

FCC SAR TEST REPORT

FOR

Applicant	:	Altis Technology (Hong Kong) Ltd.
Address	:	711, Lu Plaza, 2 Wing Yip Street, Kwun Tong, Hong Kong
Equipment under Test	:	GMRS/FRS Walkie Talkie Two-way Radio
Model No	:	PR560 BLT / PR561 BLT / PR562 BLT / PR563 BLT / PR564 BLT
Trade Mark	:	Cobra
FCC ID	:	2AHJMPREFJ
Manufacturer	:	Altis Technology (Hong Kong) Ltd.
Address	:	711, Lu Plaza, 2 Wing Yip Street, Kwun Tong, Hong Kong

Issued By: Dongguan Dongdian Testing Service Co., Ltd.

Add: No. 17, Zongbu Road 2, Songshan Lake Sci&Tech, Industry Park, Dongguan City,
Guangdong Province, China, 523808

Tel: +86-0769-22891499 [Http://www.dgddt.com](http://www.dgddt.com)

REPORT

TEST REPORT DECLARE

Applicant	:	Altis Technology (Hong Kong) Ltd.
Address	:	711, Lu Plaza, 2 Wing Yip Street, Kwun Tong, Hong Kong
Equipment under Test	:	GMRS/FRS Walkie Talkie Two-way Radio
Model No	:	PR560 BLT / PR561 BLT / PR562 BLT / PR563 BLT /PR564 BLT
Trade Mark	:	Cobra
Manufacturer	:	Altis Technology (Hong Kong) Ltd.
Address	:	711, Lu Plaza, 2 Wing Yip Street, Kwun Tong, Hong Kong

We Declare:

The equipment described above is evaluation by Dongguan Dongdian Testing Service Co., Ltd and in the configuration tested the equipment complied with the standards specified above. The test results are contained in this test report and Dongguan Dongdian Testing Service Co., Ltd is assumed of full responsibility for the accuracy and completeness of these tests.

Report No:	DDT-R17Q0112-12E4		
Date of Test:	Jan. 14, 2017 ~ Jan. 14, 2017	Date of Report:	Jan. 18, 2017

Prepared By:

Leo Liu/RF Engineer**Approved By:**

Kevin Feng/RF Manager

Note: This report applies to above tested sample only. This report shall not be reproduced in parts without written approval of Dongguan Dongdian Testing Service Co., Ltd.

**** Modified History ****

Revison	Description	Issued Data	Remark
Revsion 1.0	Initial Test Report Release	2017-01-18	Jamy Yu

Contents

<u>1.</u>	<u>TEST STANDARDS/PROCEDURES REFERENCE/FCC KDBS.....</u>	<u>6</u>
<u>2.</u>	<u>SUMMARY</u>	<u>7</u>
2.1.	General Remarks	7
2.2.	Summary SAR Results	7
2.3.	EUT Accessories	8
2.4.	Short description of the Equipment under Test (EUT)	8
2.5.	TEST Configuration	9
2.6.	EUT operation mode	9
<u>3.</u>	<u>TEST ENVIRONMENT.....</u>	<u>10</u>
3.1.	Address of the test laboratory	10
3.2.	Test Facility	10
3.3.	Environmental conditions	10
3.4.	SAR Limits	10
3.5.	Equipments Used during the Test	11
<u>4.</u>	<u>SAR MEASUREMENTS SYSTEM CONFIGURATION.....</u>	<u>12</u>
4.1.	SAR Measurement Set-up	12
4.2.	DASY5 E-field Probe System	13
4.3.	Phantoms Description	13
4.4.	Device Holder	14
4.5.	Scanning Procedure	15
4.6.	Data Storage and Evaluation	16
4.7.	SAR Measurement System	17
4.8.	Tissue equivalent liquid properties	17
4.9.	System Check	18
4.10.	SAR measurement procedure	19
<u>5.</u>	<u>TEST CONDITIONS AND RESULTS.....</u>	<u>24</u>
5.1.	Conducted Power Results	24
5.2.	Test reduction procedure	25
5.3.	Transmit Antennas Position	25
5.4.	Standalone SAR Test Exclusion Considerations	25
5.5.	Standalone Estimated SAR	26
5.6.	SAR Measurement Results	26
5.7.	SAR Reporting Results	28
5.8.	SAR Measurement Variability	30
5.9.	Measurement Uncertainty(300MHz-3GHz)	31
5.10.	System Check Results	35
5.11.	SAR Test Graph Results	37
<u>6.</u>	<u>CALIBRATION CERTIFICATE</u>	<u>41</u>
6.1.	Probe Calibration Certificate	41
6.2.	D450V3 Dipole Calibration Certificate	52
6.3.	DAE4 Calibration Certificate	60
<u>7.</u>	<u>TEST SETUP PHOTOS</u>	<u>64</u>

8. EXTERNAL PHOTOS OF THE EUT 66

1. TEST STANDARDS/PROCEDURES REFERENCE/FCC KDBs

The tests were performed according to following standards:

[IEEE 1528-2013 \(2014-06\)](#): Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques

[IEEE Std. C95-3 \(2002\)](#): IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields – RF and Microwave

[IEEE Std. C95-1 \(1991\)](#): IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

[KDB 865664D01v04 \(August 7, 2015\)](#): SAR Measurement Requirements for 100 MHz to 6 GHz

[KDB 865664D02v01r02 \(October 23, 2015\)](#): RF Exposure Compliance Reporting and Documentation Considerations

[KDB 447498D01v06 \(October 23, 2015\)](#): RF Exposure Procedures and Equipment Authorization Policies for Mobile and Portable Devices

2. SUMMARY

2.1. General Remarks

EUT* Name	:	GMRS/FRS Walkie Talkie Two-way Radio
Model Number	:	PR560 BLT / PR561 BLT / PR562 BLT / PR563 BLT /PR564 BLT
Difference of model number	:	This device have 5 models, and the difference of each models are cabinet color, sales country and accessories, all the other characteristic like circuit, PCB layout, RF power are exactly same, and PR560 BLT was used for test.
Trade Mark	:	Cobra
EUTfunction description	:	Please reference user manual of this device
Power supply	:	DC 3.6V battery
Operation frequency range	:	462.55MHz-462.7250MHz / 467.5625MHz-467.7125MHz
Modulation type	:	FM
Max Tx deviation	:	2.5KHz
Emission type	:	F3E
Antenna Type	:	FRS/GMRS: External and maximum antenna gain is 0dBi BT: Internal and maximum antenna is 1.5dBi
Date of Receipt	:	Jan.14, 2017
Sample Type	:	Series production
Exposure category:	:	General population / Uncontrolled environment
VOX function	:	Support

Note1: EUT is the ab.of equipment under test.

2.2. Summary SAR Results

The maximum of results of SAR found during testing for PR560 BLT are follows:

<Highest Reported standalone SAR Summary>

Classment Class	Frequency (MHz)	Position	Maximum Report SAR Results (W/Kg)	
			100% duty cycle	50% duty cycle
FRE	462.6375	Face-held	1.238	0.619
FRE	462.6375	Body-Worn	1.306	0.653

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 C95.1-2005 based on 50% duty cycle, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013;

<Highest Reported simultaneous SAR Summary>

Exposure Position	Frequency Band	Reported SAR _{1-g} (W/kg) (50% duty cycle)	Classment Class	Highest Reported Simultaneous Transmission SAR _{1-g} (W/kg) (50% duty cycle)
Body-worn	462.5MGMRs	0.653	FRE	0.695
	2.4GBT	0.042	DSS	

2.3. EUT Accessories

Accessory name	Internal Identification	Model	Description	Remark
Antenna	A1	N/A	External Antenna	performed
Battery	B1	FB-49AAJ	1000mAh 3XAA NiMH Battery Intrinsically Safe Li-ion Battery	performed
Belt clip	BC1	N/A	Belt clip	performed
Bluetooth headset	BH	PLANTRONIC SM165, MOTOROLA H720X	Bluetooth Headset	No-performed

AE ID: is used to identify the test sample in the lab internally.

2.4. Short description of the Equipment under Test (EUT)

FRS/GMRS Radio;

The spatial peak SAR values were assessed for systems. Battery and accessories shall be specified by the manufacturer. The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power output.

The sample enter into 100% duty cycle continuous transmit controlled by software provided by application. The sample was use test software to control transmit.

The sample enter 100% duty cycle continuous transmit for Bluetooth by software (BK32xx RF Test_V1.4) provided by application. The sample was use test software to control transmit.

This portable device operates in FRS/GMRS bands using Frequency modulation (FM). The device also contains Bluetooth technology for short range wireless devices;

The FRS/GMRS bands in this device operate in a half duplex system. A half duplex system only allows the user to transmit or receive. This device cannot transmit and receive simultaneously. The user must stop transmitting in order to receive a signal or listen for a response, regardless of PTT button or use of voice activated audio accessories. This type of operation, along with the RF safety booklet, which instructs the user to transmit no more than 50% of the time, justifies the use of 50% duty cycle factor for this device.

The device also incorporates a Bluetooth v2.1+EDR, which including classics Bluetooth. It is Class 1 device with Frequency Hopping Spread Spectrum (FHSS) technology. The Bluetooth radio modem is used to wireless link audio accessories. The maximum actual transmission duty cycle is imposed by the Bluetooth standard. The maximum duty cycle for BT is derived from 5-slots packet type operation which consists of receiving on 1-slots, and thus maximum duty cycle is 77.01%.

Table 3 below summaries the technologies, bands, maximum duty cycles and maximum output powers. Maximum output powers are defined as upper limit of the production line final test station.

Table 3

Technologies	Bands (MHz)	Transmission	Duty Cycle (%)	Maximum Averag Power (W)*
FRS	467.5625MHz-467.7125MHz	FM	50%	0.355
GMRS	462.55MHz-462.7250MHz	FM	50%	1.259
Bluetooth	2402 – 2480 MHz	GFSK, $\pi/4$ DQPSK, 8-DPSK	77.01%	0.001

Note - * maximum power including turn up tolerance;

The intended operating positions are at “at the face” with the EUT at least 2.5 cm from the mouth, and “at the body” by means of the offered body worn accessories. Body worn audio and PTT operation is accomplished by means of optional remote accessories that are connected to the radio. Operation at the body without an audio accessory attached is possible by means of BT accessories.

2.5. TEST Configuration

Face-Held Configuration

Face-held Configuration- per FCC KDB447498 page 23: “A test separation distance of 25 mm must be applied for in-front-of the face SAR test exclusion and SAR measurements.”

If a device has push-to-talk capability, 15 a minimum duty cycle of 50% (on-time) shall be used in the evaluation. A duty cycle lower than 50% is permitted only if the transmission duty cycle is an inherent property of the technology or of the design of the equipment and is not under user control. Proof of the various on-off durations and a detailed method of calculation of the average power shall be included in the RF exposure technical brief. Maximum average power levels shall be used to determine compliance.

For devices without push-to-talk capability, the duty cycle used in the evaluation shall be based on the inherent property of the transmission technology or of the design of the equipment.”

Body-worn Configuration

Body-worn measurements-per FCC KDB447498 page 22 “When body-worn accessory SAR testing is required, the body-worn accessory requirements in section 4.2.2 should be applied. PTT two-way radios that support held-to-ear operating mode must also be tested according to the exposure configurations required for handsets. This generally does not apply to cellphones with PTT options that have already been tested in more conservative configurations in applicable wireless modes for SAR compliance at 100% duty factor.”

As the FRS radio with audio port and Bluetooth through earphone. Operation at the body without an audio accessory attached is possible by means of BT accessories. Measured Body –worn configuration without any audio accessory.

CH #	FREQ (MHz)	TYPE	CH #	FREQ (MHz)	TYPE
1	462.5625	GMRS	12	467.6625	FRS
2	462.5875	GMRS	13	467.6875	FRS
3	462.6125	GMRS	14	467.7125	FRS
4	462.6375	GMRS	15	462.55	GMRS
5	462.6625	GMRS	16	462.575	GMRS
6	462.6875	GMRS	17	462.6	GMRS
7	462.7125	GMRS	18	462.625	GMRS
8	467.5625	FRS	19	462.65	GMRS
9	467.5875	FRS	20	462.675	GMRS
10	467.6125	FRS	21	462.7	GMRS
11	467.6375	FRS	22	462.725	GMRS

Note: GMRS and FRS test channel according to KDB447498 and IEEE 1528:2013 for numbers of test channels formula.

$$N_c = 2 * \text{roundup} [10 * (f_{\text{high}} - f_{\text{low}}) / f_c] + 1$$

Where

N_c = Number of channels

F_{high} = Upper channel

F_{low} = Lower channel

F_c = Center channel

2.6. EUT operation mode

The EUT has been tested under typical operating condition and The Transmitter was operated in the normal operating mode. The TX frequency was fixed which was for the purpose of the measurements.

3. TEST ENVIRONMENT

3.1. Address of the test laboratory

Shenzhen Yidajietong Test Technology Co., Ltd.

3/F., Building 12, Shangsha Innovation & Technology Park, Futian District, Shenzhen, Guangdong, China

3.2. Test Facility

The test facility is recognized, certified, or accredited by the following organizations:

CNAS-Lab Code: L7547

The Testing and Technology Center for Shenzhen Yidajietong Test Technology Co., Ltd. has been assessed and proved to be in compliance with CNAS-CL01 Accreditation Criteria for Testing and Calibration Laboratories (identical to ISO/IEC 17025: 2005 General Requirements) for the Competence of Testing and Calibration Laboratories, Date of Registration: March, 2015. Valid time is until March, 2018.

ISED SAR List Lab Number: 21298

Shenzhen Yidajietong Test Technology Co., Ltd. has been listed ISED SAR Test labs, listed number is 21298.

3.3. Environmental conditions

During the measurement the environmental conditions were within the listed ranges:

Temperature:	18-25 ° C
Humidity:	40-65 %
Atmospheric pressure:	950-1050mbar

3.4. SAR Limits

FCC Limit (1g Tissue)

EXPOSURE LIMITS	SAR (W/kg)	
	(General Population / Uncontrolled Exposure Environment)	(Occupational / Controlled Exposure Environment)
Spatial Average (averaged over the whole body)	0.08	0.4
Spatial Peak (averaged over any 1 g of tissue)	1.60	8.0
Spatial Peak (hands/wrists/feet/ankles averaged over 10 g)	4.0	20.0

Population/Uncontrolled Environments are defined as locations where there is the exposure of individual who have no knowledge or control of their exposure.

Occupational/Controlled Environments are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure (i.e. as a result of employment or occupation).

3.5. Equipments Used during the Test

Test Equipment	Manufacturer	Type/Model	Serial Number	Calibration	
				Last Calibration	Calibration Interval
Data Acquisition Electronics DAEx	SPEAG	DAE4	1315	2016/07/26	1
E-field Probe	SPEAG	ES3DV3	3292	2016/09/02	1
System Validation Dipole D450V3	SPEAG	D450V3	1079	2016/08/29	3
Network analyzer	Agilent	8753E	US37390562	2016/03/05	1
Dielectric Probe Kit	Agilent	85070E	US44020288	/	/
Power meter	Agilent	E4417A	GB41292254	2016/12/13	1
Power sensor	Agilent	8481H	MY41095360	2016/12/13	1
Power sensor	Agilent	8481H	MY41095361	2016/12/13	1
Signal generator	IFR	2032	203002/100	2016/10/10	1
Amplifier	AR	75A250	302205	2016/10/10	1

Note:

- 1) Per KDB865664D01 requirements for dipole calibration, the test laboratory has adopted three year extended calibration interval. Each measured dipole is expected to evaluate with following criteria at least on annual interval.
 - a) There is no physical damage on the dipole;
 - b) System check with specific dipole is within 10% of calibrated values;
 - c) The most recent return-loss results, 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 50 Ω from the previous measurement.
- 2) Network analyzer probe calibration against air, distilled water and a shorting block performed before measuring liquid parameters.

4. SAR Measurements System configuration

4.1. SAR Measurement Set-up

The DASY5 system for performing compliance tests consists of the following items:

A standard high precision 6-axis robot (Stäubli RX family) with controller and software. An arm extension for accommodating the data acquisition electronics (DAE).

A dosimetric probe, i.e. an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.

A data acquisition electronic (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.

A unit to operate the optical surface detector which is connected to the EOC.

The Electro-Optical Coupler (EOC) performs the conversion from the optical into a digital electric signal of the DAE. The EOC is connected to the DASY5 measurement server.

The DASY5 measurement server, which performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation. A computer operating Windows 2003.

DASY5 software and SEMCAD data evaluation software.

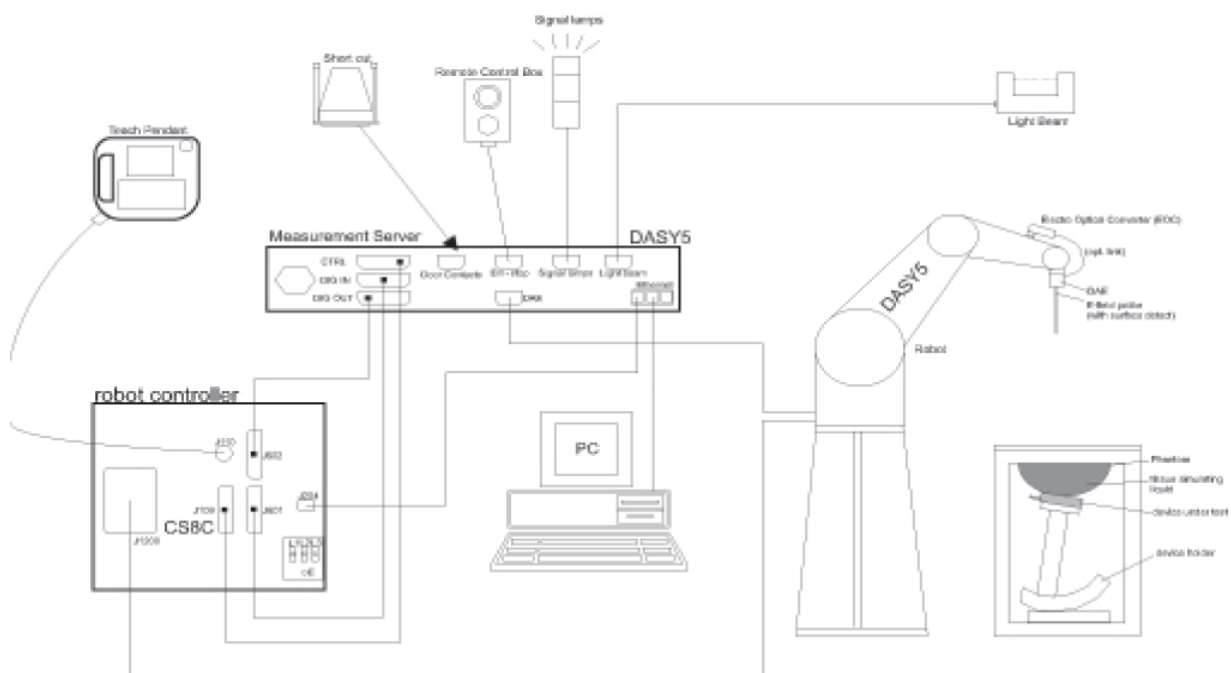
Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.

The generic twin phantom enabling the testing of left-hand and right-hand usage.

The device holder for handheld mobile phones.

Tissue simulating liquid mixed according to the given recipes.

System validation dipoles allowing to validate the proper functioning of the system.



4.2. DASY5 E-field Probe System

The SAR measurements were conducted with the dosimetric probe ES3DV3 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation.

Probe Specification

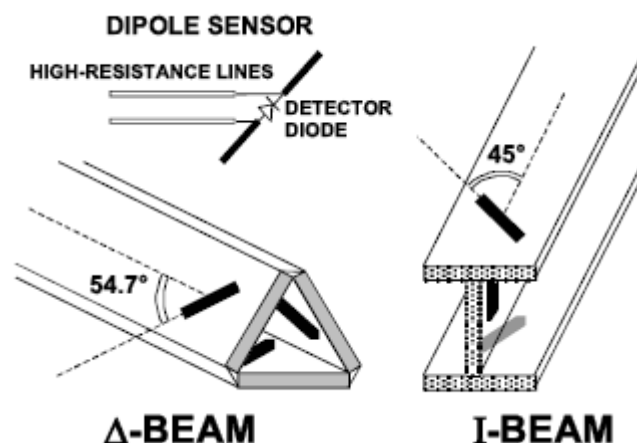
Construction	Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Calibration	ISO/IEC 17025 calibration service available.
Frequency	10 MHz to 4 GHz; Linearity: ± 0.2 dB (30 MHz to 4 GHz)
Directivity	± 0.2 dB in HSL (rotation around probe axis) ± 0.3 dB in tissue material (rotation normal to probe axis)
Dynamic Range	5 $\mu\text{W/g}$ to > 100 mW/g; Linearity: ± 0.2 dB
Dimensions	Overall length: 337 mm (Tip: 20 mm) Tip diameter: 3.9 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.0 mm
Application	General dosimetry up to 4 GHz Dosimetry in strong gradient fields Compliance tests of mobile phones
Compatibility	DASY3, DASY4, DASY52 SAR and higher, EASY4/MRI



Isotropic E-Field Probe

The isotropic E-Field probe has been fully calibrated and assessed for isotropicity, and boundary effect within a controlled environment. Depending on the frequency for which the probe is calibrated the method utilized for calibration will change.

The E-Field probe utilizes a triangular sensor arrangement as detailed in the diagram below:



4.3. Phantoms Description

SAM Twin Phantom

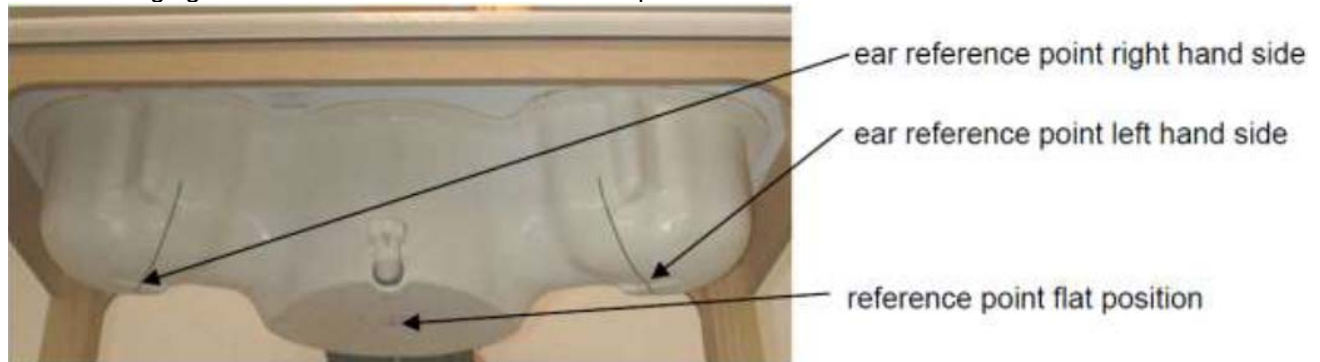
The phantom used for all tests i.e. for both system checks and device testing, was the twin-headed "SAM Phantom", manufactured by SPEAG. The SAM twin phantom is a fiberglass shell phantom with 2mm shell thickness (except the ear region, where shell thickness increases to 6mm).

System checking was performed using the flat section, whilst Head SAR tests used the left and right head profile sections. Body SAR testing also used the flat section between the head profiles.

Shell Thickness	2mm +/- 0.2 mm; The ear region: 6mm	
Filling Volume	Approximately 25 liters	
Dimensions	Major axis:600mm; Minor axis:400mm;	
Measurement Areas	Left hand Right hand Flat phantom	

The bottom plate contains three pairs 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 cover the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. Free space scans of devices on top of this phantom cover are possible. Three reference marks are provided on the phantom counter. These reference marks are used to teach the absolute phantom position relative to the robot.

The following figure shows the definition of reference point:



ELI4 Phantom

Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.

Shell Thickness	2mm +/- 0.2 mm	
Filling Volume	Approximately 30 liters	
Dimensions	Major axis:600mm; Minor axis:400mm;	
Measurement Areas	Flat phantom	

The ELI4 phantom is intended for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30MHz to 6GHz. ELI4 is fully compatible with the latest draft of the standard IEC 62209-2 and all known tissue simulating liquids.

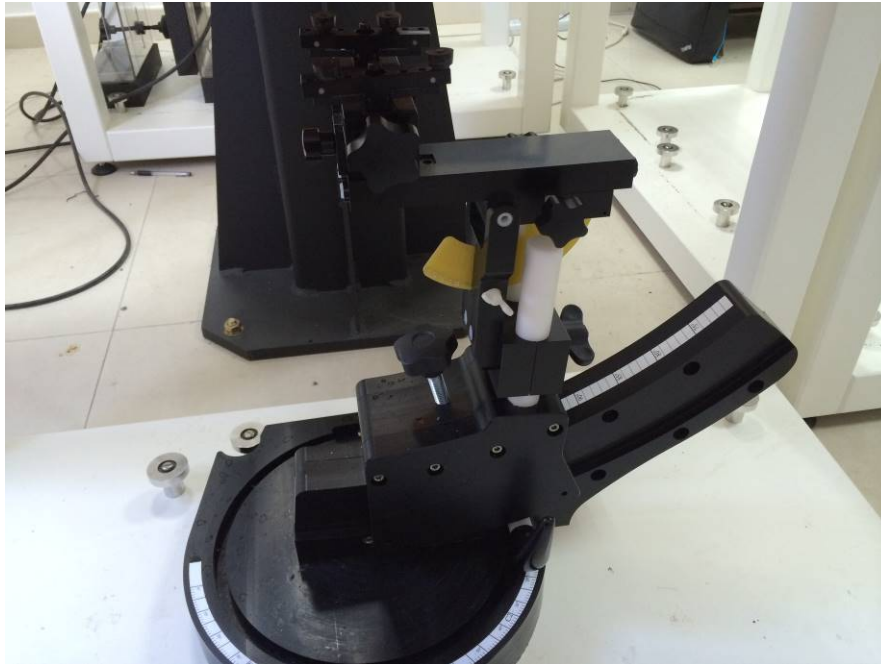
The phantom shell material is resistant to all ingredients used in the tissue-equivalent liquid recipes. The shell of the phantom including ear spacers is constructed from low permittivity and low loss material, with a relative permittivity ≤ 5 and a loss tangent ≤ 0.05 .

4.4. Device Holder

The device was placed in the device holder (illustrated below) that is supplied by SPEAG as an integral part of the DASY system.

The DASY device holder is designed to cope with the different positions given in the standard. It has two scales for device rotation (with respect to the body axis) and device inclination (with respect to the line

between the ear reference points). The rotation centers for both scales is the ear reference point (ERP). Thus the device needs no repositioning when changing the angles.



Device holder supplied by SPEAG

4.5. Scanning Procedure

The DASY5 installation includes predefined files with recommended procedures for measurements and validation. They are read-only document files and destined as fully defined but unmeasured masks. All test positions (head or body-worn) are tested with the same configuration of test steps differing only in the grid definition for the different test positions.

The “reference” and “drift” measurements are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure. The indicated drift is mainly the variation of the DUT’s output power and should vary max. $\pm 5\%$.

The “surface check” measurement tests the optical surface detection system of the DASY5 system by repeatedly detecting the surface with the optical and mechanical surface detector and comparing the results. The output gives the detecting heights of both systems, the difference between the two systems and the standard deviation of the detection repeatability. Air bubbles or refraction in the liquid due to separation of the sugar-water mixture gives poor repeatability (above $\pm 0.1\text{mm}$). To prevent wrong results tests are only executed when the liquid is free of air bubbles. The difference between the optical surface detection and the actual surface depends on the probe and is specified with each probe (It does not depend on the surface reflectivity or the probe angle to the surface within $\pm 30^\circ$.)

Area Scan

The Area Scan is used as a fast scan in two dimensions to find the area of high field values before running a detailed measurement around the hot spot. Before starting the area scan a grid spacing of $15\text{ mm} \times 15\text{ mm}$ is set. During the scan the distance of the probe to the phantom remains unchanged. After finishing area scan, the field maxima within a range of 2 dB will be ascertained.

Zoom Scan

Zoom Scans are used to estimate the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The default Zoom Scan is done by $7 \times 7 \times 7$ points within a cube whose base is centered around the maxima found in the preceding area scan.

Spatial Peak Detection

The procedure for spatial peak SAR evaluation has been implemented and can determine values of masses of 1g and 10g, as well as for user-specific masses. The DASY5 system allows evaluations that combine measured data and robot positions, such as: • maximum search • extrapolation • boundary correction • peak search for averaged SAR. During a maximum search, global and local maxima searches are automatically performed in 2-D after each Area Scan measurement with at least 6 measurement points. It is based on the evaluation of the local SAR gradient calculated by the Quadratic Shepard’s method. The algorithm will find the

global maximum and all local maxima within -2 dB of the global maxima for all SAR distributions.

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. Several measurements at different distances are necessary for the extrapolation. Extrapolation routines require at least 10 measurement points in 3-D space. They are used in the Zoom Scan to obtain SAR values between the lowest measurement points and the inner phantom surface. The routine uses the modified Quadratic Shepard's method for extrapolation. For a grid using 7x7x7 measurement points with 5mm resolution amounting to 343 measurement points, the uncertainty of the extrapolation routines is less than 1% for 1g and 10g cubes.

A Z-axis scan measures the total SAR value at the x-and y-position of the maximum SAR value found during the cube 7x7x7 scan. The probe is moved away in z-direction from the bottom of the SAM phantom in 5mm steps.

4.6. Data Storage and Evaluation

Data Storage

The DASY5 software stores the acquired data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension ".DA4". The 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 incorrect parameter settings. For example, if a measurement has been performed with a wrong crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be re-evaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type ([V/m], [A/m], [°C], [mW/g], [mW/cm²], [dBrel], etc.). Some of these units are not available in certain situations or show meaningless results, e.g., a SAR output in a lossless media will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

Data Evaluation

The SEMCAD software 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	Normi, ai0, ai1, ai2
	- Conversion factor	ConvFi
	- Diode compression point	Dcpi
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 DASY5 components. In the direct measuring mode of the multimeter 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:

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

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:

$$E - \text{fieldprobes} : \quad E_i = \sqrt{\frac{V_i}{\text{Norm}_i \cdot \text{ConvF}}}$$

$$H - \text{fieldprobes} : \quad H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1}f + a_{i2}f^2}{f}$$

With V_i = compensated signal of channel i ($i = x, y, z$)
 Norm_i = sensor sensitivity of channel i ($i = x, y, z$)
 [mV/(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):

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

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

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1'000}$$

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/cm³

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid.

4.7. SAR Measurement System

The SAR measurement system being used is the DASY5 system, the system is controlled remotely from a PC, which contains the software to control the robot and data acquisition equipment. The software also displays the data obtained from test scans.

In operation, the system first does an area (2D) scan at a fixed depth within the liquid from the inside wall of the phantom. When the maximum SAR point has been found, the system will then carry out a 3D scan centred at that point to determine volume averaged SAR level.

4.7.1 Tissue Dielectric Parameters for Head and Body Phantoms

The liquid is consisted of water,salt,Glycol,Sugar,Preventol and Cellulose.The liquid has previously been proven to be suited for worst-case. It's satisfying the latest tissue dielectric parameters requirements proposed by the KDB865664.

Target Frequency	Head		Body	
(MHz)	ϵ_r	σ (S/m)	ϵ_r	σ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800-2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5800	35.3	5.27	48.2	6.00

(ϵ_r = relative permittivity, σ = conductivity and $\rho = 1000 \text{ kg/m}^3$)

4.8. Tissue equivalent liquid properties

Dielectric performance of Head and Body tissue simulating liquid.

Composition of the Head Tissue Equivalent Matter

Mixture %	Frequency 450MHz
Water	38.56
Sugar	56.32
Salt	3.95
Preventol	0.10
Cellulose	1.07
Dielectric Parameters Target Value	$f=450\text{MHz}$ $\epsilon_r=43.5$ $\sigma=0.87$

Composition of the Body Tissue Equivalent Matter

Mixture %	Frequency 450MHz
Water	56.16
Sugar	46.78
Salt	1.49
Preventol	0.10
Cellulose	0.47
Dielectric Parameters Target Value	$f=450\text{MHz}$ $\epsilon_r=56.7$ $\sigma=0.94$

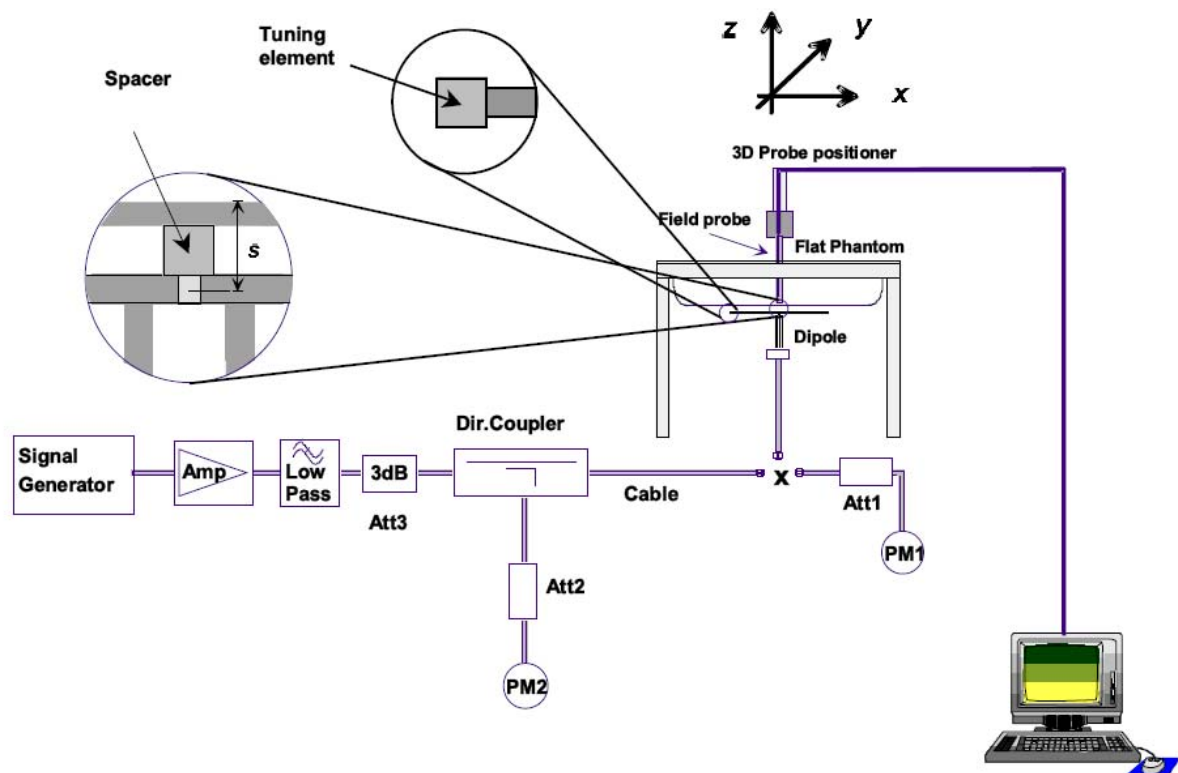
Tissue Type	Measured Frequency (MHz)	Target Tissue		Measured Tissue				Liquid Temp.	Test Data
		ϵ_r	σ	ϵ_r	Dev. %	σ	Dev. %		
450H	450	43.5	0.87	43.33	-0.39%	0.89	2.30%	22 degree	2017/1/14
450B	450	56.7	0.94	56.74	0.07%	0.93	-1.06%	22 degree	2017/1/14

4.9. System Check

The purpose of the system check is to verify that the system operates within its specifications at the device test frequency. The system check is simple check of repeatability to make sure that the system works correctly at the time of the compliance test;

System check results have to be equal or near the values determined during dipole calibration with the relevant liquids and test system ($\pm 10\%$).

System check is performed regularly on all frequency bands where tests are performed with the DASY5 system.



The output power on dipole port must be calibrated to 24 dBm (250mW) before dipole is connected.

Justification for Extended SAR Dipole Calibrations

Referring to KDB 865664D01V01r04, if dipoles are verified in return loss ($< -20\text{dB}$, within 20% of prior calibration), and in impedance (within 5 ohm of prior calibration), the annual calibration is not necessary and the calibration interval can be extended. While calibration intervals not exceed 3 years.

System Check in Head Tissue Simulating Liquid

Freq	Test Date	Dielectric Parameters		Temp	250mW Measured		1W Normalized		1W Target		Limit ($\pm 10\%$ Deviation)	
		ϵ_r	$\sigma(\text{s/m})$		$\text{SAR}_{1\text{g}}$	$\text{SAR}_{10\text{g}}$	$\text{SAR}_{1\text{g}}$	$\text{SAR}_{10\text{g}}$	$\text{SAR}_{1\text{g}}$	$\text{SAR}_{10\text{g}}$	$\text{SAR}_{1\text{g}}$	$\text{SAR}_{10\text{g}}$
450MHz	2017/1/14	43.33	0.89	22	1.25	0.732	5	2.928	4.8	3.19	4.17%	-8.21%

System Check in Body Tissue Simulating Liquid

Freq	Test Date	Dielectric Parameters		Temp	250mW Measured		1W Normalized		1W Target		Limit ($\pm 10\%$ Deviation)	
		ϵ_r	$\sigma(\text{s/m})$		$\text{SAR}_{1\text{g}}$	$\text{SAR}_{10\text{g}}$	$\text{SAR}_{1\text{g}}$	$\text{SAR}_{10\text{g}}$	$\text{SAR}_{1\text{g}}$	$\text{SAR}_{10\text{g}}$	$\text{SAR}_{1\text{g}}$	$\text{SAR}_{10\text{g}}$
450MHz	2017/1/14	56.74	0.93	22	1.11	0.763	4.72	3.172	4.69	3.08	0.64%	2.99%

4.10. SAR measurement procedure**4.10.1 Tests to be performed**

In order to determine the highest value of the peak spatial-average SAR of a handset, all device positions, configurations and operational modes shall be tested for each frequency band according to steps 1 to 3 below. A flowchart of the test process is shown in Picture 11.1.

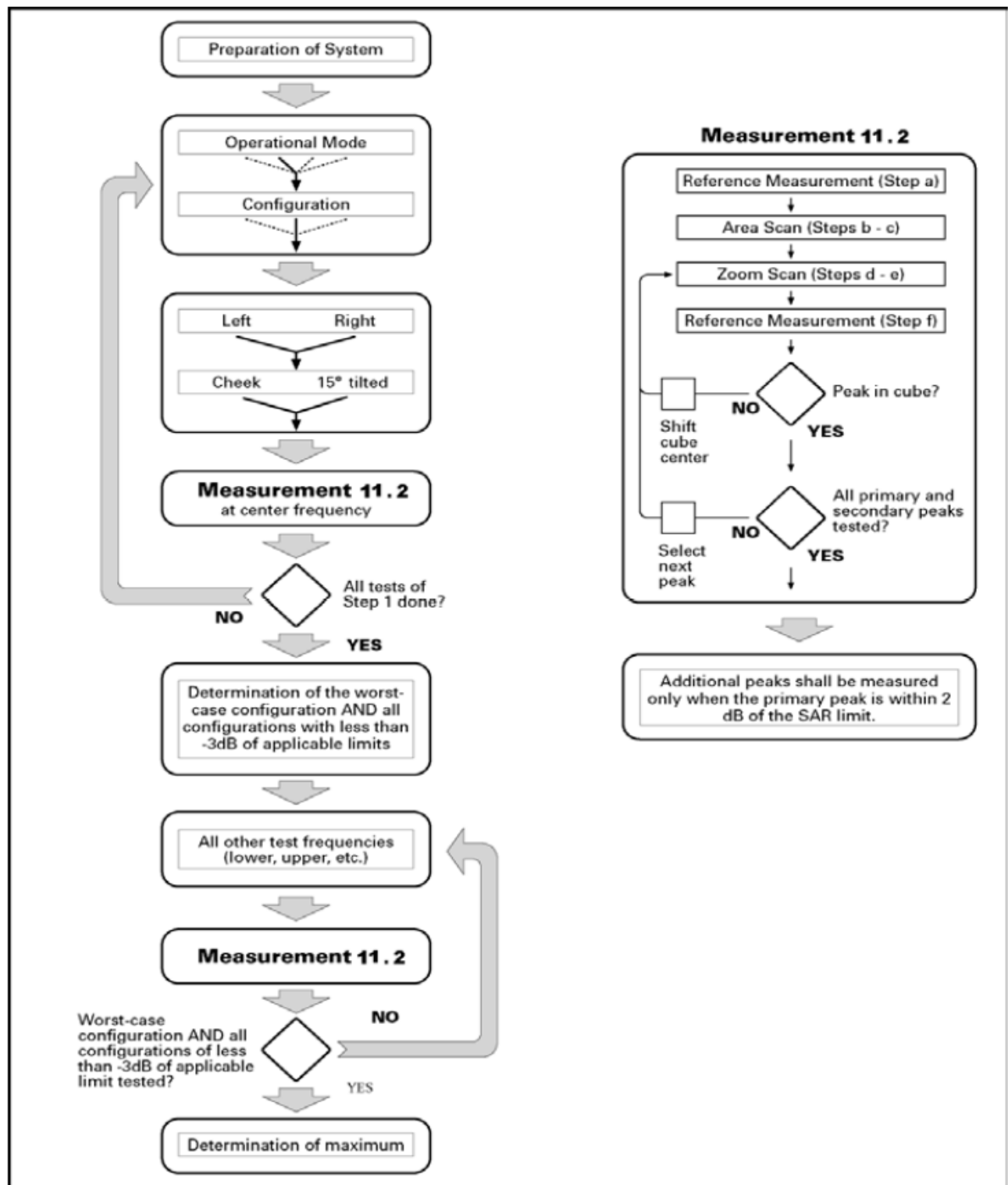
Step 1: The tests described in 11.2 shall be performed at the channel that is closest to the centre of the transmit frequency band (f_c) for:

- all device positions (cheek and tilt, for both left and right sides of the SAM phantom;
- all configurations for each device position in a), e.g., antenna extended and retracted, and
- all operational modes, e.g., analogue and digital, for each device position in a) and configuration in b) in each frequency band.

If more than three frequencies need to be tested according to 11.1 (i.e., $N_c > 3$), then all frequencies, configurations and modes shall be tested for all of the above test conditions.

Step 2: For the condition providing highest peak spatial-average SAR determined in Step 1, perform all tests described in 11.2 at all other test frequencies, i.e., lowest and highest frequencies. In addition, for all other conditions (device position, configuration and operational mode) where the peak spatial-average SAR value determined in Step 1 is within 3 dB of the applicable SAR limit, it is recommended that all other test frequencies shall be tested as well.

Step 3: Examine all data to determine the highest value of the peak spatial-average SAR found in Steps 1 to 2.



Picture 10.1 Block diagram of the tests to be performed

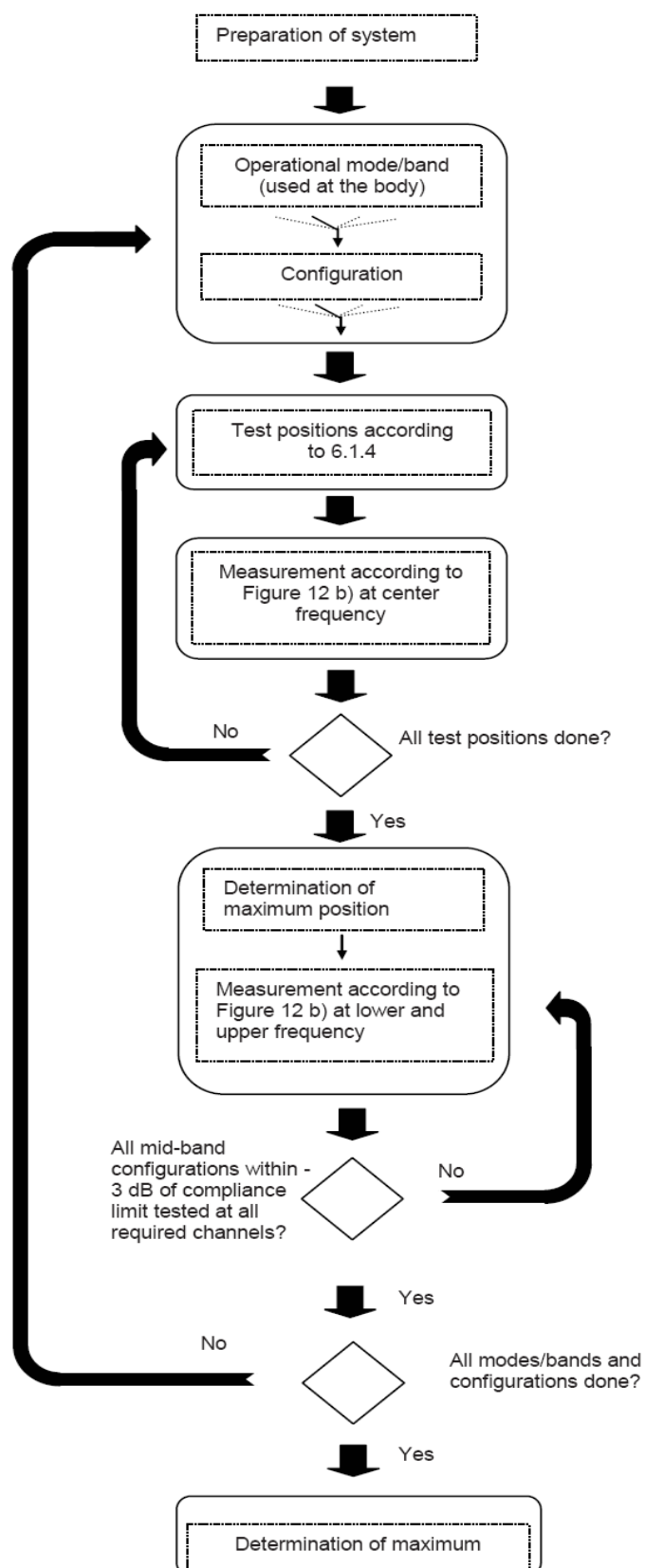


Figure 12a – Tests to be performed

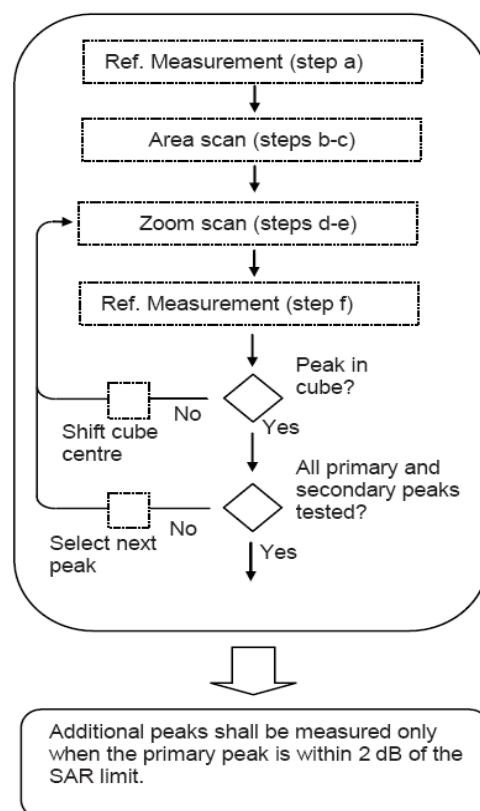


Figure 12b – General procedure

Picture 12 Block diagram of the tests to be performed

Measurement procedure

The following procedure shall be performed for each of the test conditions (see Picture 11) described in 11.1:

- Measure the local SAR at a test point within 8 mm or less in the normal direction from the inner surface of the phantom.
- Measure the two-dimensional SAR distribution within the phantom (area scan procedure). The boundary of the measurement area shall not be closer than 20 mm from the phantom side walls. The distance between the measurement points should enable the detection of the location of local maximum with an

accuracy of better than half the linear dimension of the tissue cube after interpolation. A maximum grip spacing of 20 mm for frequencies below 3 GHz and $(60/f \text{ [GHz]})$ mm for frequencies of 3GHz and greater is recommended. The maximum distance between the geometrical centre of the probe detectors and the inner surface of the phantom shall be 5 mm for frequencies below 3 GHz and $\delta \ln(2)/2$ mm for frequencies of 3 GHz and greater, where δ is the plane wave skin depth and $\ln(x)$ is the natural logarithm. The maximum variation of the sensor-phantom surface shall be ± 1 mm for frequencies below 3 GHz and ± 0.5 mm for frequencies of 3 GHz and greater. At all measurement points the angle of the probe with respect to the line normal to the surface should be less than 5° . If this cannot be achieved for a measurement distance to the phantom inner surface shorter than the probe diameter, additional measurement distance to the phantom inner surface shorter than the probe diameter, additional

- c) From the scanned SAR distribution, identify the position of the maximum SAR value, in addition identify the positions of any local maxima with SAR values within 2 dB of the maximum value that are not within the zoom-scan volume; additional peaks shall be measured only when the primary peak is within 2 dB of the SAR limit. This is consistent with the 2 dB threshold already stated;
- d) Measure the three-dimensional SAR distribution at the local maxima locations identified in step
- e) The horizontal grid step shall be $(24 / f[\text{GHz}])$ mm or less but not more than 8 mm. The minimum zoom size of 30 mm by 30 mm and 30 mm for frequencies below 3 GHz. For higher frequencies, the minimum zoom size of 22 mm by 22 mm and 22 mm. The grip step in the vertical direction shall be $(8-f[\text{GHz}])$ mm or less but not more than 5 mm, if uniform spacing is used. If variable spacing is used in the vertical direction, the maximum spacing between the two closest measured points to the phantom shell shall be $(12 / f[\text{GHz}])$ mm or less but not more than 4 mm, and the spacing between father points shall increase by an incremental factor not exceeding 1.5. When variable spacing is used, extrapolation routines shall be tested with the same spacing as used in measurements. The maximum distance between the geometrical centre of the probe detectors and the inner surface of the phantom shall be 5 mm for frequencies below 3 GHz and $\delta \ln(2)/2$ mm for frequencies of 3 GHz and greater, where δ is the plane wave skin depth and $\ln(x)$ is the natural logarithm. Separate grids shall be centered on each of the local SAR maxima found in step c). Uncertainties due to field distortion between the media boundary and the dielectric enclosure of the probe should also be minimized, which is achieved is the distance between the phantom surface and physical tip of the probe is larger than probe tip diameter. Other methods may utilize correction procedures for these boundary effects that enable high precision measurements closer than half the probe diameter. For all measurement points, the angle of the probe with respect to the flat phantom surface shall be less than 5° . If this cannot be achieved an additional uncertainty evaluation is needed.
- f) Use post processing(e.g. interpolation and extrapolation) procedures to determine the local SAR values at the spatial resolution needed for mass averaging.

Measurement procedure

The following procedure shall be performed for each of the test conditions (see Picture 11) described in 11.1:

- g) Measure the local SAR at a test point within 8 mm or less in the normal direction from the inner surface of the phantom.
- h) Measure the two-dimensional SAR distribution within the phantom (area scan procedure). The boundary of the measurement area shall not be closer than 20 mm from the phantom side walls. The distance between the measurement points should enable the detection of the location of local maximum with an accuracy of better than half the linear dimension of the tissue cube after interpolation. A maximum grip spacing of 20 mm for frequencies below 3 GHz and $(60/f \text{ [GHz]})$ mm for frequencies of 3GHz and greater is recommended. The maximum distance between the geometrical centre of the probe detectors and the inner surface of the phantom shall be 5 mm for frequencies below 3 GHz and $\delta \ln(2)/2$ mm for frequencies of 3 GHz and greater, where δ is the plane wave skin depth and $\ln(x)$ is the natural logarithm. The maximum variation of the sensor-phantom surface shall be ± 1 mm for frequencies below 3 GHz and ± 0.5 mm for frequencies of 3 GHz and greater. At all measurement points the angle of the probe with respect to the line normal to the surface should be less than 5° . If this cannot be achieved for a measurement distance to the phantom inner surface shorter than the probe diameter, additional measurement distance to the phantom inner surface shorter than the probe diameter, additional
- i) From the scanned SAR distribution, identify the position of the maximum SAR value, in addition identify the positions of any local maxima with SAR values within 2 dB of the maximum value that are not within the zoom-scan volume; additional peaks shall be measured only when the primary peak is within 2 dB of the SAR limit. This is consistent with the 2 dB threshold already stated;
- j) Measure the three-dimensional SAR distribution at the local maxima locations identified in step
- k) The horizontal grid step shall be $(24 / f[\text{GHz}])$ mm or less but not more than 8 mm. The minimum zoom size of 30 mm by 30 mm and 30 mm for frequencies below 3 GHz. For higher frequencies, the minimum zoom size of 22 mm by 22 mm and 22 mm. The grip step in the vertical direction shall be $(8-f[\text{GHz}])$ mm or less but not more than 5 mm, if uniform spacing is used. If variable spacing is used in the vertical direction, the maximum spacing between the two closest measured points to the phantom shell shall be $(12 / f[\text{GHz}])$ mm or less but not more than 4 mm, and the spacing between father points shall increase by an incremental factor not exceeding 1.5. When variable spacing is used, extrapolation routines shall be tested with the same spacing as used in measurements. The maximum distance between the geometrical

centre of the probe detectors and the inner surface of the phantom shall be 5 mm for frequencies below 3 GHz and $\delta \ln(2)/2$ mm for frequencies of 3 GHz and greater, where δ is the plane wave skin depth and $\ln(x)$ is the natural logarithm. Separate grids shall be centered on each of the local SAR maxima found in step c). Uncertainties due to field distortion between the media boundary and the dielectric enclosure of the probe should also be minimized, which is achieved is the distance between the phantom surface and physical tip of the probe is larger than probe tip diameter. Other methods may utilize correction procedures for these boundary effects that enable high precision measurements closer than half the probe diameter. For all measurement points, the angle of the probe with respect to the flat phantom surface shall be less than 5°. If this cannot be achieved an additional uncertainty evaluation is needed.

- l) Use post processing(e.g. interpolation and extrapolation) procedures to determine the local SAR values at the spatial resolution needed for mass averaging.

4.10.2 General Measurement Procedure

The area and zoom scan resolutions specified in the table below must be applied to the SAR measurements and fully documented in SAR reports to qualify for TCB approval. Probe boundary effect error compensation is required for measurements with the probe tip closer than half a probe tip diameter to the phantom surface. Both the probe tip diameter and sensor offset distance must satisfy measurement protocols; to ensure probe boundary effect errors are minimized and the higher fields closest to the phantom surface can be correctly measured and extrapolated to the phantom surface for computing 1-g SAR. Tolerances of the post-processing algorithms must be verified by the test laboratory for the scan resolutions used in the SAR measurements, according to the reference distribution functions specified in IEEE Std 1528-2003. The results should be documented as part of the system validation records and may be requested to support test results when all the measurement parameters in the following table are not satisfied.

			≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface			5 mm ±1 mm	$\frac{1}{2} \cdot \delta \cdot \ln(2)$ mm ± 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.	
Maximum zoom scan spatial resolution: Δx _{Zoom} , Δy _{Zoom}			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: Δz _{Zoom} (n)		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	Δ z _{Zoom} (1): between 1 st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		Δ z _{Zoom} (n>1): between subsequent points	≤ 1.5· Δ z _{Zoom} (n-1) mm	
Minimum zoom scan volume	x, y, z		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm
Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see IEEE Std 1528-2013 for details.				
* When zoom scan is required and the reported SAR from the area scan based 1-g SAR estimation procedures of KDB Publication 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.				

4.10.3 Power Drift

To control the output power stability during the SAR test, DASY5 system calculates the power drift by measuring the E-field at the same location at the beginning and at the end of the measurement for each test position. These drift values can be found in Table 14.1 to Table 14.11 labeled as: (Power Drift [dB]). This ensures that the power drift during one measurement is within 5%.

5. TEST CONDITIONS AND RESULTS

5.1. Conducted Power Results

According KDB 447498 D01 General RF Exposure Guidance v06 Section 4.1 2) states that “Unless it is specified differently in the published RF exposure KDB procedures, these requirements also apply to test reduction and test exclusion considerations. Time-averaged maximum conducted output power applies to SAR and, as required by § 2.1091(c), time-averaged ERP applies to MPE. When an antenna port is not available on the device to support conducted power measurement, such as FRS and certain Part 15 transmitters with built-in integral antennas, the maximum output power allowed for production units should be used to determine RF exposure test exclusion and compliance.”

Table 4

Mode/ Modulation Type	Channel	Frequency (MHz)	Conducted Average Power (dBm)
FRS/FM	8	467.5625	25.37
	11	467.6375	25.25
	14	467.7125	25.24
GMRS/FM	15	462.55	30.77
	4	462.6375	30.62
	22	462.7250	30.66

<Bluetooth Conducted Power>

Table 5

Mode	Channel	Frequency (MHz)	Conducted Average Power (dBm)
GFSK	0	2402	-1.43
	39	2441	-1.69
	78	2480	-3.77
$\pi/4$ DQPSK	0	2402	-2.78
	39	2441	-2.84
	78	2480	-6.12
8DPSK	0	2402	-2.80
	39	2441	-2.96
	78	2480	-6.04

Manufacturing tolerance

GMRS (Average)			
Test Frequency(MHz)	462.55	462.6375	462.7250
Target (dBm)	24.5	24.5	24.5
Tolerance $\pm$ (dB)	± 1.0	± 1.0	± 1.0
FRS (Average)			
Test Frequency(MHz)	467.5625	467.6375	467.7125
Target (dBm)	30.0	30.0	30.0
Tolerance $\pm$ (dB)	± 1.0	± 1.0	± 1.0

Bluetooth

GFSK (Average)			
Frequency (MHz)	2402	2441	2480
Target (dBm)	-1.0	-1.0	-3.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
$\pi/4$ DQPSK (Average)			
Frequency (MHz)	2402	2441	2480
Target (dBm)	-2.0	-2.0	-6.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0
8DPSK (Average)			
Frequency (MHz)	2402	2441	2480
Target (dBm)	-2.0	-2.0	-6.0
Tolerance $\pm$ (dB)	1.0	1.0	1.0

5.2. Test reduction procedure

The calculated 1-g and 10-g average SAR results indicated as “Max Calc. SAR1-g” and “Max Calc. SAR10-g” in the data Tables is scaling the measured SAR to account for power levelling variations and power slump. For this device the “Max Calc. 1g-SAR” and “Max Calc.10g-SAR” are scaled using the following formula:

$$\text{Max_Calc} = \text{SAR_Adju} \cdot \text{DC} \cdot (\text{P_max} / \text{P_cond})$$

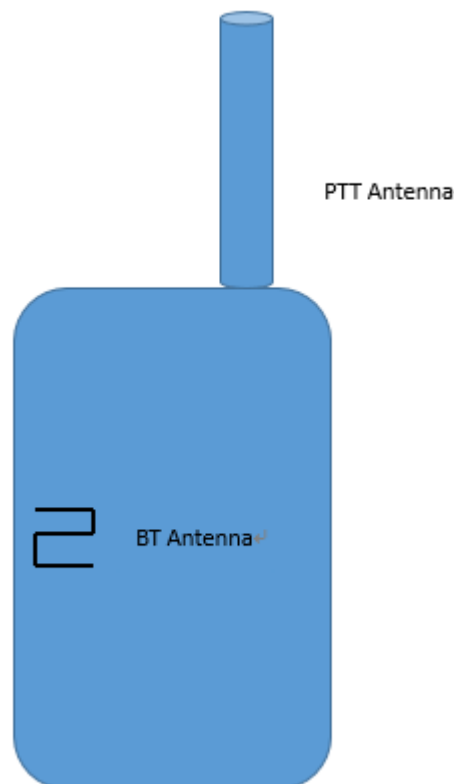
P_max = highest power including turn up tolerance (W)

P_cond_high = highest power in conduct measured (W)

DC = Transmission mode Duty Cycle in % where applicable 50% duty cycle is applied for PTT operation

SAR_adju = Adjust 1-g and 10-g Average SAR from measured SAR (W/kg)

5.3. Transmit Antennas Position



5.4. Standalone SAR Test Exclusion Considerations

Per KDB447498 for standalone 1-g head or body SAR evaluation by measurement or numerical simulation is not required when the corresponding SAR Exclusion Threshold condition, listed below, is satisfied.

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0 \text{ for 1-g SAR and } \leq 7.5 \text{ for 10-g extremity SAR, where}$$

- 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
- 3.0 and 7.5 are referred to as the numeric thresholds in the step 2 below

Per KDB447498 for PTT device, the operating configurations of handheld PTT two-way radios generally require SAR testing for in-front-of the face and body-worn accessory exposure conditions. A duty factor of 50% should be applied to determine compliance for radios with maximum operating duty factors $\leq 50\%$. When a body-worn accessory is not supplied with the PTT radio, a test separation distance ≤ 10 mm, applicable to the device form factor, must be applied to determine body-worn accessory SAR test exclusion. A test separation distance of 25 mm must be applied for in-front-of the face SAR test exclusion and SAR measurements.

Standalone SAR test exclusion considerations								
Modulation /Type	Frequency (MHz)	Configuration	Maximum Average Power* (dBm)	Separation Distance (mm)	Duty Cycle	Calculation Result	SAR Exclusion Thresholds	Standalone SAR Exclusion
FM/GMRS	462.5	Face-held	31.00	25	50%	17.1	3.0	no
		Body-worn	31.00	5	50%	85.6	3.0	no
FM/FRS	467.5	Face-held	25.50	25	50%	4.9	3.0	no
		Body-worn	25.50	5	50%	24.3	3.0	no
Bluetooth	2450	Face-held	0.00	25	100%	0.1	3.0	yes
		Body-worn	0.00	5	100%	0.3	3.0	yes

Remark:

1. Maximum average power including tune-up tolerance;
2. Maximum average power = maximum average power * Duty cycle;
3. A distance of 5mm is applied to determine Body-worn SAR exclusion;
4. PTT device apply duty cycle 50% to determine SAR exclusion;
5. Bluetooth duty refer to 100% (not 77.01%) controlled by software;

5.5. Standalone Estimated SAR

Per KDB447498 requires when the standalone SAR test exclusion of section 4.3.1 is applied to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to the following 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.
- 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distances is > 50 mm

Per FCC KD B447498 D01, simultaneous transmission SAR test exclusion may be applied when the sum of the 1-g SAR for the entire transmitting antenna in a specific a physical test configuration is ≤1.6 W/Kg. When the sum is greater than the SAR limit, AR test exclusion is determined by the SAR to peak location separation ratio.

$$\text{Ratio} = \frac{(\text{SAR}_1 + \text{SAR}_2)^{1.5}}{(\text{peak location separation, mm})} < 0.04$$

Estimated Standalone SAR

Estimated stand alone SAR					
Communication system	Frequency (MHz)	Configuration	Maximum Power (dBm)	Separation Distance (mm)	Estimated SAR _{1-g} (W/kg)
Bluetooth	2450	Face-held	0.00	25.0	0.008
		Body-worn	0.00	5.00	0.042

Remark:

1. Maximum average power including tune-up tolerance;
2. A distance of 5mm and 25mm are applied to determine Body-worn and Face-held SAR estimated;

5.6. SAR Measurement Results

5.6.1.1 PMR Assessment at the Face-held for 462.55 – 462.725 MHz Band and 467.5625 – 467.7125 MHz Band

3*1.2V AAA Battery was selected as the default battery for assessment at the Head and Body because it is only battery (refer to external photos for battery illustration). The default battery was used during conducted power measurements for all test channels in listed in Table 4. The channel with the highest conducted power (or middle channel) will be identified as the default channel per KDB 447498. SAR plots of the highest results are presented in SAR measurement results according to KDB 865664D02;

Table 6

Test Frequency		Mode	P_cond_high (W)	Carry Access.	Audio Access.	Spacing (mm)	SAR_meas. (mW/g)	Power Drift (dB)
Channel	MHz							
8	467.5625	FRS	0.344	A1, B1, BC1	n/a	25	0.307	-0.20
11	467.6375		0.335	A1, B1, BC1	n/a	25	0.315	-0.11
14	467.7125		0.334	A1, B1, BC1	n/a	25	0.309	-0.15
15	462.55	GMRS	1.194	A1, B1, BC1	n/a	25	0.964	-0.12
4	462.6375		1.153	A1, B1, BC1	n/a	25	0.987	-0.19
22	462.7250		1.164	A1, B1, BC1	n/a	25	0.973	-0.19

Antenna Distance (mm)

Antenna Type	Separation Distance (mm)		
	@ front surface of the EUT	@ antenna's base	@ antenna's tip
A1	25.0	28.2	30.7

Face-held SAR Test Considerations Note:

- Passive body-worn and audio accessories generally do not apply to the head SAR of PTT radios. Head SAR is measured with the front surface of the radio positioned at 2.5 cm parallel to a flat phantom. A phantom shell thickness of 2 mm is required. When the front of the radio has a contour or non-uniform surface with a variation of 1.0 cm or more, the average distance of such variations is used to establish the 2.5 cm test separation from the phantom.
- Testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:
 - ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
 - ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
 - ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz
- Measured SAR based on 100% duty cycle, while PTT device use 50% duty cycle

5.6.1 PMR Assessment at the Body for 462.55 – 462.725 MHz Band and 467.5625 – 467.7125 MHz Band with B1 and BC1**Table 7**

Test Frequency		Mode	P_cond_high (W)	Carry Accessory	Audio Accessory	Bottom Surface Distance (mm)	SAR_meas. (mW/g)	Power Drift (dB)
Channel	MHz							
8	467.5625	FRS	0.344	A1, B1, BC1	n/a	0	0.349	-0.18
11	467.6375	FRS	0.335	A1, B1, BC1	n/a	0	0.363	-0.11
14	467.7125	FRS	0.334	A1, B1, BC1	n/a	0	0.341	-0.18
15	462.55	GMRS	1.194	A1, B1, BC1	n/a	0	0.992	-0.16
4	462.6375	GMRS	1.153	A1, B1, BC1	n/a	0	1.030	-0.18
22	462.7250	GMRS	1.164	A1, B1, BC1	n/a	0	0.986	-0.19

Antenna Distance (mm)

Antenna Type	Separation Distance (mm)		
	@ front surface of the EUT	@ antenna's base	@ antenna's tip
A1	4.2	7.8	7.1

Body SAR Test Considerations Note:

- Body SAR is measured with the radio placed in a body-worn accessory, positioned against a flat phantom, representative of the normal operating conditions expected by users and typically with a standard default audio accessory supplied with the radio. Since audio accessories, including any default audio accessories supplied with a radio, may be designed to operate with a subset of the combinations of antennas, batteries and body-worn accessories, when a default audio accessory does not fully support all the test configurations required in this section for body-worn accessories testing an alternative audio accessory must be selected to be the default audio accessory for body-worn accessories testing. If an alternative audio accessory cannot be identified, body-worn accessories should be tested without any audio accessory. In general, all sides of the radio that may be positioned facing the user when using a body-worn accessory must be considered for SAR compliance.
- Testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:
 - ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
 - ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
 - ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz

3. Measured SAR based on 100% duty cycle, while PTT device use at 50% duty cycle.
4. Operation at body without an audio accessory attached is possible by means of BT accessories.

5.7. SAR Reporting Results

These are not actual measurement SAR values, measurement SAR values taken from Section 5.6 SAR Measurement Results; we also take Section 5.2 formula to calculate maximum report SAR in 50% duty cycle.

$$\text{Max_Calc} = \text{SAR_Adju} * \text{DC} * (\text{P_max} / \text{P_cond})$$

P_max = highest power including turn up tolerance (W)

P_cond_high = highest power in conduct measured (W)

DC = Transmission mode Duty Cycle in % where applicable 50% or 100% duty cycle is applied for PTT operation

SAR_adju = Adjust 1-g and 10-g Average SAR from measured SAR (W/kg)

5.7.1 Standalone

5.7.1.1 PMR Assessment at the Face-held for 462.55 – 462.725 MHz Band and 467.5625 – 467.7125 MHz Band

Table 8

Test Frequency		Mode	P_cond_high (W)	P_max	Carry Access.	Audio Access.	Spacing (mm)	SAR_mea. (mW/g)	Power Drift (dB)	Scaling Factor	Max Calc. SAR _{1-g} (mW/g)	Plot
Channel	MHz											
8	467.5625	FRS	0.344	0.355	A1, B1, BC1	n/a	25	0.307	-0.20	1.073	0.165	2
11	467.6375	FRS	0.335	0.355			25	0.315	-0.11	1.075	0.169	
14	467.7125	FRS	0.334	0.355			25	0.309	-0.15	1.074	0.166	
15	462.55	GMRS	1.194	1.259	A1, B1, BC1	n/a	25	0.964	-0.12	1.249	0.602	1
4	462.6375	GMRS	1.153	1.259			25	0.987	-0.19	1.255	0.619	
22	462.7250	GMRS	1.164	1.259			25	0.973	-0.19	1.251	0.609	

Antenna Distance (mm)

Antenna Type	Separation Distance (mm)		
	@ front surface of the EUT	@ antenna's base	@ antenna's tip
A1	25.0	28.2	30.7

Face-held SAR Test Considerations Note:

1. Passive body-worn and audio accessories generally do not apply to the head SAR of PTT radios. Head SAR is measured with the front surface of the radio positioned at 2.5 cm parallel to a flat phantom. A phantom shell thickness of 2 mm is required. When the front of the radio has a contour or non-uniform surface with a variation of 1.0 cm or more, the average distance of such variations is used to establish the 2.5 cm test separation from the phantom.
2. Testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:
 - a. ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
 - b. ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
 - c. ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz
3. Measured SAR based on 100% duty cycle, while PTT device use at 50% duty cycle.

5.7.2 PMR Assessment at the Body for 462.55 – 462.725 MHz Band and 467.5625 – 467.7125 MHz Band with B1 and BC1

Table 9

Test Frequency		Mode	P_cond_high (W)	P_max	Carry Access.	Audio Access.	Bottom Surface Distance (mm)	SAR_mea. (mW/g)	Power Drift (dB)	Scaling Factor	Max Calc. SAR _{1-g} (mW/g)	Plot
Channel	MHz											
8	467.5625	FRS	0.344	0.355	A1, B1, BC1	n/a	0	0.349	-0.18	1.073	0.189	4
11	467.6375	FRS	0.335	0.355			0	0.363	-0.11	1.075	0.197	
14	467.7125	FRS	0.334	0.355			0	0.341	-0.18	1.074	0.184	
15	462.55	GMRS	1.194	1.259	A1, B1, BC1	n/a	0	0.992	-0.16	1.249	0.623	3
4	462.6375	GMRS	1.153	1.259			0	1.030	-0.18	1.255	0.653	
22	462.7250	GMRS	1.164	1.259			0	0.986	-0.19	1.251	0.619	

Antenna Distance (mm)

Antenna Type	Separation Distance (mm)		
	@ front surface of the EUT	@ antenna's base	@ antenna's tip
A1	4.2	7.8	7.1

Body SAR Test Considerations Note:

1. Body SAR is measured with the radio placed in a body-worn accessory, positioned against a flat phantom, representative of the normal operating conditions expected by users and typically with a standard default audio accessory supplied with the radio. Since audio accessories, including any default audio accessories supplied with a radio, may be designed to operate with a subset of the combinations of antennas, batteries and body-worn accessories, when a default audio accessory does not fully support all the test configurations required in this section for body-worn accessories testing an alternative audio accessory must be selected to be the default audio accessory for body-worn accessories testing. If an alternative audio accessory cannot be identified, body-worn accessories should be tested without any audio accessory. In general, all sides of the radio that may be positioned facing the user when using a body-worn accessory must be considered for SAR compliance.
2. Measured SAR based on 100% duty cycle, while PTT device use at 50% duty cycle.
3. Operation at body without an audio accessory attached is possible by means of BT accessories.
4. Testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:
 - a. ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
 - b. ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
 - c. ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz

5.7.2 Simultaneous SAR Considerations**5.7.2.1 Introduction**

Simultaneous transmission SAR test exclusion is determined for each operating configuration and exposure condition according to the reported standalone SAR of each applicable simultaneously transmitting antenna. For the DUT, the BT and PMR modules sharing difference modular and difference antenna, can simultaneous transmit, need consider simultaneous.

Application Simultaneous Transmission information:

Air-Interface	Band (MHz)	Type	Simultaneous Transmissions	Voice over Digital Transport(Data)
PMR	GMRS 462.5	VO	Yes, BT	N/A
	FRS 467.5	VO		
BT	2450	DT	Yes, PMR	N/A

Note: VO-Voice Service only; DT-Digital Transport

5.7.2.2 Evaluation of Simultaneous SAR

The following tables list information which is relevant for the decision if a simultaneous transmit evaluation is necessary according to FCC KDB 447498D01 General RF Exposure Guidance v06.

Face-held Exposure Conditions

reported SAR WWAN and BT, Σ SAR evaluation, SPLSRi						
Frequency band	Position	SAR _{1-gmax} /W/kg		Σ SAR <1.6W/Kg	Distance Ri, mm	Ratio ≤ 0.040
		PMR	BT			
FRS 467	Face-held	0.169	0.008	0.177		
GMRS 462	Face-held	0.619	0.008	0.627		

Body-worn Exposure Conditions

reported SAR WWAN and BT, Σ SAR evaluation, SPLSRi						
Frequency band	Position	SAR _{1-gmax} /W/kg		Σ SAR <1.6W/Kg	Distance Ri, mm	Ratio ≤ 0.040
		PMR	BT			
FRS 467	Face-held	0.197	0.042	0.239		
GMRS 462	Face-held	0.653	0.042	0.695		

Remark:

1. The value with block color is the maximum values of standalone
2. The value with blue color is the maximum values of Σ SAR_{1-g}

5.8. SAR Measurement Variability

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. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. The following procedures are applied to determine if repeated measurements are required.

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

Thus the following procedures are applied to determine if repeated measurements are required for occupational exposure.

- 1) Repeated measurement is not required when the original highest measured SAR is < 4.00 W/kg; steps 6) through 8) do not apply.
- 2) When the original highest measured SAR is ≥ 4.00 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 > 6.00 or when the original or repeated measurement is ≥ 7.25 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 ≥ 7.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

Frequency (MHz)	Air Interface	RF Exposure Configuration	Test Position	Repeated SAR (yes/no)	Highest SAR _{1-g} (W/Kg)	First Repeated	
						SAR _{1-g} (W/Kg)	Largest to Smallest SAR Ratio
467.50	FRS	Standalone	Body-worn	no	0.182*	no	no
462.50	GMRS	Standalone	Body-worn	no	0.515	no	no

Remark:

1. Highest measurement SAR = highest measurement SAR (100% duty cycle)*Duty cycle;

5.9. Measurement Uncertainty(300MHz-3GHz)

According to IEC62209-1:2016/IEEE 1528:2013										
No.	Error Description	Type	Uncertainty Value	Probably Distribution	Div.	(Ci) 1g	(Ci) 10g	Std. Unc. (1g)	Std. Unc. (10g)	Degree of freedom
Measurement System										
1	Probe calibration	B	5.50%	N	1	1	1	5.50%	5.50%	∞
2	Axial isotropy	B	4.70%	R	$\sqrt{3}$	0.7	0.7	1.90%	1.90%	∞
3	Hemispherical isotropy	B	9.60%	R	$\sqrt{3}$	0.7	0.7	3.90%	3.90%	∞
4	Boundary Effects	B	1.00%	R	$\sqrt{3}$	1	1	0.60%	0.60%	∞
5	Probe Linearity	B	4.70%	R	$\sqrt{3}$	1	1	2.70%	2.70%	∞
6	Detection limit	B	1.00%	R	$\sqrt{3}$	1	1	0.60%	0.60%	∞
7	RF ambient conditions-noise	B	0.00%	R	$\sqrt{3}$	1	1	0.00%	0.00%	∞
8	RF ambient conditions-reflection	B	0.00%	R	$\sqrt{3}$	1	1	0.00%	0.00%	∞
9	Response time	B	0.80%	R	$\sqrt{3}$	1	1	0.50%	0.50%	∞
10	Integration time	B	5.00%	R	$\sqrt{3}$	1	1	2.90%	2.90%	∞
11	RF ambient	B	3.00%	R	$\sqrt{3}$	1	1	1.70%	1.70%	∞
12	Probe positioned mech. restrictions	B	0.40%	R	$\sqrt{3}$	1	1	0.20%	0.20%	∞
13	Probe positioning with respect to phantom shell	B	2.90%	R	$\sqrt{3}$	1	1	1.70%	1.70%	∞
14	Max.SAR evaluation	B	3.90%	R	$\sqrt{3}$	1	1	2.30%	2.30%	∞
Test Sample Related										
15	Test sample positioning	A	1.86%	N	1	1	1	1.86%	1.86%	∞
16	Device holder uncertainty	A	1.70%	N	1	1	1	1.70%	1.70%	∞
17	Drift of output power	B	5.00%	R	$\sqrt{3}$	1	1	2.90%	2.90%	∞
Phantom and Set-up										
18	Phantom uncertainty	B	4.00%	R	$\sqrt{3}$	1	1	2.30%	2.30%	∞
19	Liquid conductivity (target)	B	5.00%	R	$\sqrt{3}$	0.64	0.43	1.80%	1.20%	∞
20	Liquid conductivity (meas.)	A	0.50%	N	1	0.64	0.43	0.32%	0.26%	∞
21	Liquid permittivity (target)	B	5.00%	R	$\sqrt{3}$	0.64	0.43	1.80%	1.20%	∞
22	Liquid cpermittivity (meas.)	A	0.16%	N	1	0.64	0.43	0.10%	0.07%	∞

Combined standard uncertainty	$u_c = \sqrt{\sum_{i=1}^{22} c_i^2 u_i^2}$	/	/	/	/	/	10.20%	10.00%	∞
Expanded uncertainty (confidence interval of 95 %)	$u_e = 2u_c$	/	R	K=2	/	/	20.40%	20.00%	∞

According to IEC62209-2/2010										
No.	Error Description	Type	Uncertainty Value	Probably Distribution	Div.	(Ci) 1g	(Ci) 10g	Std. Unc. (1g)	Std. Unc. (10g)	Degree of freedom
Measurement System										
1	Probe calibration	B	6.20%	N	1	1	1	6.20%	6.20%	∞
2	Axial isotropy	B	4.70%	R	$\sqrt{3}$	0.7	0.7	1.90%	1.90%	∞
3	Hemispherical isotropy	B	9.60%	R	$\sqrt{3}$	0.7	0.7	3.90%	3.90%	∞
4	Boundary Effects	B	2.00%	R	$\sqrt{3}$	1	1	1.20%	1.20%	∞
5	Probe Linearity	B	4.70%	R	$\sqrt{3}$	1	1	2.70%	2.70%	∞
6	Detection limit	B	1.00%	R	$\sqrt{3}$	1	1	0.60%	0.60%	∞
7	RF ambient conditions-noise	B	0.00%	R	$\sqrt{3}$	1	1	0.00%	0.00%	∞
8	RF ambient conditions-reflection	B	0.00%	R	$\sqrt{3}$	1	1	0.00%	0.00%	∞
9	Response time	B	0.80%	R	$\sqrt{3}$	1	1	0.50%	0.50%	∞
10	Integration time	B	5.00%	R	$\sqrt{3}$	1	1	2.90%	2.90%	∞
11	RF Ambient	B	3.00%	R	$\sqrt{3}$	1	1	1.70%	1.70%	∞
12	Probe positioned mech. restrictions	B	0.80%	R	$\sqrt{3}$	1	1	0.50%	0.50%	∞
13	Probe positioning with respect to phantom shell	B	6.70%	R	$\sqrt{3}$	1	1	3.90%	3.90%	∞
14	Max.SAR Evalation	B	3.90%	R	$\sqrt{3}$	1	1	2.30%	2.30%	∞
15	Modulation Response	B	2.40%	R	$\sqrt{3}$	1	1	1.40%	1.40%	∞
Test Sample Related										
16	Test sample positioning	A	1.86%	N	1	1	1	1.86%	1.86%	∞
17	Device holder uncertainty	A	1.70%	N	1	1	1	1.70%	1.70%	∞
18	Drift of output power	B	5.00%	R	$\sqrt{3}$	1	1	2.90%	2.90%	∞
Phantom and Set-up										
19	Phantom uncertainty	B	6.10%	R	$\sqrt{3}$	1	1	3.50%	3.50%	∞
20	SAR correction	B	1.90%	R	$\sqrt{3}$	1	0.84	1.11%	0.90%	∞

21	Liquid conductivity (target)	B	5.00%	R	$\sqrt{3}$	0.64	0.43	1.80%	1.20%	∞
22	Liquid conductivity (meas.)	A	0.50%	N	1	0.64	0.43	0.32%	0.26%	∞
23	Liquid permittivity (target)	B	5.00%	R	$\sqrt{3}$	0.64	0.43	1.80%	1.20%	∞
24	Liquid permittivity (meas.)	A	0.16%	N	1	0.64	0.43	0.10%	0.07%	∞
25	Temp.Unc.-Conductivity	B	3.40%	R	$\sqrt{3}$	0.78	0.71	1.50%	1.40%	∞
26	Temp.Unc.-Permittivity	B	0.40%	R	$\sqrt{3}$	0.23	0.26	0.10%	0.10%	∞
Combined standard uncertainty	$u_c = \sqrt{\sum_{i=1}^{22} c_i^2 u_i^2}$		/	/	/	/	/	12.90%	12.70%	∞
Expanded uncertainty (confidence interval of 95 %)	$u_e = 2u_c$		/	R	K=2	/	/	25.80%	25.40%	∞

Uncertainty of a System Performance Check with DASY5 System										
According to IEC62209-2/2010										
No.	Error Description	Type	Uncertainty Value	Probably Distribution	Div.	(Ci) 1g	(Ci) 10g	Std. Unc. (1g)	Std. Unc. (10g)	Degree of freedom
Measurement System										
1	Probe calibration	B	6.00%	N	1	1	1	6.00%	6.00%	∞
2	Axial isotropy	B	4.70%	R	$\sqrt{3}$	0.7	0.7	1.90%	1.90%	∞
3	Hemispherical isotropy	B	0.00%	R	$\sqrt{3}$	0.7	0.7	0.00%	0.00%	∞
4	Boundary Effects	B	1.00%	R	$\sqrt{3}$	1	1	0.60%	0.60%	∞
5	Probe Linearity	B	4.70%	R	$\sqrt{3}$	1	1	2.70%	2.70%	∞
6	Detection limit	B	1.00%	R	$\sqrt{3}$	1	1	0.60%	0.60%	∞
7	RF ambient conditions-noise	B	0.00%	R	$\sqrt{3}$	1	1	0.00%	0.00%	∞
8	RF ambient conditions-reflection	B	0.00%	R	$\sqrt{3}$	1	1	0.00%	0.00%	∞
9	Response time	B	0.80%	R	$\sqrt{3}$	1	1	0.50%	0.50%	∞
10	Integration time	B	5.00%	R	$\sqrt{3}$	1	1	2.90%	2.90%	∞
11	RF Ambient	B	3.00%	R	$\sqrt{3}$	1	1	1.70%	1.70%	∞
12	Probe positioned mech. restrictions	B	0.80%	R	$\sqrt{3}$	1	1	0.50%	0.50%	∞
13	Probe positioning with respect to phantom shell	B	6.70%	R	$\sqrt{3}$	1	1	3.90%	3.90%	∞

14	Max.SAR Evalation	B	3.90%	R	$\sqrt{3}$	1	1	2.30%	2.30%	∞
15	Modulation Response	B	2.40%	R	$\sqrt{3}$	1	1	1.40%	1.40%	∞
Test Sample Related										
16	Test sample positioning	A	0.00%	N	1	1	1	0.00%	0.00%	∞
17	Device holder uncertainty	A	2.00%	N	1	1	1	2.00%	2.00%	∞
18	Drift of output power	B	3.40%	R	$\sqrt{3}$	1	1	2.00%	2.00%	∞
Phantom and Set-up										
19	Phantom uncertainty	B	4.00%	R	$\sqrt{3}$	1	1	2.30%	2.30%	∞
20	SAR correction	B	1.90%	R	$\sqrt{3}$	1	0.84	1.11%	0.90%	∞
21	Liquid conductivity (meas.)	A	0.50%	N	1	0.64	0.43	0.32%	0.26%	∞
22	Liquid cpermittivity (meas.)	A	0.16%	N	1	0.64	0.43	0.10%	0.07%	∞
23	Temp.Unc.- Conductivity	B	1.70%	R	$\sqrt{3}$	0.78	0.71	0.80%	0.80%	∞
24	Temp.Unc.- Permittivity	B	0.40%	R	$\sqrt{3}$	0.23	0.26	0.10%	0.10%	∞
Combined standard uncertainty	$u_c = \sqrt{\sum_{i=1}^{22} c_i^2 u_i^2}$		/	/	/	/	/	12.90%	12.70%	∞
Expanded uncertainty (confidence interval of 95 %)	$u_e = 2u_c$		/	R	K=2	/	/	18.80%	18.40%	∞

5.10. System Check Results

System Performance Check at 450 MHz Head TSL

DUT: Dipole450 MHz; Type: D450V2; Serial: 1079

Date/Time: 01/14/2017 08:32:46 AM

Communication System: DuiJiangJi; Frequency: 450 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 450$ MHz; $\sigma = 0.89$ S/m; $\epsilon_r = 43.33$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

Probe: ES3DV3 - SN3292; ConvF(7.12, 7.12, 7.12); Calibrated: 09/02/2016;

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1315; Calibrated: 07/26/2016

Phantom: ELI 4.0; Type: QDOVA001BA;

Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6824)

System Performance Check at 450MHz/Area Scan (61x201x1): Interpolated grid: dx=1.50 mm, dy=1.50 mm

Maximum value of SAR (interpolated) = 1.45 mW/g

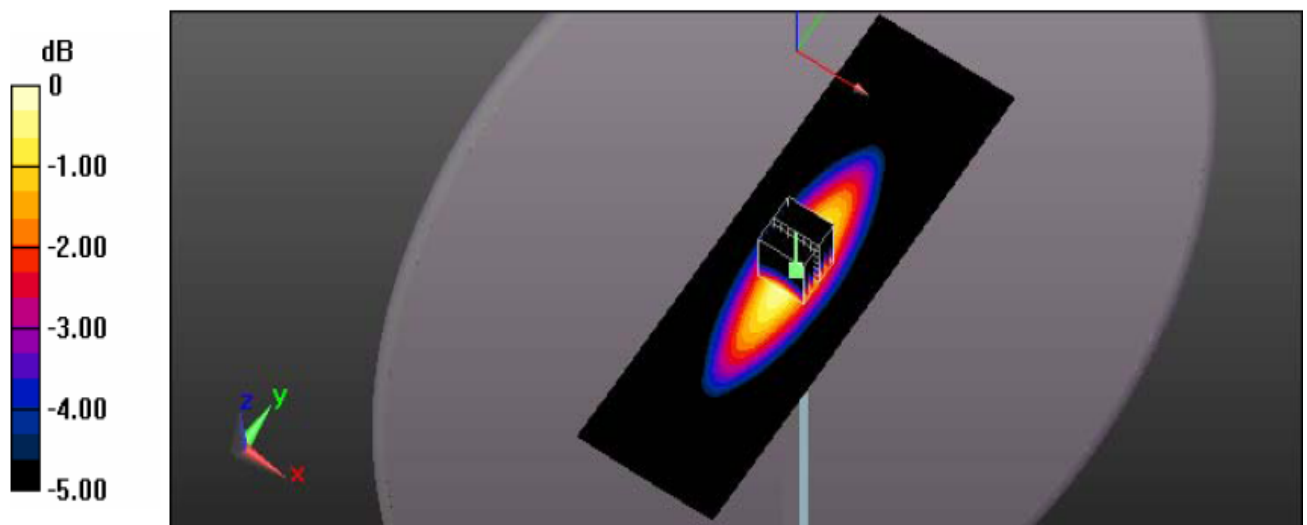
System Performance Check at 450MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 41.8 V/m; Power Drift = -0.11 dB

Peak SAR (extrapolated) = 1.62 mW/g

SAR(1 g) = 1.25 mW/g; SAR(10 g) = 0.732 mW/g

Maximum value of SAR (measured) = 1.52 mW/g



0 dB = 1.52 W/Kg = 1.82 dB mW/g

System Performance Check 450MHz Head 250mW

System Performance Check at 450 MHz Body TSL

DUT: Dipole450 MHz; Type: D450V2; Serial: 1079

Date/Time: 01/14/2016 14:21:20

Medium parameters used (interpolated): $f = 450$ MHz; $\sigma = 0.93$ S/m; $\epsilon_r = 56.74$; $\rho = 1000$ kg/m³

Communication System: DuiJiangJi; Frequency: 450 MHz; Duty Cycle: 1:1

Phantom section: Flat Section

DASY5 Configuration:

Probe: ES3DV3 - SN3292; ConvF(7.33, 7.33, 7.33); Calibrated: 09/02/2016;

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1315; Calibrated: 07/26/2016

Phantom: ELI 4.0; Type: QDOVA001BA;

Measurement SW: DASY52, Version 52.8 (2); SEMCAD X Version 14.6.6 (6824)

System Performance Check at 450MHz/Area Scan (61x201x1): Interpolated grid: dx=1.50 mm, dy=1.50 mm

Maximum value of SAR (interpolated) = 1.52 mW/g

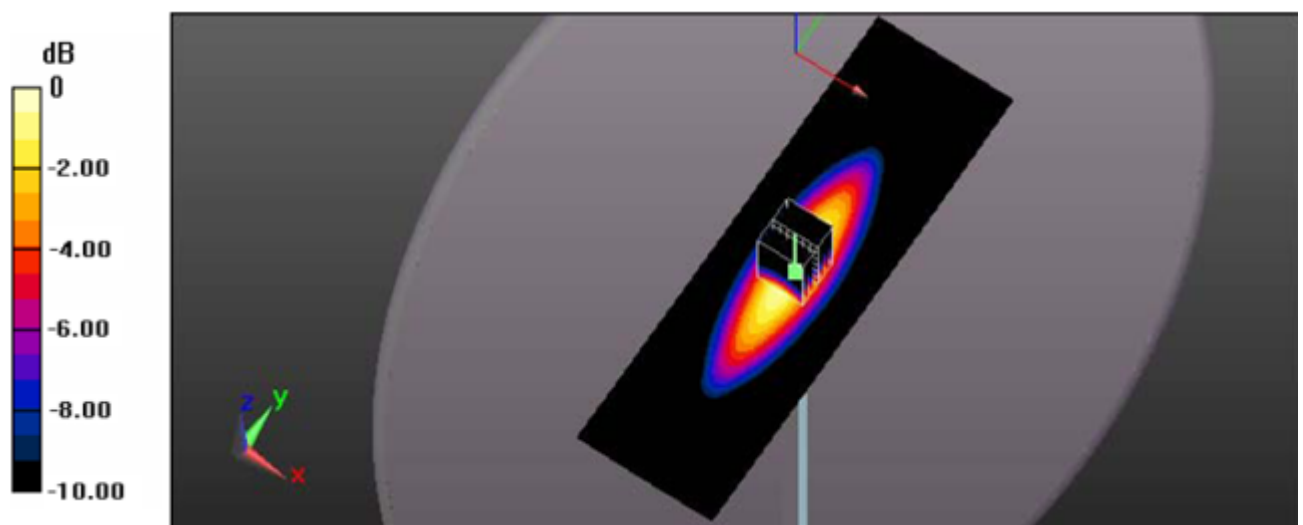
System Performance Check at 450MHz/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 41.3 V/m; Power Drift = -0.02 dB

Peak SAR (extrapolated) = 1.72 mW/g

SAR(1 g) = 1.11 mW/g; SAR(10 g) = 0.763 mW/g

Maximum value of SAR (measured) = 1.47 mW/g



0 dB = 1.47 mW/g = 1.67 dB mW/g

System Performance Check 450MHz Body 250mW

5.11. SAR Test Graph Results

Face Held for GMRS at 12.5 KHz Channel Separation, Front towards Phantom 462.6375 MHz

Communication System: DuiJiangJi; Frequency: 462.6375 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): 462.6375 MHz; $\sigma = 0.90$ S/m; $\epsilon_r = 43.21$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

Probe: ES3DV3 - SN3292; ConvF(7.12, 7.12, 7.12); Calibrated: 09/02/2016;

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1315; Calibrated: 07/26/2016

Phantom: ELI 4.0; Type: QDOVA001BA;

Measurement SW: DASY52, Version 52.8.8 (1222); SEMCAD X Version 14.6.10 (7331)

Towards Phantom 462.6375 MHz / Area Scan (51x101x1): Interpolated grid: dx=1.50 mm, dy=1.50 mm

Maximum value of SAR (interpolated) = 1.03 mW/g

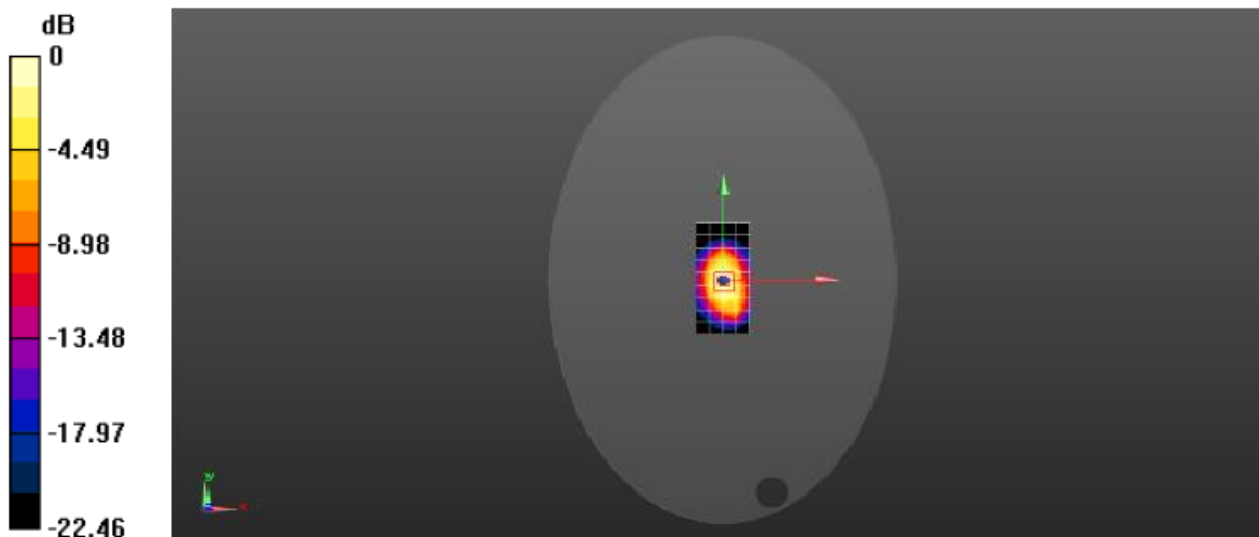
Towards Phantom 462.6375 MHz / Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 33.34 V/m; Power Drift = - 0.19 dB

Peak SAR (extrapolated) = 1.32 mW/g

SAR(1 g) = 0.987 mW/g; SAR(10 g) = 0.423 mW/g

Maximum value of SAR (measured) = 1.29 mW/g



0dB = 1.29 mW/g = 1.11 dB mW/g

Date/Time: 01/14/2017 12:44:18 AM

Figure 1: Face held for GMRS at 12.5 KHz Channel Separation, Front towards Phantom 462.6375 MHz

Face Held for FRS at 12.5 KHz Channel Separation, Front towards Phantom 467.6375 MHz

Communication System: DuiJiangJi; Frequency: 467.6375 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 467.6375$ MHz; $\sigma = 0.90$ S/m; $\epsilon_r = 43.17$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

Probe: ES3DV3 - SN3292; ConvF(7.12, 7.12, 7.12); Calibrated: 09/02/2016;

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1315; Calibrated: 07/26/2016

Phantom: ELI 4.0; Type: QDOVA001BA;

Measurement SW: DASY52, Version 52.8.8 (1222); SEMCAD X Version 14.6.10 (7331)

Towards Phantom 467.6375 MHz / Area Scan (51x101x1): Interpolated grid: $dx=1.50$ mm, $dy=1.50$ mm

Maximum value of SAR (interpolated) = 0.41 mW/g

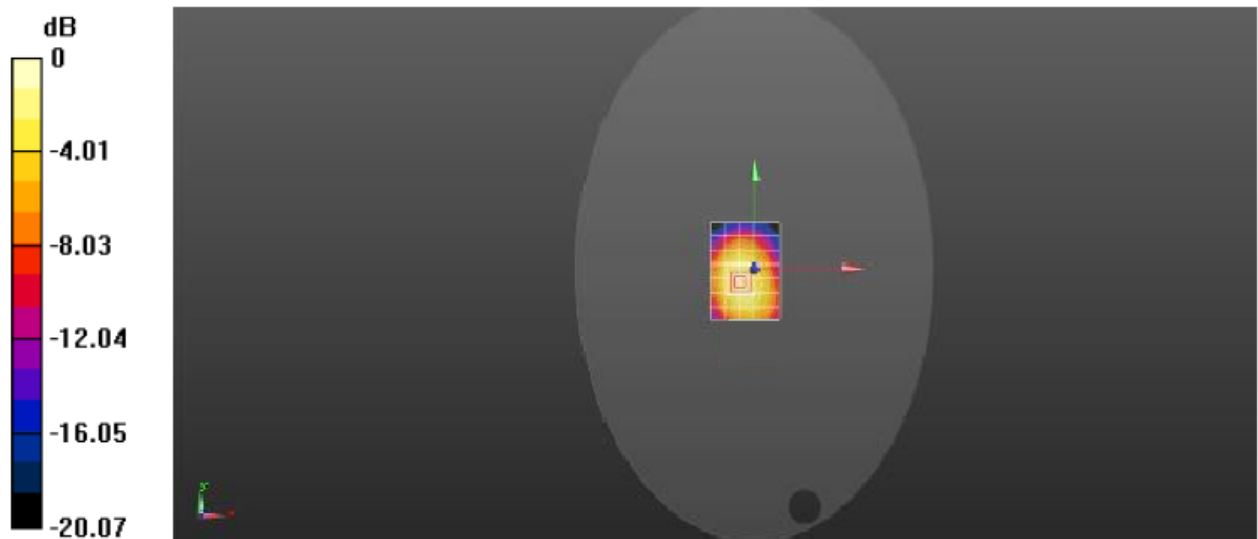
Towards Phantom 467.6375 MHz / Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 15.324 V/m; Power Drift = - 0.11 dB

Peak SAR (extrapolated) = 0.38 mW/g

SAR(1 g) = 0.315mW/g; SAR(10 g) = 0.162 mW/g

Maximum value of SAR (measured) = 0.389 mW/g



0 dB = 0.389 mW/g = -4.1 dB mW/g

Date/Time: 01/14/2017 10:22:45 AM

Figure 2: Face Held for FRS at 12.5 KHz Channel Separation, Front towards Phantom 467.6375 MHz

Body- Worn GMRS at 12.5 KHz Channel Separation with A1, B1, BC1, Front towards Ground 462.6375 MHz

Communication System: DuiJiangJi; Frequency: 462.6375 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): 462.6375 MHz; $\sigma = 0.94$ S/m; $\epsilon_r = 56.43$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

Probe: ES3DV3 - SN3292; ConvF(7.33, 7.33, 7.33); Calibrated: 09/02/2016;

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1315; Calibrated: 07/26/2016

Phantom: ELI 4.0; Type: QDOVA001BA;

Measurement SW: DASY52, Version 52.8.8 (1222); SEMCAD X Version 14.6.10 (7331)

Towards Ground 462.6375 MHz / Area Scan (51x101x1): Interpolated grid: dx=1.50 mm, dy=1.50 mm

Maximum value of SAR (interpolated) = 0.98 mW/g

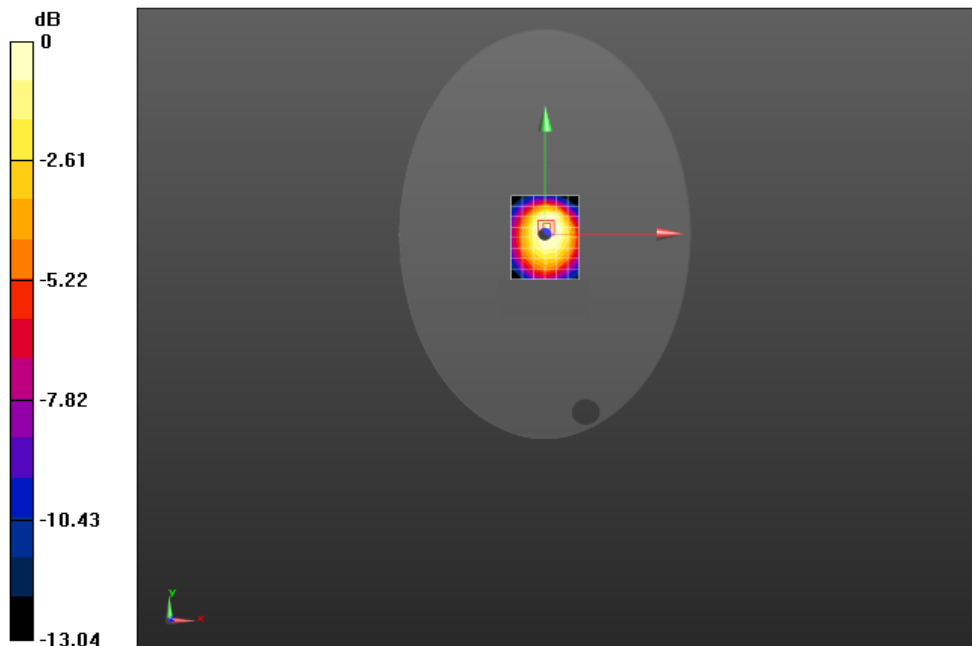
Towards Ground 462.6375 MHz / Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 31.331 V/m; Power Drift = - 0.18 dB

Peak SAR (extrapolated) = 1.09 mW/g

SAR(1 g) = 1.03 mW/g; SAR(10 g) = 0.362 mW/g

Maximum value of SAR (measured) = 1.21 mW/g



0 dB = 1.21 mW/g = 0.83 dB mW/g

Date/Time: 01/14/2017 18:01:07 PM

Figure 3: Body- Worn GMRS at 12.5 KHz Channel Separation with A1, B1, BC1, Front towards Ground 462.6375 MHz

Body- Worn FRS at 12.5 KHz Channel Separation with A1, B1, BC1, Front towards Ground 467.6375 MHz

Communication System: DuiJiangJi; Frequency: 467.6375 MHz; Duty Cycle: 1:1

Medium parameters used (interpolated): $f = 467.6375$ MHz; $\sigma = 0.94$ S/m; $\epsilon_r = 56.43$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

DASY5 Configuration:

Probe: ES3DV3 - SN3292; ConvF(7.33, 7.33, 7.33); Calibrated: 09/02/2016;

Sensor-Surface: 2mm (Mechanical Surface Detection)

Electronics: DAE4 Sn1315; Calibrated: 07/26/2016

Phantom: ELI 4.0; Type: QDOVA001BA;

Measurement SW: DASY52, Version 52.8.8 (1222); SEMCAD X Version 14.6.10 (7331)

Towards Phantom 467.6375 MHz / Area Scan (51x101x1): Interpolated grid: dx=1.50 mm, dy=1.50 mm

Maximum value of SAR (interpolated) = 0.38 mW/g

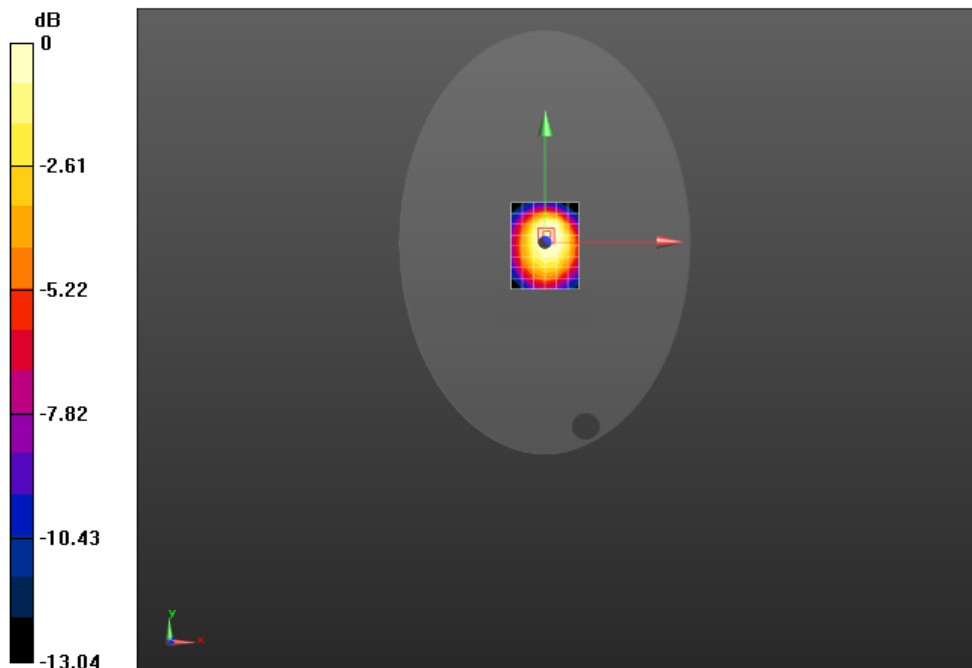
Towards Phantom 467.6375 MHz / Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 21.121 V/m; Power Drift = - 0.11 dB

Peak SAR (extrapolated) = 0.416 mW/g

SAR(1 g) = 0.363 mW/g; SAR(10 g) = 0.293 mW/g

Maximum value of SAR (measured) = 0.39 mW/g



0 dB = 0.39 mW/g = -4.1 dB mW/g

Date/Time: 01/14/2017 15:56:30 PM

Figure 4: Body- Worn FRS at 12.5 KHz Channel Separation with A1, B1, BC1, Front towards Ground 467.6375 MHz

6. Calibration Certificate

6.1. Probe Calibration Certificate

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**

Client **CIQ-SZ (Auden)**

Certificate No: **ES3-3292_Sep16**

CALIBRATION CERTIFICATE

Object **ES3DV3 - SN:3292** *SAR 15.2R*

Calibration procedure(s) **QA CAL-01.v9, QA CAL-12.v9, QA CAL-23.v5, QA CAL-25.v6**
 Calibration procedure for dosimetric E-field probes

Calibration date: **September 2, 2016**

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 $(22 \pm 3)^\circ\text{C}$ 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	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: S5277 (20x)	05-Apr-16 (No. 217-02293)	Apr-17
Reference Probe ES3DV2	SN: 3013	31-Dec-15 (No. ES3-3013_Dec15)	Dec-16
DAE4	SN: 660	23-Dec-15 (No. DAE4-660_Dec15)	Dec-16
Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-16)	In house check: Jun-18
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-16)	In house check: Jun-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

	Name	Function	Signature
Calibrated by:	Michael Weber	Laboratory Technician	<i>M. Weber</i>
Approved by:	Katja Pokovic	Technical Manager	<i>K. Pokovic</i>

Issued: September 2, 2016

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

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)

Accreditation No.: **SCS 0108**

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

Glossary:

TSL	tissue simulating liquid
NORM _{x,y,z}	sensitivity in free space
ConvF	sensitivity in TSL / NORM _{x,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., $\vartheta = 0$ 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:

- 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
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- 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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

- NORM_{x,y,z}**: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORM_{x,y,z} are only intermediate values, i.e., the uncertainties of NORM_{x,y,z} does not affect the E²-field uncertainty inside TSL (see below ConvF).
- NORM(f)_{x,y,z}** = NORM_{x,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.
- DCP_{x,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
- A_{x,y,z}; B_{x,y,z}; C_{x,y,z}; D_{x,y,z}; VR_{x,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 $f \leq 800$ 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 NORM_{x,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 NORM_x (no uncertainty required).

ES3DV3 – SN:3292

September 2, 2016

Probe ES3DV3

SN:3292

Manufactured:	July 6, 2010
Repaired:	August 29, 2016
Calibrated:	September 2, 2016

Calibrated for DASY/EASY Systems
(Note: non-compatible with DASY2 system!)

ES3DV3- SN:3292

September 2, 2016

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3292**Basic Calibration Parameters**

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu\text{V}/(\text{V}/\text{m})^2$) ^A	0.94	0.95	0.93	± 10.1 %
DCP (mV) ^B	105.7	101.2	111.7	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB $\sqrt{\mu\text{V}}$	C	D dB	VR mV	Unc ^E (k=2)
0	CW	X	0.0	0.0	1.0	0.00	205.6	±3.5 %
		Y	0.0	0.0	1.0		212.6	
		Z	0.0	0.0	1.0		204.7	

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 E²-field uncertainty inside TSL (see Pages 5 and 6).

^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.

ES3DV3- SN:3292

September 2, 2016

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3292

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)
450	43.5	0.87	7.12	7.12	7.12	0.20	1.30	± 13.3 %
750	41.9	0.89	6.76	6.76	6.76	0.80	1.19	± 12.0 %
835	41.5	0.90	6.53	6.53	6.53	0.43	1.64	± 12.0 %
900	41.5	0.97	6.40	6.40	6.40	0.53	1.43	± 12.0 %
1750	40.1	1.37	5.54	5.54	5.54	0.80	1.15	± 12.0 %
1900	40.0	1.40	5.26	5.26	5.26	0.55	1.47	± 12.0 %
2450	39.2	1.80	4.97	4.97	4.97	0.64	1.41	± 12.0 %
2600	39.0	1.96	4.77	4.77	4.77	0.80	1.28	± 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. 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.

ES3DV3- SN:3292

September 2, 2016

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3292**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)	Unc (k=2)
450	56.7	0.94	7.33	7.33	7.33	0.13	1.50	± 13.3 %
750	55.5	0.96	6.25	6.25	6.25	0.38	1.66	± 12.0 %
835	55.2	0.97	6.27	6.27	6.27	0.47	1.56	± 12.0 %
900	55.0	1.05	6.16	6.16	6.16	0.80	1.15	± 12.0 %
1750	53.4	1.49	5.28	5.28	5.28	0.70	1.36	± 12.0 %
1900	53.3	1.52	5.05	5.05	5.05	0.64	1.44	± 12.0 %
2450	52.7	1.95	4.70	4.70	4.70	0.74	1.22	± 12.0 %
2600	52.5	2.16	4.52	4.52	4.52	0.80	1.13	± 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. Above 5 GHz frequency validity can be extended to ± 110 MHz.

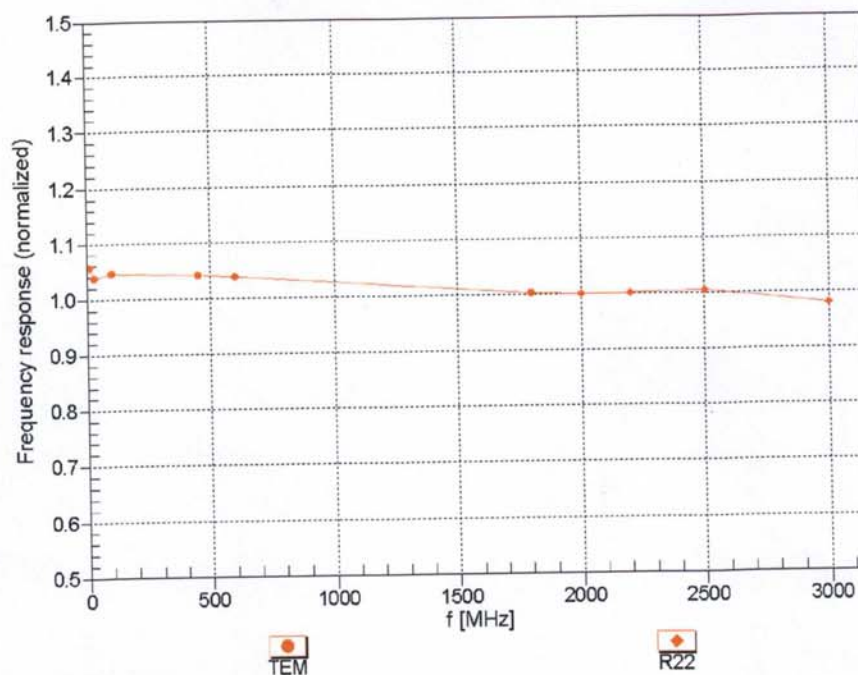
^F At frequencies below 3 GHz, the validity of tissue parameters (ϵ and σ) can be relaxed to ± 10% if liquid compensation formula is applied to measured SAR values. At frequencies above 3 GHz, the validity of tissue parameters (ϵ and σ) is restricted to ± 5%. The uncertainty is the RSS of the ConvF uncertainty 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.

ES3DV3- SN:3292

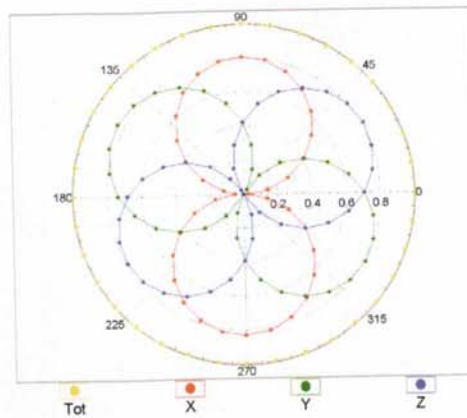
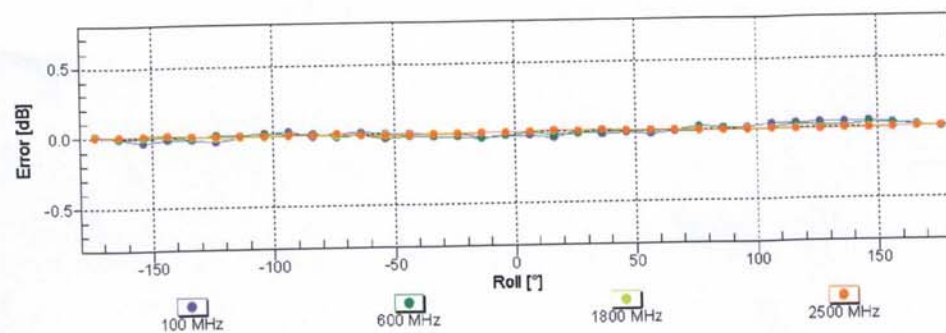
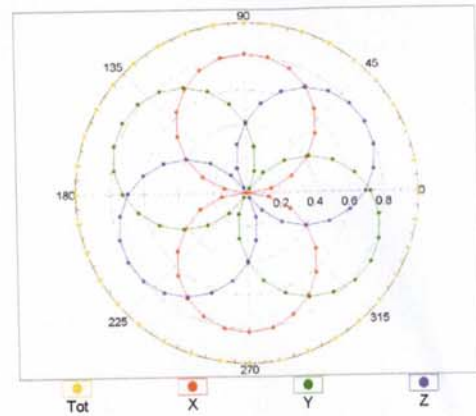
September 2, 2016

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

Uncertainty of Frequency Response of E-field: $\pm 6.3\%$ ($k=2$)

ES3DV3- SN:3292

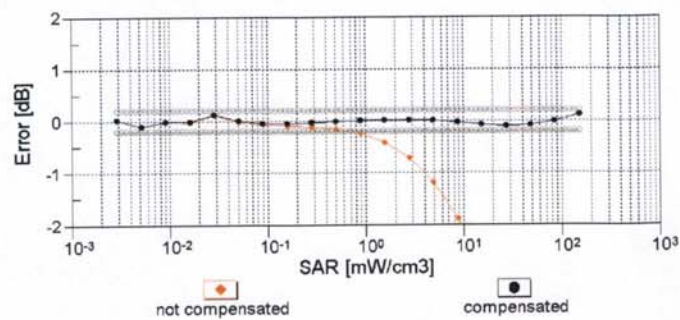
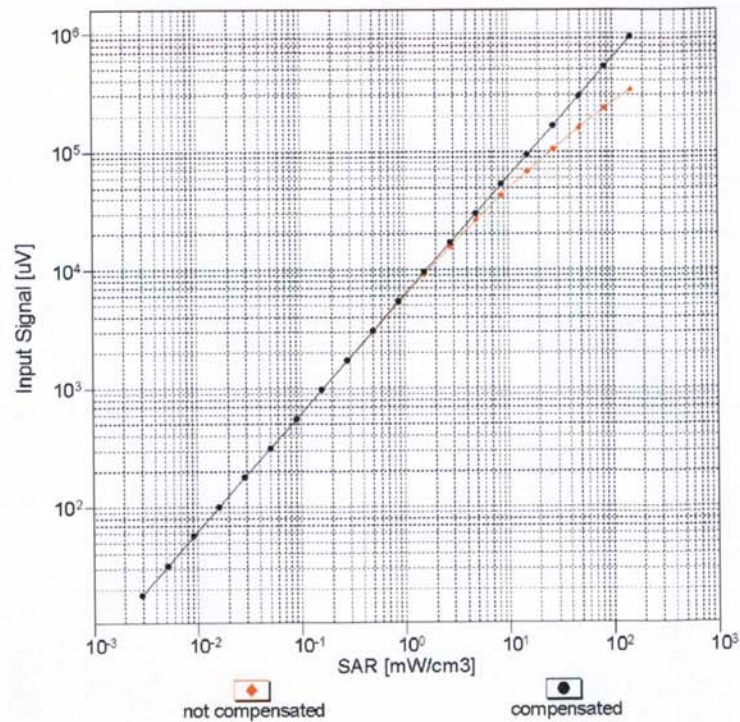
September 2, 2016

Receiving Pattern (ϕ), $\theta = 0^\circ$ **f=600 MHz,TEM****f=1800 MHz,R22****Uncertainty of Axial Isotropy Assessment: $\pm 0.5\%$ ($k=2$)**

ES3DV3- SN:3292

September 2, 2016

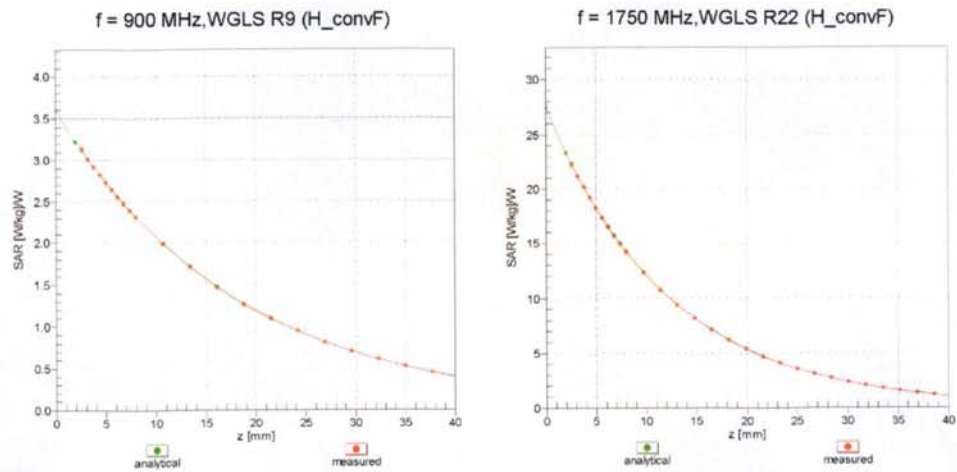
Dynamic Range $f(\text{SAR}_{\text{head}})$ (TEM cell, $f_{\text{eval}} = 1900 \text{ MHz}$)

Uncertainty of Linearity Assessment: $\pm 0.6\%$ ($k=2$)

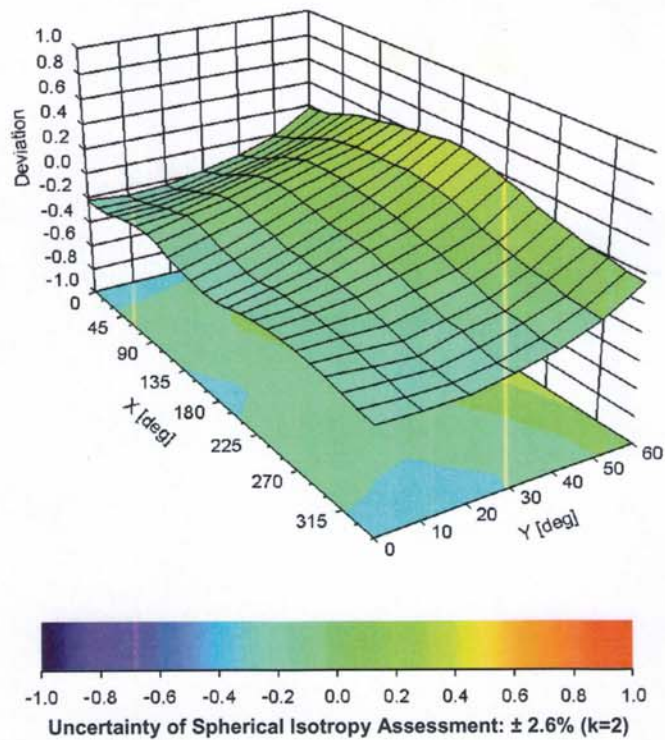
ES3DV3- SN:3292

September 2, 2016

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, θ), $f = 900 \text{ MHz}$ 

ES3DV3- SN:3292

September 2, 2016

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3292**Other Probe Parameters**

Sensor Arrangement	Triangular
Connector Angle (°)	36.3
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	4 mm
Probe Tip to Sensor X Calibration Point	2 mm
Probe Tip to Sensor Y Calibration Point	2 mm
Probe Tip to Sensor Z Calibration Point	2 mm
Recommended Measurement Distance from Surface	3 mm

6.2. D450V3 Dipole Calibration Certificate

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
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)

Accreditation No.: **SCS 0108**

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

Client **CIQ-SZ (Auden)**

Certificate No: **D450V3-1079_Aug16**

CALIBRATION CERTIFICATE

Object **D450V3 - SN: 1079** *SHP 113158 (60M) JD462*

Calibration procedure(s) **QA CAL-15.v8**
 Calibration procedure for dipole validation kits below 700 MHz

Calibration date: **August 29, 2016**

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	06-Apr-16 (No. 217-02288/02289)	Apr-17
Power sensor NRP-Z91	SN: 103244	06-Apr-16 (No. 217-02288)	Apr-17
Power sensor NRP-Z91	SN: 103245	06-Apr-16 (No. 217-02289)	Apr-17
Reference 20 dB Attenuator	SN: 5277 (20x)	05-Apr-16 (No. 217-02293)	Apr-17
Type-N mismatch combination	SN: 5047.2 / 06327	05-Apr-16 (No. 217-02295)	Apr-17
Reference Probe ET3DV6	SN: 1507	31-Dec-15 (No. ET3-1507_Dec15)	Dec-16
DAE4	SN: 654	12-Aug-16 (No. DAE4-654_Aug16)	Aug-17
Secondary Standards	ID #	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (No. 217-02285/02284)	In house check: Jun-18
Power sensor E4412A	SN: MY41498087	06-Apr-16 (No. 217-02285)	In house check: Jun-18
Power sensor E4412A	SN: 000110210	06-Apr-16 (No. 217-02284)	In house check: Jun-18
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-16)	In house check: Jun-18
Network Analyzer HP 8753E	SN: US37390585	18-Oct-01 (in house check Oct-15)	In house check: Oct-16

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	<i>[Signature]</i>
Approved by:	Katja Pokovic	Technical Manager	<i>[Signature]</i>

Issued: August 30, 2016

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

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
S 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:

- 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
- IEC 62209-1, "Procedure to measure the Specific Absorption Rate (SAR) for hand-held devices used in close proximity to the ear (frequency range of 300 MHz to 3 GHz)", February 2005
- 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
- KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

- 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	V52.8.8
Extrapolation	Advanced Extrapolation	
Phantom	ELI4 Flat Phantom	Shell thickness: 2 ± 0.2 mm
Distance Dipole Center - TSL	15 mm	with Spacer
Zoom Scan Resolution	dx, dy, dz = 5 mm	
Frequency	450 MHz $\pm$ 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	43.5	0.87 mho/m
Measured Head TSL parameters	(22.0 $\pm$ 0.2) °C	44.3 $\pm$ 6 %	0.89 mho/m $\pm$ 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	1.16 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	4.58 W/kg $\pm$ 18.1 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Head TSL	condition	
SAR measured	250 mW input power	0.775 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	3.06 W/kg $\pm$ 17.6 % (k=2)

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	56.7	0.94 mho/m
Measured Body TSL parameters	(22.0 $\pm$ 0.2) °C	56.7 $\pm$ 6 %	0.95 mho/m $\pm$ 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm ³ (1 g) of Body TSL	Condition	
SAR measured	250 mW input power	1.16 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	4.60 W/kg $\pm$ 18.1 % (k=2)

SAR averaged over 10 cm ³ (10 g) of Body TSL	condition	
SAR measured	250 mW input power	0.764 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	3.03 W/kg $\pm$ 17.6 % (k=2)

Appendix (Additional assessments outside the scope of SCS 0108)**Antenna Parameters with Head TSL**

Impedance, transformed to feed point	58.0 Ω - 2.9 j Ω
Return Loss	- 22.0 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	56.1 Ω - 5.8 j Ω
Return Loss	- 22.0 dB

General Antenna Parameters and Design

Electrical Delay (one direction)	1.348 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
Manufactured on	March 03, 2011

DASY5 Validation Report for Head TSL

Date: 29.08.2

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 450 MHz; Type: D450V3; Serial: D450V3 - SN: 1079

Communication System: UID 0 - CW; Frequency: 450 MHz

Medium parameters used: $f = 450$ MHz; $\sigma = 0.89$ S/m; $\epsilon_r = 44.3$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(6.58, 6.58, 6.58); Calibrated: 31.12.2015;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 12.08.2016
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Head Tissue/d=15mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:

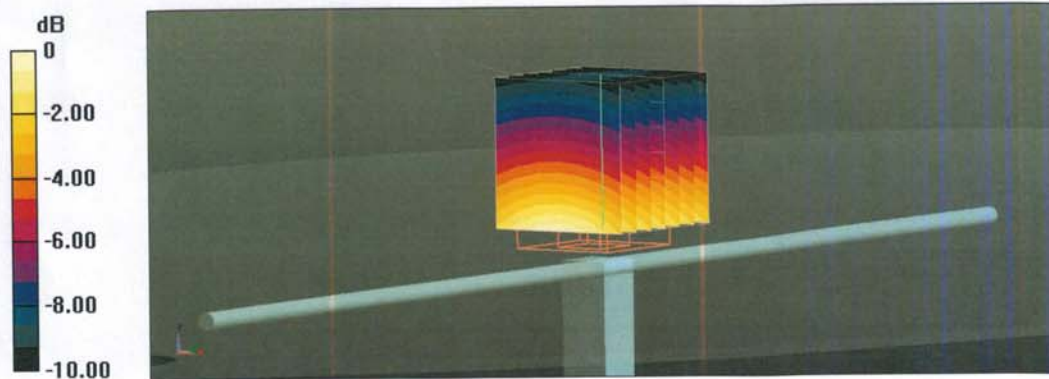
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 39.87 V/m; Power Drift = -0.05 dB

Peak SAR (extrapolated) = 1.69 W/kg

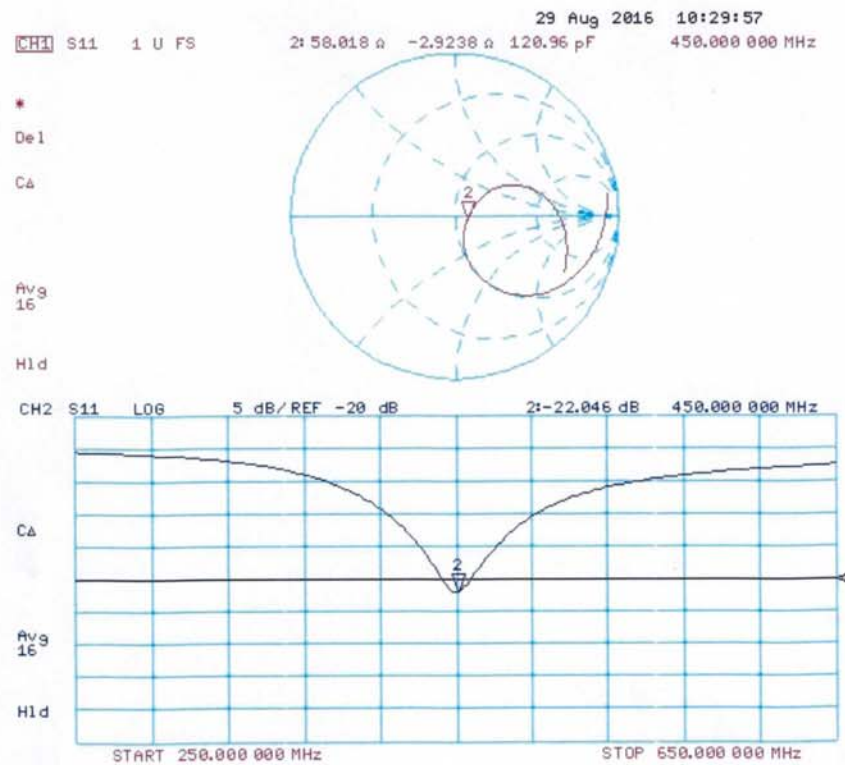
SAR(1 g) = 1.16 W/kg; SAR(10 g) = 0.775 W/kg

Maximum value of SAR (measured) = 1.26 W/kg



0 dB = 1.26 W/kg = 1.00 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 29.08.2016

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: Dipole 450 MHz D450V3; Type: D450V3; Serial: D450V3 - SN:1079

Communication System: UID 0 - CW; Frequency: 450 MHz

Medium parameters used: $f = 450$ MHz; $\sigma = 0.95$ S/m; $\epsilon_r = 56.7$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2011)

DASY52 Configuration:

- Probe: ET3DV6 - SN1507; ConvF(6.99, 6.99, 6.99); Calibrated: 31.12.2015;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 12.08.2016
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.8.8(1258); SEMCAD X 14.6.10(7372)

Dipole Calibration for Body Tissue/d=15mm, Pin=250mW/Zoom Scan (7x7x7)/Cube 0:

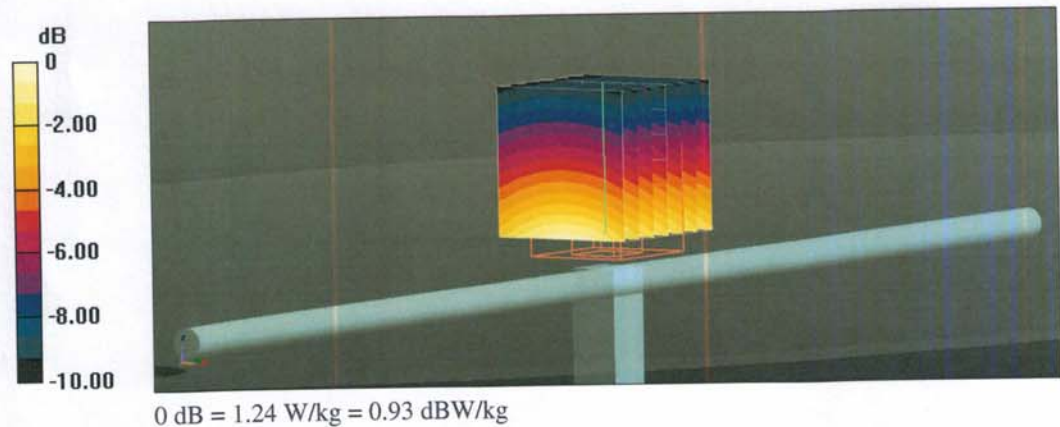
Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 37.17 V/m; Power Drift = -0.01 dB

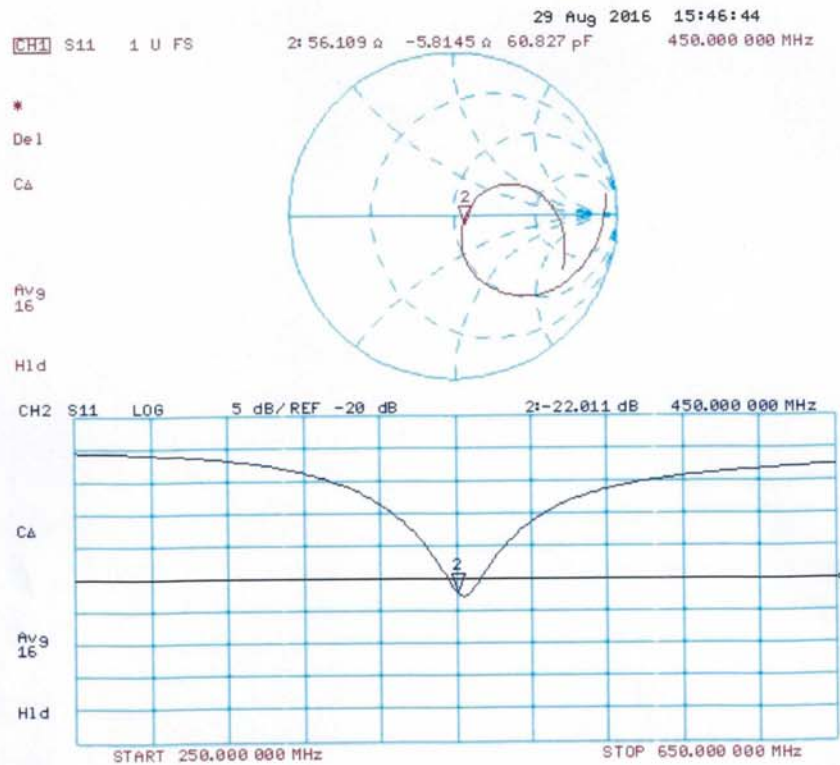
Peak SAR (extrapolated) = 1.82 W/kg

SAR(1 g) = 1.16 W/kg; SAR(10 g) = 0.764 W/kg

Maximum value of SAR (measured) = 1.24 W/kg



Impedance Measurement Plot for Body TSL



6.3. DAE4 Calibration Certificate

In Collaboration withCALIBRATION LABORATORY中国
国际互
校准
CALIBRA
CNAS LO

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
E-mail: cttl@chinattl.com [Http://www.chinattl.cn](http://www.chinattl.cn)

Client : **CIQ(Shenzhen)** Certificate No: **Z16-97120**

CALIBRATION CERTIFICATE

Object **DAE4 - SN: 1315** *JP462*

Calibration Procedure(s) **FD-Z11-2-002-01**
Calibration Procedure for the Data Acquisition Electronics (DAEx)

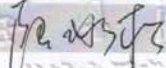
Calibration date: **July 26, 2016**

This calibration Certificate documents the traceability to national standards, which realize the physical units c 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(Calibrated by, Certificate No.)	Scheduled Calibration
Process Calibrator 753	1971018	27-June-16 (CTTL, No:J16X04778)	June-17

	Name	Function	Signature
Calibrated by:	Yu Zongying	SAR Test Engineer	
Reviewed by:	Qi Dianyuan	SAR Project Leader	
Approved by:	Lu Bingsong	Deputy Director of the laboratory	

Issued: July 27, 2016

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



Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
E-mail: cttl@chinattl.com Http://www.chinattl.cn

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.



Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2218 Fax: +86-10-62304633-2209
E-mail: cttl@chinattl.com Http://www.chinattl.cn

DC Voltage Measurement

A/D - Converter Resolution nominal

High Range: 1LSB = $6.1\mu\text{V}$, full range = $-100\dots+300\text{ mV}$

Low Range: 1LSB = 61nV , full range = $-1\dots+3\text{mV}$

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

Calibration Factors	X	Y	Z
High Range	$405.179 \pm 0.15\% (k=2)$	$405.018 \pm 0.15\% (k=2)$	$404.98 \pm 0.15\% (k=2)$
Low Range	$3.99015 \pm 0.7\% (k=2)$	$3.98549 \pm 0.7\% (k=2)$	$3.98861 \pm 0.7\% (k=2)$

Connector Angle

Connector Angle to be used in DASY system	$20.5^\circ \pm 1^\circ$
---	--------------------------

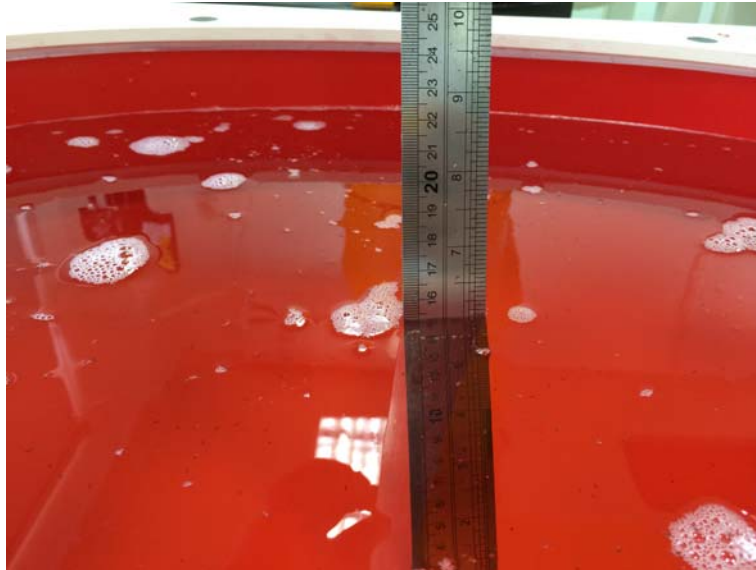


**Acceptable Conditions for SAR Measurements Using Probes and Dipoles
Calibrated under the SPEAG-CTTL Dual-Logo Calibration Program to
Support FCC Equipment Certification**

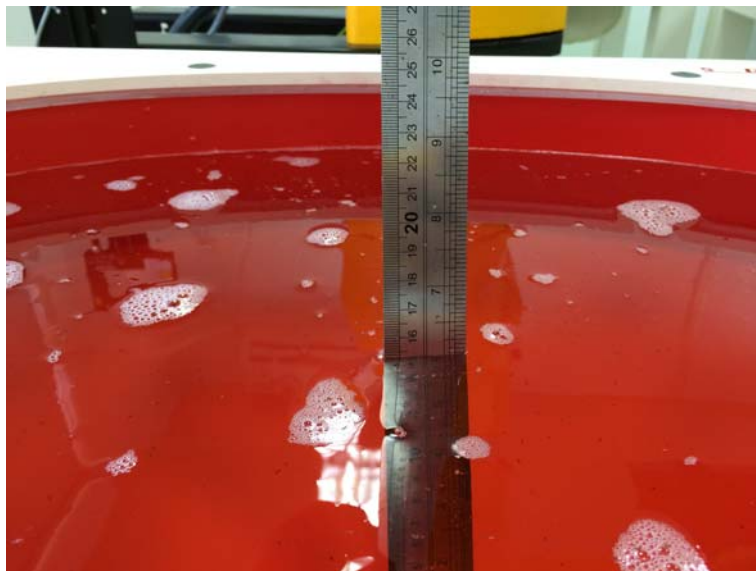
The acceptable conditions for SAR measurements using probes, dipoles and DAEs calibrated by CTTL (*China Telecommunication Technology Labs*), under the Dual-Logo Calibration Certificate program and quality assurance (QA) protocols established between SPEAG (*Schmid & Partner Engineering AG, Switzerland*) and CTTL, to support FCC (*U.S. Federal Communications Commission*) equipment certification are defined and described in the following. The conditions in this KDB are valid until December 31, 2015.

- 1) The agreement established between SPEAG and CTTL is only applicable to calibration services performed by CTTL where its clients (companies and divisions of such companies) are headquartered in the Greater China Region, including Taiwan and Hong Kong. CTTL shall inform the FCC of any changes or early termination to the agreement.
- 2) Only a subset of the calibration services specified in the SPEAG-CTTL agreement, while it remains valid, are applicable to SAR measurements performed using such equipment for supporting FCC equipment certification. These are identified in the following.
 - a) Calibration of dosimetric (SAR) probes EX3DVx, ET3DVx and ES3DVx.
 - i) Free-space E-field and H-field probes, including those used for HAC (hearing aid compatibility) evaluation, temperature probes, other probes or equipment not identified in this document, when calibrated by CTTL, are excluded and cannot be used for measurements to support FCC equipment certification.
 - ii) Signal specific and bundled probe calibrations based on PMR (probe modulation response) characteristics or probe sensor model based linearization methods that are not fully described in SAR standards are excluded and cannot be used for measurements to support FCC equipment certification.
 - b) Calibration of SAR system validation dipoles, excluding HAC dipoles.
 - c) Calibration of data acquisition electronics DAE3Vx, DAE4Vx and DAEasyVx.
 - d) For FCC equipment certification purposes, the frequency range of SAR probe and dipole calibrations is limited to 700 MHz - 6 GHz and provided it is supported by the equipment identified in the CTTL QA protocol (a separate attachment to this document).
 - e) The identical system and equipment setup, measurement configurations, hardware, evaluation algorithms, calibration and QA protocols, including the format of calibration certificates and reports used by SPEAG shall be applied by CTTL. Equivalent test equipment and measurement configurations may be considered only when agreed by both SPEAG and the FCC.
 - f) The calibrated items are only applicable to SPEAG DASY 4 and DASY 5 systems or higher version systems that satisfy the requirements of this KDB.
- 3) The SPEAG-CTTL agreement includes specific protocols identified in the following to ensure the quality of calibration services provided by CTTL under this SPEAG-

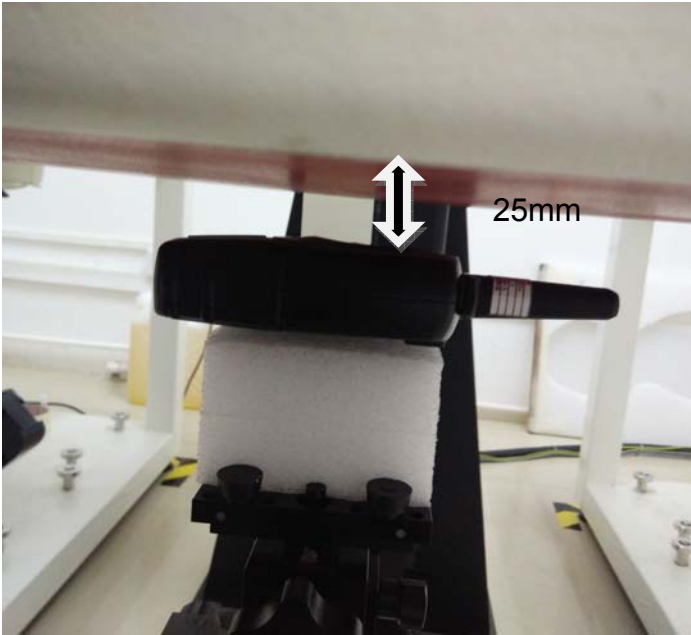
7. Test Setup Photos



Photograph of the depth in the Head Phantom (450MHz, 15.2cm)



Photograph of the depth in the Body Phantom (450MHz, 15.3cm)



Face-held, the front of the EUT towards phantom

Antenna Type	Antenna Distance (mm)		
	Separation Distance (mm)		
	@ front surface of the EUT	@ antenna's base	@ antenna's tip
A1	25.0	28.2	30.7



Body-worn Configuration with A1, B1, BC1

Antenna Type	Antenna Distance (mm)		
	Separation Distance (mm)		
	@ front surface of the EUT	@ antenna's base	@ antenna's tip
A1	4.2	7.8	7.1

8. External Photos of the EUT

External photo – front side



External photo – rear side



B1 – Battery, Intrinsically Safe Li-ion Battery



BC1- Belt clip



END OF REPORT