MHz of the EUT frequencies.
3) The above measured tissue parameters were used in the DASY software to perform interpolation via the DASY software to determine actual dielectric parameters at the test frequencies. The SAR test plots may slightly differ from the table above since the DASY rounds to three significant digits.

6.2 SYSTEM CHECK PROCEDURE

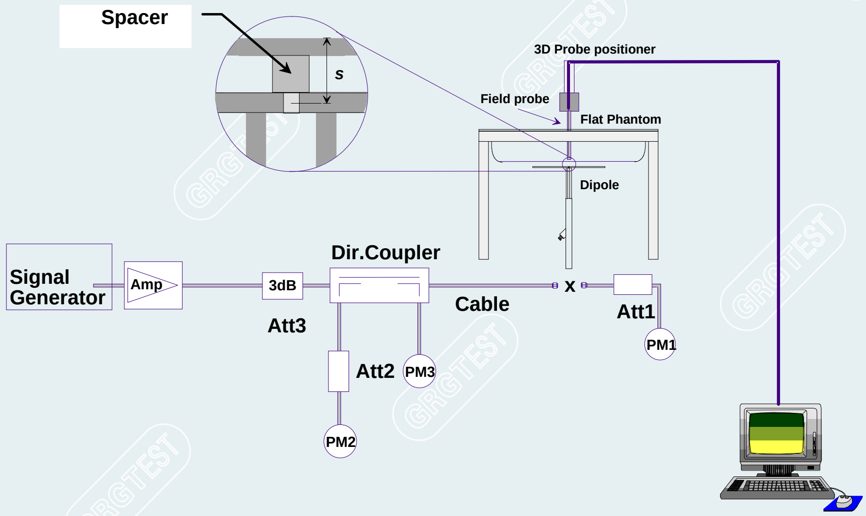
Each DASY system is equipped with one or more system validation kits. These units, together with the predefined measurement procedures within the DASY software, enable the user to conduct the system performance check and system validation. System validation kit includes a dipole, tripod holder to fix it underneath the flat phantom and a corresponding distance holder.

➢ **Purpose of System Performance check**

The system performance check verifies that the system operates within its specifications. System and operator errors can be detected and corrected. It is recommended that the system performance check be performed prior to any usage of the system in order to guarantee reproducible results. The system performance check uses normal SAR measurements in a simplified setup with a well characterized source. This setup was selected to give a high sensitivity to all parameters that might fail or vary over time. The system check does not intend to replace the calibration of the components, but indicates situations where the system uncertainty is exceeded due to drift or failure.

➢ **System Setup**

In the simplified setup for system evaluation, the EUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom section of the SAM twin phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The equipment setup is shown below:



System Setup for System Evaluation

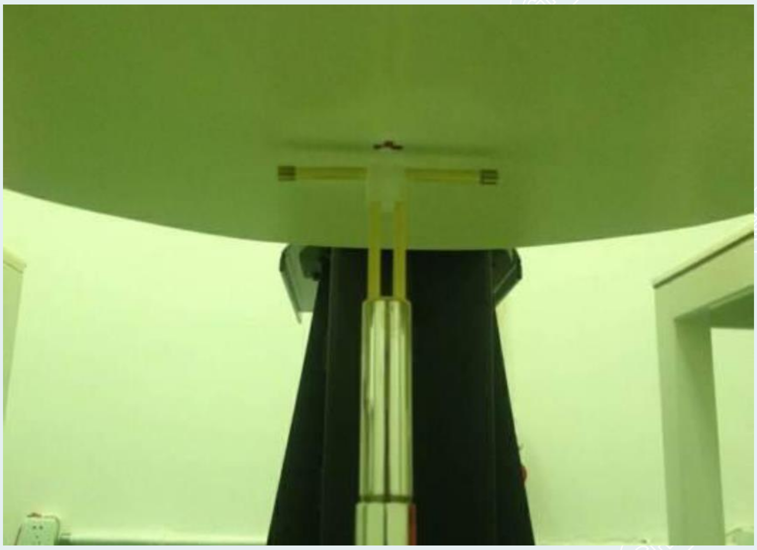


Photo of Dipole Setup

- **Validation Results**

Comparing to the original SAR value provided by SPEAG, the verification data should be within its specification of 10%. The table below shows the target SAR and measured SAR after normalized to 1W input power. It indicates that the system performance check can meet the variation criterion and the plots can be referred to Appendix A of this report.

Dipole	Tissue Type	Target Value(W/Kg) (±10%) (Normalized to 1W)		Measured Value (W/Kg)(1W)		Tissue temperature (℃)	Measured Date
		1g	10g	1g	10g		
D2450V2	2450 HSL	51.10 （45.99~56.21）	23.40 (21.06~25.74)	49.00	22.80	19.1	Jan. 12, 2021

Target and Measurement SAR after Normalized

7. SAR MEASUREMENT VARIABILITY AND UNCERTAINTY

7.1 SAR MEASUREMENT VARIABILITY

Per KDB865664 D01 SAR measurement 100 MHz to 6 GHz, SAR measurement variability must be assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. The additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

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

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

The detailed repeated measurement results are shown in Chapter 12.

7.2 MEASUREMENT UNCERTAINTY

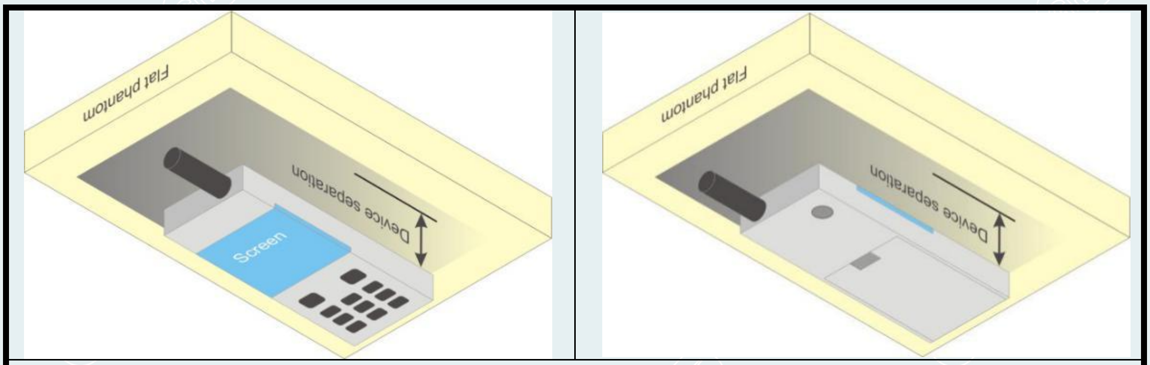
Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is< 1.5 W/Kg, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval.

8. EUT TESTING POSITION

8.1 BODY WORN POSITION

Body-worn operating configurations are tested with the belt-clips and holsters attached to the device and positioned against a flat phantom in a normal use configuration. Per KDB 648474 D04, 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 FCC KDB 447498 D01 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 a 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 handset attached to the handset.

Accessories for body-worn operation configurations are divided into two categories: those that do not contain metallic components and those that do contain metallic components and those that do contain metallic components. When multiple accessories that do not contain metallic components are supplied with the device, the device is tested with only the accessory that dictates the closest spacing to the body. Then multiple accessories that contain metallic components are test with the device with each accessory. If multiple accessories share an identical metallic component (i.e. the same metallic belt-chip used with different holsters with no other metallic components) only the accessory that dictates the closest spacing to the body is tested.



Body Worn Position

9. MEASUREMENT PROCEDURES

The measurement procedures are as follows:

(a) Use base station simulator (if applicable) or engineering software to transmit RF power continuously (continuous Tx) in the middle channel.
(b) Keep EUT to radiate maximum output power or 100% duty factor (if applicable)
(c) Measure output power through RF cable and power meter.
(d) Place the EUT in the positions as setup photos demonstrates.
(e) Set scan area, grid size and other setting on the DASY software.
(f) Measure SAR transmitting at the middle channel for all applicable exposure positions.
(g) Identify the exposure position and device configuration resulting the highest SAR
(h) Measure SAR at the lowest and highest channels at the worst exposure position and device configuration if applicable.

According to the test standard, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

(a) Power reference measurement
(b) Area scan
(c) Zoom scan
(d) Power drift measurement

9.1 SPATIAL PEAK SAR EVALUATION

The procedure for spatial peak SAR evaluation has been implemented according to the test standard. It can be conducted for 1g and 10g, as well as for user-specific masses. The DASY software includes all numerical procedures necessary to evaluate the spatial peak SAR value.

The base for the evaluation is a "cube" measurement. The measured volume must include the 1g and 10g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan.

The entire evaluation of the spatial peak values is performed within the post-processing engine (SEMCAD). The system always gives the maximum values for the 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

(a) Extraction of the measured data (grid and values) from the Zoom Scan
(b) Calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
(c) Generation of a high-resolution mesh within the measured volume
(d) Interpolation of all measured values form the measurement grid to the high-resolution grid
(e) Extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
(f) Calculation of the averaged SAR within masses of 1g and 10g

9.2 POWER REFERENCE MEASUREMENT

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

9.3 AREA SCAN PROCEDURES

The area scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum found in the scanned area, within a range of the global maximum. The range (in dB0 is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan), if only one zoom scan follows the area scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of zoom scans has to be increased accordingly.

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

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

9.4 ZOOM SCAN PROCEDURES

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

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

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

9.5 VOLUME SCAN PROCEDURES

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

9.6 POWER DRIFT MONITORING

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

10.CONDUCTED POWER

<Bluetooth Conducted Power>

Left

Mode	Channel	Frequency (MHz)	Conducted Power (dBm)
GFSK	00	2402	11.81
	39	2441	11.95
	78	2480	11.93
π/4DQPSK	00	2402	11.76
	39	2441	11.86
	78	2480	**12.00**
8DPSK	00	2402	11.73
	39	2441	11.88
	78	2480	11.95

Right

Mode	Channel	Frequency (MHz)	Conducted Power (dBm)
GFSK	00	2402	11.43
	39	2441	11.50
	78	2480	11.53
π/4DQPSK	00	2402	11.42
	39	2441	**11.54**
	78	2480	11.51
8DPSK	00	2402	11.40
	39	2441	11.52
	78	2480	11.49

Note:

1. Per KDB 447498 D01Chapter 4.3.1, the 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances $\leq$ 50 mm are determined by:
   [(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] $[\sqrt{f(GHz)}] \leq 3.0$ for 1-g SAR and ≤ 7.5 for 10-g extremity SAR
   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

Bluetooth Max Power (dBm)	Separation Distance (mm)	Frequency (GHz)	exclusion thresholds
12.00	0	2.48	4.99
11.54	0	2.441	4.45

2. Per KDB 447498 D01Chapter 4.3.1, when the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion. The test exclusion threshold are 4.99 and 4.45 which are > 3, SAR test for Left and Right part of the earphone are required.
3. Per KDB 447498 D01Chapter 4.3.2b), When an antenna qualifies for the standalone SAR test exclusion

of 4.3.1 and also transmits simultaneously with other antennas, the standalone SAR value must be estimated according to the following to determine the simultaneous transmission SAR test exclusion criteria:

[(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.

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

11.SAR TEST RESULTS SUMMARY

General Note:

1. Per KDB 447498 D01v05r01, the reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.
   Scaling Factor = tune-up limit power (mW) / EUT RF power (mW), where tune-up limit is the maximum rated power among all production units.
   Reported SAR(W/kg)= Measured SAR(W/kg) Scaling Factor*
2. Per KDB 447498 D01v05r01, for each exposure position, if the highest output channel reported SAR≤0.8W/kg, other channels SAR testing are not necessary
3. Per KDB865664 D01, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥0.8W/Kg; if the deviation among the repeated measurement is ≤20%,and the measured SAR <1.45W/Kg, only one repeated measurement is required.

Sample	Band	Mode	Test Position	Gap (mm)	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Scaling Factor	Power Drift (dB)	Measured SAR_{1g} (W/kg)	Reported SAR_{1g} (W/kg)	Plot No.
Left Ear	Bluetooth	π/4-DQPSK	Front Face	0	2480	12.00	12.50	1.12	-0.05	0.013	**0.01456**	#1
Left Ear	Bluetooth	π/4-DQPSK	Rear Face	0	2480	12.00	12.50	1.12	0.10	0.063	**0.07056**	#2
Left Ear	Bluetooth	π/4-DQPSK	Left Side	0	2480	12.00	12.50	1.12	-0.07	0.035	0.0392	
Left Ear	Bluetooth	π/4-DQPSK	Right Side	0	2480	12.00	12.50	1.12	-0.11	0.029	0.03248	
Left Ear	Bluetooth	π/4-DQPSK	Top Side	0	2480	12.00	12.50	1.12	0.08	0.00329	0.0036848	
Left Ear	Bluetooth	π/4-DQPSK	Bottom Side	0	2480	12.00	12.50	1.12	0.07	0.032	0.03584	
Right Ear	Bluetooth	π/4-DQPSK	Front Face	0	2441	11.54	12.00	1.11	-0.03	0.024	**0.02664**	#3
Right Ear	Bluetooth	π/4-DQPSK	Rear Face	0	2441	11.54	12.00	1.11	0.08	0.035	0.03885	
Right Ear	Bluetooth	π/4-DQPSK	Left Side	0	2441	11.54	12.00	1.11	0.01	0.044	**0.04884**	#4
Right Ear	Bluetooth	π/4-DQPSK	Right Side	0	2441	11.54	12.00	1.11	0.19	0.00473	0.0052503	
Right Ear	Bluetooth	π/4-DQPSK	Top Side	0	2441	11.54	12.00	1.11	-0.05	0.00508	0.0056388	
Right Ear	Bluetooth	π/4-DQPSK	Bottom Side	0	2441	11.54	12.00	1.11	-0.10	0.00481	0.0053391	

12.Simultaneous Transmission Analysis

N/A.

APPENDIX A. SYSTEM CHECKING SCANS

2450MHz Head System Check

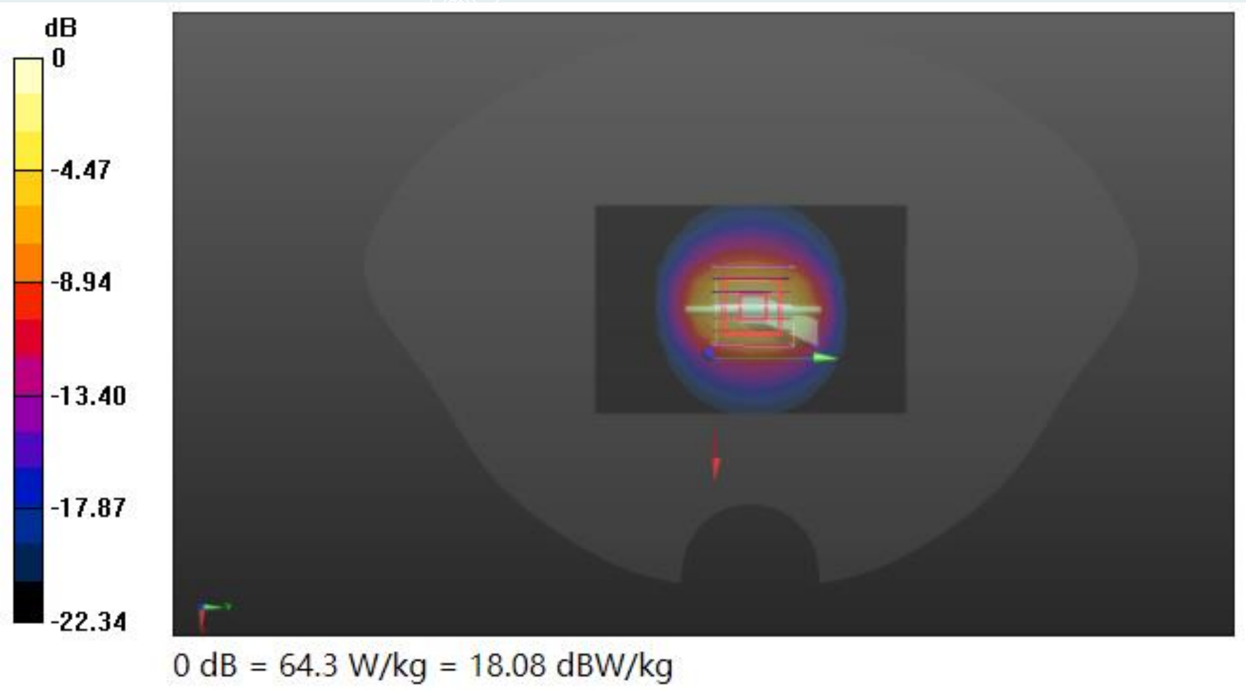
Communication System: UID 0, CW (0); Frequency: 2450 MHz
Medium parameters used: f = 2450 MHz; σ = 1.83 S/m; ε_r = 39.621; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY Configuration:

- Probe: EX3DV4 - SN7514; ConvF(7.18, 7.18, 7.18); Calibrated: 2020/9/1;
- Sensor-Surface: 3mm (Mechanical Surface Detection), z = 2.0, 32.0
- Electronics: DAE4 Sn796; Calibrated: 2020/5/6
- Phantom: Left Twin-SAM V5.0 (20deg probe tilt); Type: QD 000 P40 CD;
- DASY52 52.10.0(1442); SEMCAD X 14.6.10(7331)

Configuration/Head/Area Scan (9x13x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 63.9 W/kg

Configuration/Head/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 188.8 V/m; Power Drift = 0.02 dB
Peak SAR (extrapolated) = 99.6 W/kg
SAR(1 g) = 49 W/kg; SAR(10 g) = 22.8 W/kg
Maximum value of SAR (measured) = 64.3 W/kg



APPENDIX B. MEASUREMENT SCANS

2021/01/12

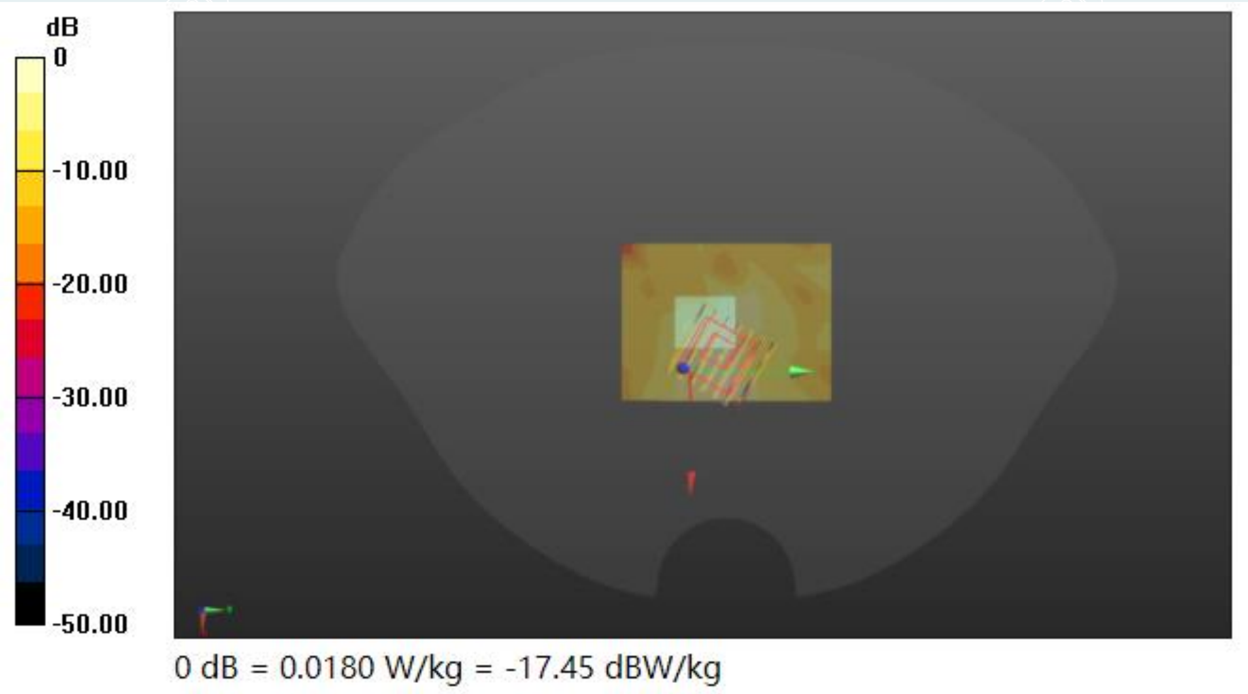
BT_Left Ear_Front Face_Ch78 **#1**
Communication System: UID 0, Bluetooth (0); Frequency: 2480 MHz
Medium parameters used: f = 2480 MHz; σ = 1.891 S/m; εr = 39.547; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY Configuration:

- Probe: EX3DV4 - SN7514; ConvF(7.18, 7.18, 7.18); Calibrated: 2020/9/1;
- Sensor-Surface: 3mm (Mechanical Surface Detection), z = -9.0, 31.0
- Electronics: DAE4 Sn796; Calibrated: 2020/5/6
- Phantom: Left Twin-SAM V5.0 (20deg probe tilt); Type: QD 000 P40 CD;
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Left Ear/Front Face/Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 0.0174 W/kg

Left Ear/Front Face/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 0.7160 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 0.0280 W/kg
SAR(1 g) = 0.013 W/kg; SAR(10 g) = 0.00523 W/kg
Maximum value of SAR (measured) = 0.0180 W/kg



2021/01/12

BT_Left Ear_Rear Face_Ch78 **#2**

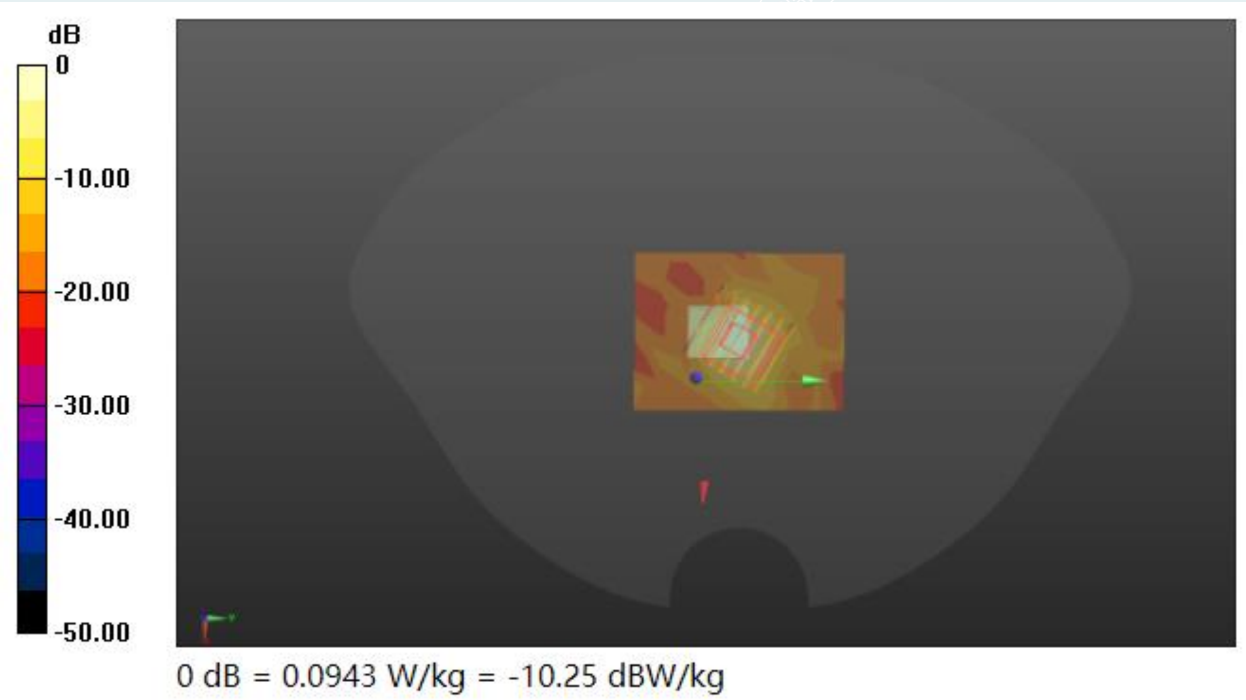
Communication System: UID 0, Bluetooth (0); Frequency: 2480 MHz
Medium parameters used: f = 2480 MHz; σ = 1.891 S/m; εr = 39.547; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY Configuration:

- Probe: EX3DV4 - SN7514; ConvF(7.18, 7.18, 7.18); Calibrated: 2020/9/1;
- Sensor-Surface: 3mm (Mechanical Surface Detection), z = -9.0, 31.0
- Electronics: DAE4 Sn796; Calibrated: 2020/5/6
- Phantom: Left Twin-SAM V5.0 (20deg probe tilt); Type: QD 000 P40 CD;
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Left Ear/Rear Face/Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 0.100 W/kg

Left Ear/Rear Face/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 7.160 V/m; Power Drift = 0.10 dB
Peak SAR (extrapolated) = 0.145 W/kg
SAR(1 g) = 0.063 W/kg; SAR(10 g) = 0.023 W/kg
Maximum value of SAR (measured) = 0.0943 W/kg



2021/01/12

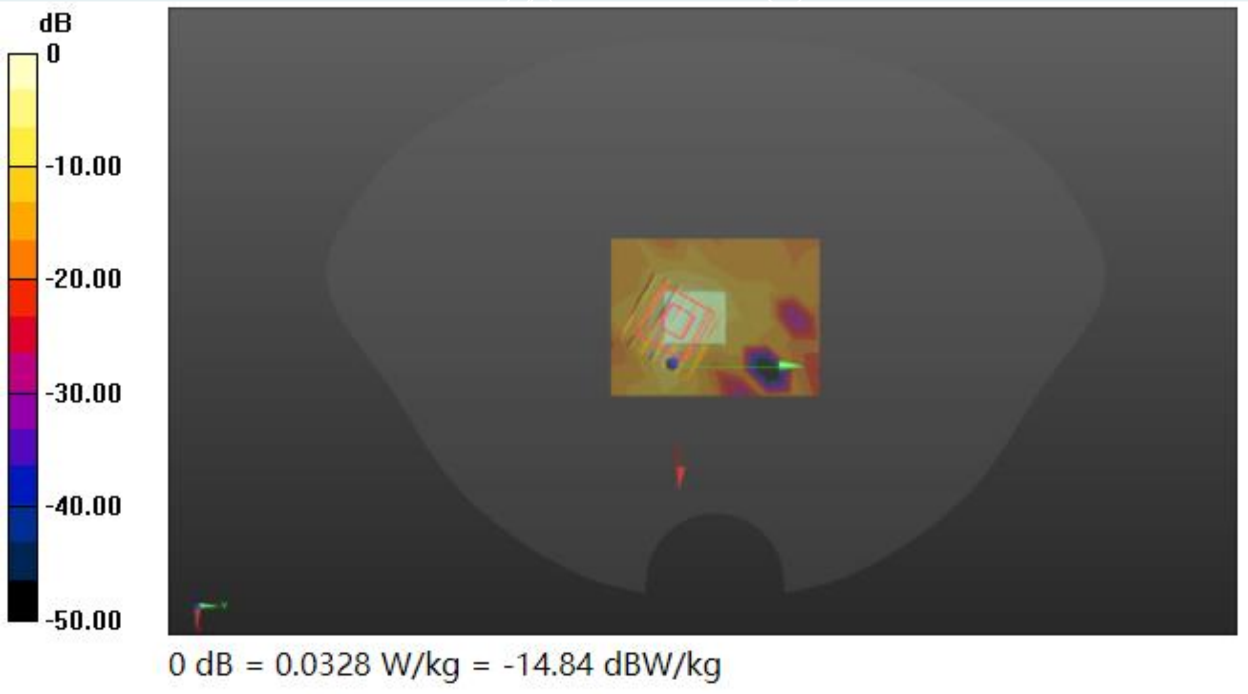
BT_Right Ear_Front Face_Ch39
#3
Communication System: UID 0, Bluetooth (0); Frequency: 2441 MHz
Medium parameters used: f = 2441 MHz; σ = 1.804 S/m; εr = 39.604; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY Configuration:

- Probe: EX3DV4 - SN7514; ConvF(7.18, 7.18, 7.18); Calibrated: 2020/9/1;
- Sensor-Surface: 3mm (Mechanical Surface Detection), z = -9.0, 31.0
- Electronics: DAE4 Sn796; Calibrated: 2020/5/6
- Phantom: Left Twin-SAM V5.0 (20deg probe tilt); Type: QD 000 P40 CD;
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Front Face/Front Face/Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 0.0268 W/kg

Front Face/Front Face/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 0.6870 V/m; Power Drift = -0.03 dB
Peak SAR (extrapolated) = 0.138 W/kg
SAR(1 g) = 0.024 W/kg; SAR(10 g) = 0.00522 W/kg
Maximum value of SAR (measured) = 0.0328 W/kg



2021/01/12

BT_Right Ear_Left Side_Ch39 **#4**

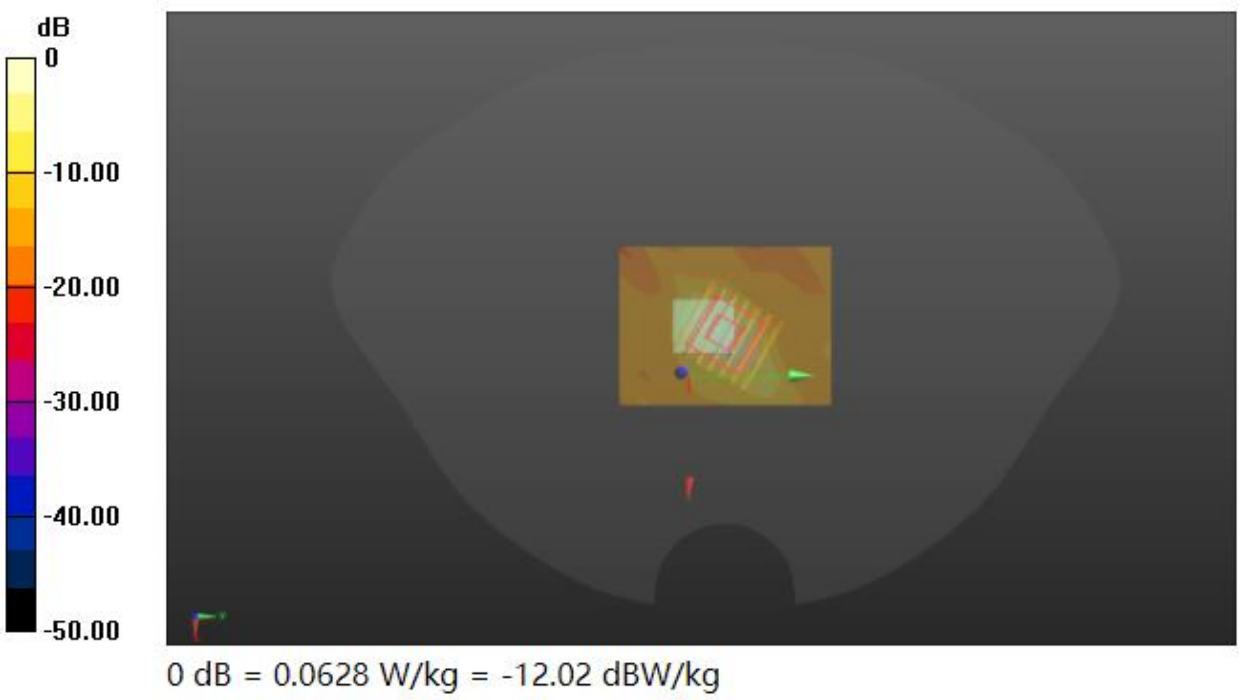
Communication System: UID 0, Bluetooth (0); Frequency: 2441 MHz
Medium parameters used: f = 2441 MHz; σ = 1.804 S/m; εr = 39.604; ρ = 1000 kg/m3
Phantom section: Flat Section

DASY Configuration:

- Probe: EX3DV4 - SN7514; ConvF(7.18, 7.18, 7.18); Calibrated: 2020/9/1;
- Sensor-Surface: 3mm (Mechanical Surface Detection), z = -9.0, 31.0
- Electronics: DAE4 Sn796; Calibrated: 2020/5/6
- Phantom: Left Twin-SAM V5.0 (20deg probe tilt); Type: QD 000 P40 CD;
- DASY52 52.8.8(1222); SEMCAD X 14.6.10(7331)

Right Ear/Left Side/Area Scan (7x9x1): Measurement grid: dx=10mm, dy=10mm
Maximum value of SAR (measured) = 0.0547 W/kg

Right Ear/Left Side/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 5.291 V/m; Power Drift = 0.01 dB
Peak SAR (extrapolated) = 0.114 W/kg
SAR(1 g) = 0.044 W/kg; SAR(10 g) = 0.017 W/kg
Maximum value of SAR (measured) = 0.0628 W/kg



APPENDIX C. RELEVANT PAGES FROM PROBE CALIBRATION REPORT(S)

In Collaboration with speag CALIBRATION LABORATORY

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中国认可 国际互认 校准 CALIBRATION CNAS L0570

Client GRG METROLOGY&TEST Certificate No: Z20-60143

CALIBRATION CERTIFICATE

Object: EX3DV4 - SN : 7514

Calibration Procedure(s): FF-Z11-004-02
Calibration Procedures for Dosimetric E-field Probes

Calibration date: September 01, 2020

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)℃ and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Power Meter NRP2	101919	16-Jun-20(CTTL, No.J20X04344)	Jun-21
Power sensor NRP-Z91	101547	16-Jun-20(CTTL, No.J20X04344)	Jun-21
Power sensor NRP-Z91	101548	16-Jun-20(CTTL, No.J20X04344)	Jun-21
Reference 10dBAttenuator	18N50W-10dB	10-Feb-20(CTTL, No.J20X00525)	Feb-22
Reference 20dBAttenuator	18N50W-20dB	10-Feb-20(CTTL, No.J20X00526)	Feb-22
Reference Probe EX3DV4	SN 7307	29-May-20(SPEAG, No.EX3-7307_May20)	May-21
DAE4	SN 1556	4-Feb-20(SPEAG, No.DAE4-1556_Feb20)	Feb-21
Secondary Standards	**ID #**	**Cal Date(Calibrated by, Certificate No.)**	**Scheduled Calibration**
SignalGenerator MG3700A	6201052605	23-Jun-20(CTTL, No.J20X04343)	Jun-21
Network Analyzer E5071C	MY46110673	10-Feb-20(CTTL, No.J20X00515)	Feb-21

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: September 03, 2020

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Glossary:

TSL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMx,y,z
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A,B,C,D	modulation dependent linearization parameters
Polarization Φ	Φ rotation around probe axis
Polarization θ	θ rotation around an axis that is in the plane normal to probe axis (at measurement center), i 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) 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"

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z:* Assessed for E-field polarization θ=0 (f≤900MHz in TEM-cell; f>1800MHz: waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not effect 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 (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;VRx,y,z:*A,B,C 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≤800MHz) and inside waveguide using analytical field distributions based on power measurements for f >800MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty valued 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±50MHz to±100MHz.
- *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).

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DASY/EASY – Parameters of Probe: EX3DV4 – SN:7514

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (*k*=2)
Norm($\mu V/(V/m)^2$)[A]	0.46	0.44	0.40	±10.0%
DCP(mV)[B]	97.2	101.0	98.5	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Unc[E] (*k*=2)
0	CW	X	0.0	0.0	1.0	0.00	166.7	±2.1%
		Y	0.0	0.0	1.0		183.9	
		Z	0.0	0.0	1.0		195.6	

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 4 and Page 5).
[B] Numerical linearization parameter: uncertainty not required.
[E] Uncertainly is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

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DASY/EASY – Parameters of Probe: EX3DV4 – SN:7514

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)	Unct. (k=2)
750	41.9	0.89	9.69	9.69	9.69	0.40	0.80	±12.1%
835	41.5	0.90	9.39	9.39	9.39	0.22	1.13	±12.1%
900	41.5	0.97	9.34	9.34	9.34	0.28	1.04	±12.1%
1450	40.5	1.20	8.35	8.35	8.35	0.14	1.19	±12.1%
1640	40.3	1.29	8.20	8.20	8.20	0.33	0.88	±12.1%
1750	40.1	1.37	8.14	8.14	8.14	0.23	1.11	±12.1%
1900	40.0	1.40	7.68	7.68	7.68	0.24	1.08	±12.1%
2100	39.8	1.49	7.63	7.63	7.63	0.21	1.20	±12.1%
2300	39.5	1.67	7.45	7.45	7.45	0.59	0.70	±12.1%
2450	39.2	1.80	7.18	7.18	7.18	0.62	0.71	±12.1%
2600	39.0	1.96	7.00	7.00	7.00	0.67	0.69	±12.1%
3300	38.2	2.71	6.82	6.82	6.82	0.35	1.15	±13.3%
3500	37.9	2.91	6.62	6.62	6.62	0.40	1.04	±13.3%
3700	37.7	3.12	6.40	6.40	6.40	0.40	1.20	±13.3%
3900	37.5	3.32	6.42	6.42	6.42	0.40	1.15	±13.3%
4100	37.2	3.53	6.23	6.23	6.23	0.40	1.20	±13.3%
4200	37.1	3.63	6.18	6.18	6.18	0.30	1.35	±13.3%
4400	36.9	3.84	6.12	6.12	6.12	0.35	1.33	±13.3%
4600	36.7	4.04	6.03	6.03	6.03	0.40	1.40	±13.3%
4800	36.4	4.25	5.93	5.93	5.93	0.40	1.35	±13.3%
4950	36.3	4.40	5.70	5.70	5.70	0.40	1.35	±13.3%
5200	36.0	4.66	5.26	5.26	5.26	0.40	1.50	±13.3%
5300	35.9	4.76	5.14	5.14	5.14	0.45	1.35	±13.3%
5500	35.6	4.96	4.73	4.73	4.73	0.40	1.60	±13.3%
5600	35.5	5.07	4.60	4.60	4.60	0.45	1.42	±13.3%
5800	35.3	5.27	4.56	4.56	4.56	0.50	1.30	±13.3%

[C] Frequency validity above 300 MHz of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of 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. Above 5 GHz frequency validity can be extended to ± 110 MHz.

[F] At frequency 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 the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

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DASY/EASY – Parameters of Probe: EX3DV4 – SN:7514

Calibration Parameter Determined in Body Tissue Simulating Media

f [MHz][C]	Relative Permittivity[F]	Conductivity (S/m)[F]	ConvF X	ConvF Y	ConvF Z	Alpha[G]	Depth[G] (mm)	Unct. (*k*=2)
750	55.5	0.96	9.79	9.79	9.79	0.40	0.80	±12.1%
835	55.2	0.97	9.40	9.40	9.40	0.22	1.24	±12.1%
900	55.0	1.05	9.38	9.38	9.38	0.39	0.93	±12.1%
1450	54.0	1.30	8.16	8.16	8.16	0.25	1.00	±12.1%
1640	53.8	1.40	7.99	7.99	7.99	0.24	1.13	±12.1%
1750	53.4	1.49	7.87	7.87	7.87	0.23	1.21	±12.1%
1900	53.3	1.52	7.56	7.56	7.56	0.27	1.01	±12.1%
2100	53.2	1.62	7.43	7.43	7.43	0.22	1.25	±12.1%
2300	52.9	1.81	7.29	7.29	7.29	0.54	0.83	±12.1%
2450	52.7	1.95	7.22	7.22	7.22	0.64	0.75	±12.1%
2600	52.5	2.16	7.02	7.02	7.02	0.68	0.69	±12.1%
3300	51.6	3.08	6.48	6.48	6.48	0.40	1.15	±13.3%
3500	51.3	3.31	6.42	6.42	6.42	0.40	1.15	±13.3%
3700	51.0	3.55	6.12	6.12	6.12	0.40	1.25	±13.3%
3900	51.2	3.78	6.10	6.10	6.10	0.40	1.32	±13.3%
4100	50.5	4.01	6.05	6.05	6.05	0.40	1.20	±13.3%
4200	50.4	4.13	5.95	5.95	5.95	0.40	1.20	±13.3%
4400	50.1	4.37	5.85	5.85	5.85	0.35	1.40	±13.3%
4600	49.8	4.60	5.55	5.55	5.55	0.40	1.50	±13.3%
4800	49.6	4.83	5.32	5.32	5.32	0.45	1.65	±13.3%
4950	49.4	5.01	5.14	5.14	5.14	0.45	1.70	±13.3%
5200	49.0	5.30	4.64	4.64	4.64	0.45	1.75	±13.3%
5300	48.9	5.42	4.58	4.58	4.58	0.45	1.75	±13.3%
5500	48.6	5.65	4.24	4.24	4.24	0.50	1.70	±13.3%
5600	48.5	5.77	4.03	4.03	4.03	0.55	1.55	±13.3%
5800	48.2	6.00	3.96	3.96	3.96	0.55	1.70	±13.3%

[C] Frequency validity above 300 MHz of ±100MHz only applies for DASY v4.4 and higher (Page 2), else it is restricted to ±50MHz. The uncertainty is the RSS of 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. Above 5 GHz frequency validity can be extended to ± 110 MHz.

[F] At frequency 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 the frequencies between 3-6 GHz at any distance larger than half the probe tip diameter from the boundary.

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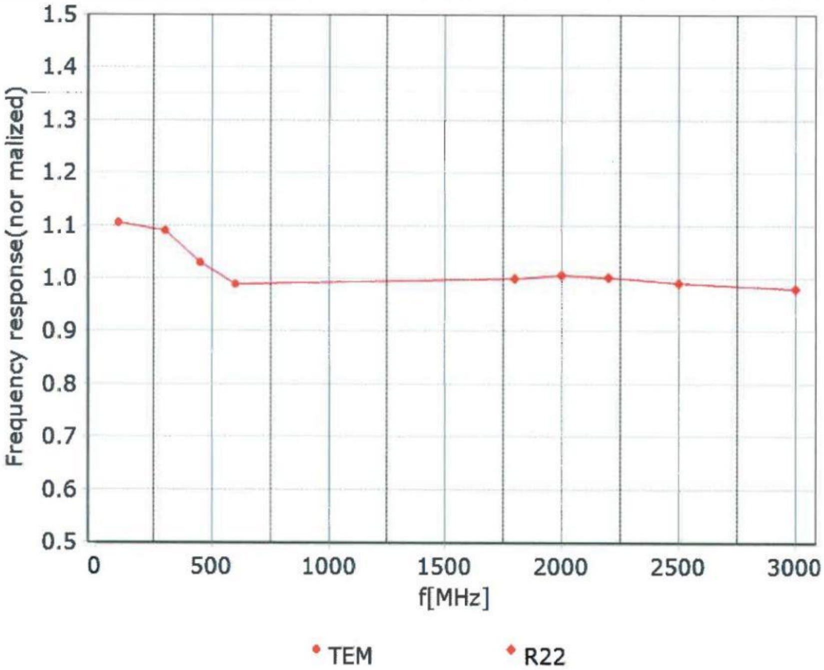
Frequency Response of E-Field
(TEM-Cell: ifi110 EXX, Waveguide: R22)



Uncertainty of Frequency Response of E-field: ±7.4% (*k*=2)

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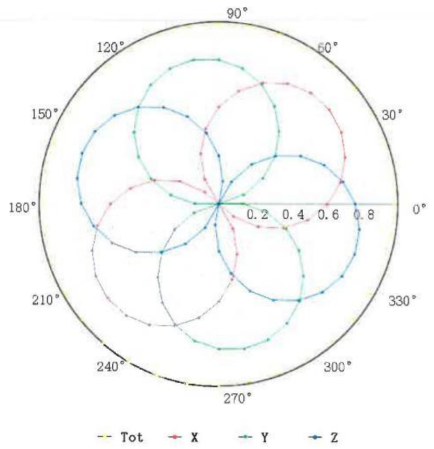
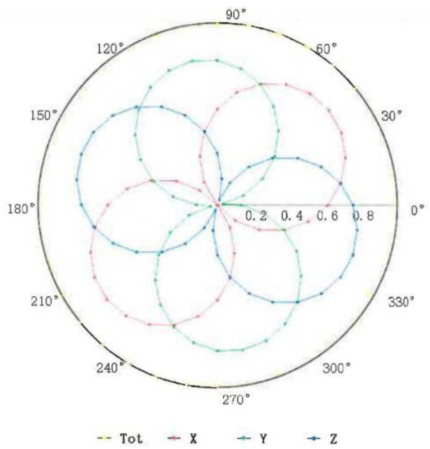
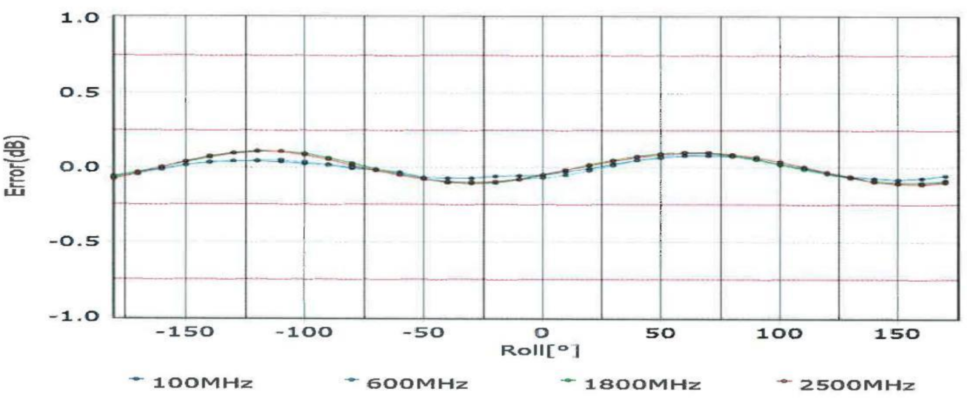
Receiving Pattern (Φ), θ=0°

f=600 MHz, TEM



f=1800 MHz, R22





Uncertainty of Axial Isotropy Assessment: ±1.2% (k=2)

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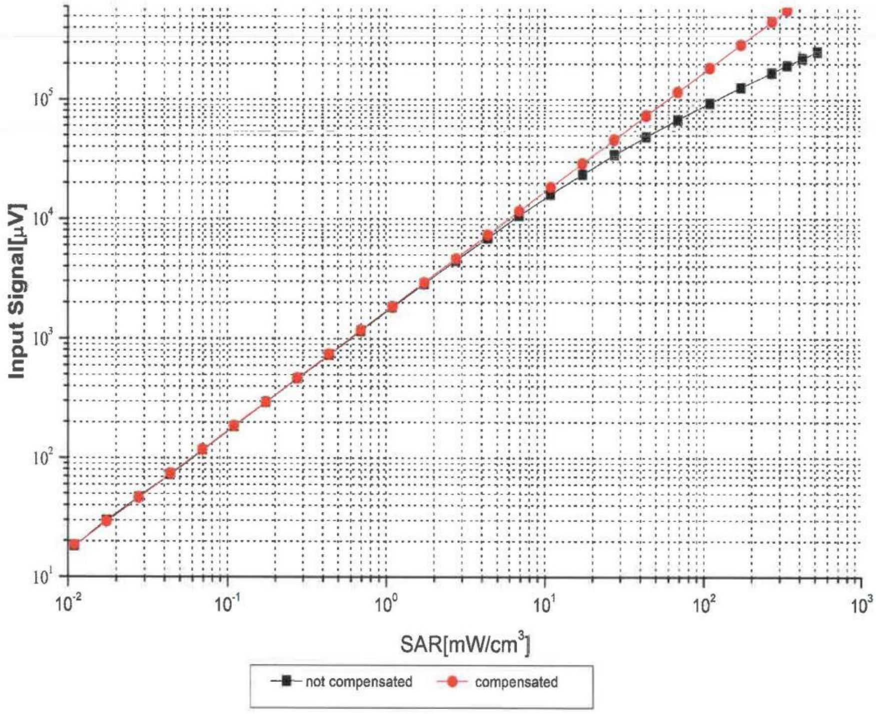
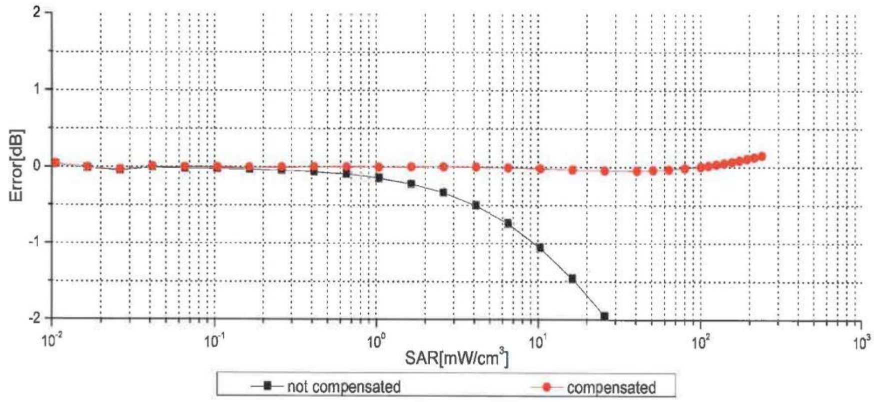
Dynamic Range f(SAR$_{head}$)
(TEM cell, f = 900 MHz)





Uncertainty of Linearity Assessment: ±0.9% (*k*=2)

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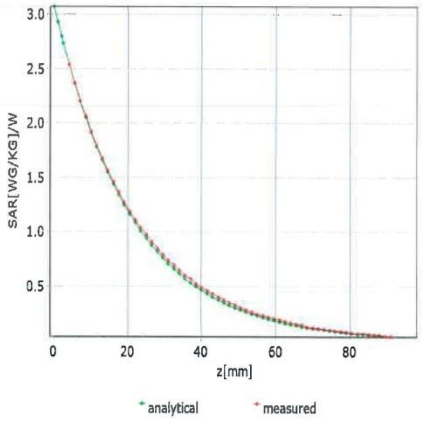
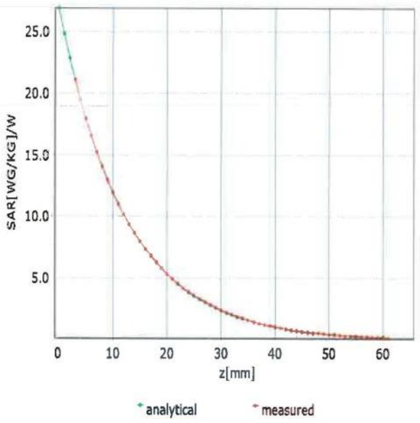
Conversion Factor Assessment

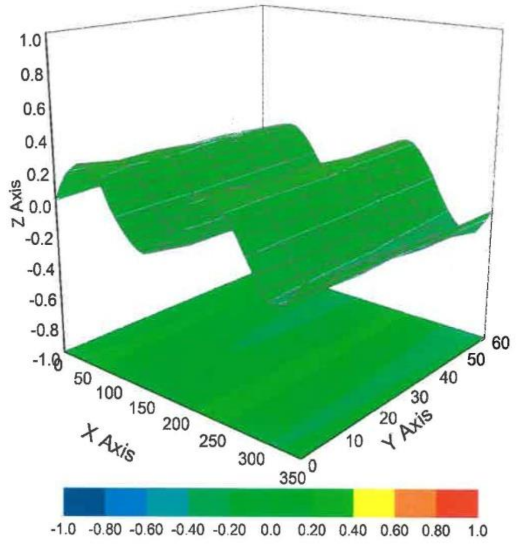
f=750 MHz,WGLS R9(H_convF)



f=1750 MHz,WGLS R22(H_convF)



Deviation from Isotropy in Liquid



Uncertainty of Spherical Isotropy Assessment: ±3.2% (*k*=2)

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DASY/EASY – Parameters of Probe: EX3DV4 – SN:7514

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	160.7
Mechanical Surface Detection Mode	enabled
Optical Surface Detection Mode	disable
Probe Overall Length	337mm
Probe Body Diameter	10mm
Tip Length	10mm
Tip Diameter	2.5mm
Probe Tip to Sensor X Calibration Point	1mm
Probe Tip to Sensor Y Calibration Point	1mm
Probe Tip to Sensor Z Calibration Point	1mm
Recommended Measurement Distance from Surface	1.4mm

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国际互认
校准
CALIBRATION
CNAS L0570

Client : GRG METROLOGY&TEST

Certificate No: Z20-60145

CALIBRATION CERTIFICATE

Object	DAE4 - SN: 796
Calibration Procedure(s)	FF-Z11-002-01 Calibration Procedure for the Data Acquisition Electronics (DAEx)
Calibration date:	May 06, 2020

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)℃ and humidity<70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Process Calibrator 753	1971018	24-Jun-19 (CTTL, No.J19X05126)	Jun-20

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Lin Hao	SAR Test Engineer	
Approved by:	Qi Dianyuan	SAR Project Leader	

Issued: May 08, 2020

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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 report provide only calibration results for DAE, it does not contain other performance test results.

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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	404.868 ± 0.15% (k=2)	403.821 ± 0.15% (k=2)	404.089 ± 0.15% (k=2)
Low Range	3.98056 ± 0.7% (k=2)	3.94146 ± 0.7% (k=2)	3.96869 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	262° ± 1 °