SAR Test Report

Report No.: AGC01570141105FH01

FCC ID	:	WRYHLT-5199V
APPLICATION PURPOSE	**:**	Original Equipment
Product Designation	:	Handheld Two Way Radio
Brand Name	:	Havoc
Model Name	:	HLT-5199V , HLT-A31 , HLT-A31V
Client	:	EKL Imports LLC
Date of Issue	:	Dec. 19,2014
STANDARD(S)	:	IEEE Std. 1528:2003 47CFR § 2.1093 IEEE/ANSI C95.1
REPORT VERSION	:	V1.0

Attestation of ***G***lobal ***C***ompliance(Shenzhen) Co., Ltd.

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Report Revise Record

Report Version	Revise Time	Issued Date	Valid Version	Notes
V1.0	/	Dec. 19,2014	Valid	Original Report

Test Report Certification

Applicant Name	EKL Imports LLC
Applicant Address	PO Box 1997 Gig Harbor WA 98335 USA
Manufacturer Name	Juston Electronic Equipment Co., Ltd.
Manufacturer Address	No.115-119,Yuantai 3rd Road, Jiangnan Hi-tech Park, Licheng District, Quanzhou China, 362000
Product Name	Handheld Two Way Radio
Brand Name	Havoc
Model Name	HLT-5199V , HLT-A31 , HLT-A31V
Difference Description	All the same, except for the model name. The test model is HLT-5199V.
EUT Voltage	DC7.4V by battery
Applicable Standard	IEEE Std. 1528:2003 47CFR § 2.1093 IEEE/ANSI C95.1
Test Date	Dec. 19,2014
Performed Location	Attestation of Global Compliance (Shenzhen)Co., Ltd. 2F, Building 2, No.1-No.4, Chaxi Sanwei Technical Industrial Park, Gushu, Xixiang Street, Bao'an District, Shenzhen, China
Report Template	AGCRT-US-PPT/SAR (2013-03-01)

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1. SUMMARY OF MAXIMUM SAR VALUE

The maximum results of Specific Absorption Rate (SAR) found during testing for EUT are as follows:

Highest Report tested & scaled SAR Summary（with 50% duty cycle）

VHF:

Exposure Position	Separation	Highest Tested 1g-SAR(W/Kg)	Highest Reported SAR(W/Kg)
Face Up	12.5 KHz	2.190	**2.379**
Back Touch	12.5 KHz	3.285	**3.569**

This device is compliance with Specific Absorption Rate (SAR) for Occupational / Controlled Exposure Environment limits (8.0W/Kg) specified in 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1, and had been tested in accordance with measurement methods and procedures specified in IEEE 1528-2003 and the following specific FCC Test Procedures:

KDB 865664 D01 SAR Measurement 100MHz to 6GHz v01r03

KDB 643646 D01 SAR Test for PTT Radios V01r01

2. GENERAL INFORMATION

2.1. EUT Description

General Information	
Product Name	Handheld Two Way Radio
Test Model	HLT-5199V
Hardware Version	N/A
Software Version	N/A
Exposure Category:	Occupational/Controlled Exposure
Device Category	FM VHF Portable Transceiver
Modulation Type	FM
TX Frequency Range	136-174MHz
Rated Power	5Watt
Max. Average Power	36.64dBm
Channel Spacing	12.5 KHz
Antenna Type	External Antenna
Antenna Gain	2.15dBi
Body-Worn Accessories:	Belt Clip with headset
Face-Head Accessories:	None
Battery Type (s) Tested:	DC 7.4V, 1600mAh (by battery)

Product	Type	
	☒ Production unit	☐ Identical Prototype

2.2. Test Procedure

1	Setup the EUT for two typical configuration of hold to face and body worn individually
2	Power on the EUT and make it continuously transmitting on required operating channel
3	Make sure the EUT work normally during the test

2.3. Test Environment

Ambient conditions in the laboratory:

Items	Required	Actual
Temperature (°C)	18-25	21 ± 2
Humidity (%RH)	30-70	56

3. SAR MEASUREMENT SYSTEM

3.1. Specific Absorption Rate (SAR)

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

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

$$\mathrm{SAR} = \frac{\mathrm{d}}{\mathrm{d}t}\left(\frac{\mathrm{d}W}{\mathrm{d}m}\right) = \frac{\mathrm{d}}{\mathrm{d}t}\left(\frac{\mathrm{d}W}{\rho \mathrm{d}V}\right)$$

SAR is expressed in units of Watts per kilogram (W/Kg)

SAR can be obtained using either of the following equations:

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

$$\mathrm{SAR} = c_h \left.\frac{\mathrm{d}T}{\mathrm{d}t}\right|_{t=0}$$

Where

SAR is the specific absorption rate in watts per kilogram;
E is the r.m.s. value of the electric field strength in the tissue in volts per meter;
σ is the conductivity of the tissue in siemens per metre;
ρ is the density of the tissue in kilograms per cubic metre;
c_h is the heat capacity of the tissue in joules per kilogram and Kelvin;

$\frac{\mathrm{dT}}{\mathrm{dt}} \mid \mathrm{t} = 0$ is the initial time derivative of temperature in the tissue in kelvins per second

3.2. SAR Measurement Procedure

The EUT is set to transmit at the required power in line with product specification, at each frequency relating to the LOW, MID, and HIGH channel settings.

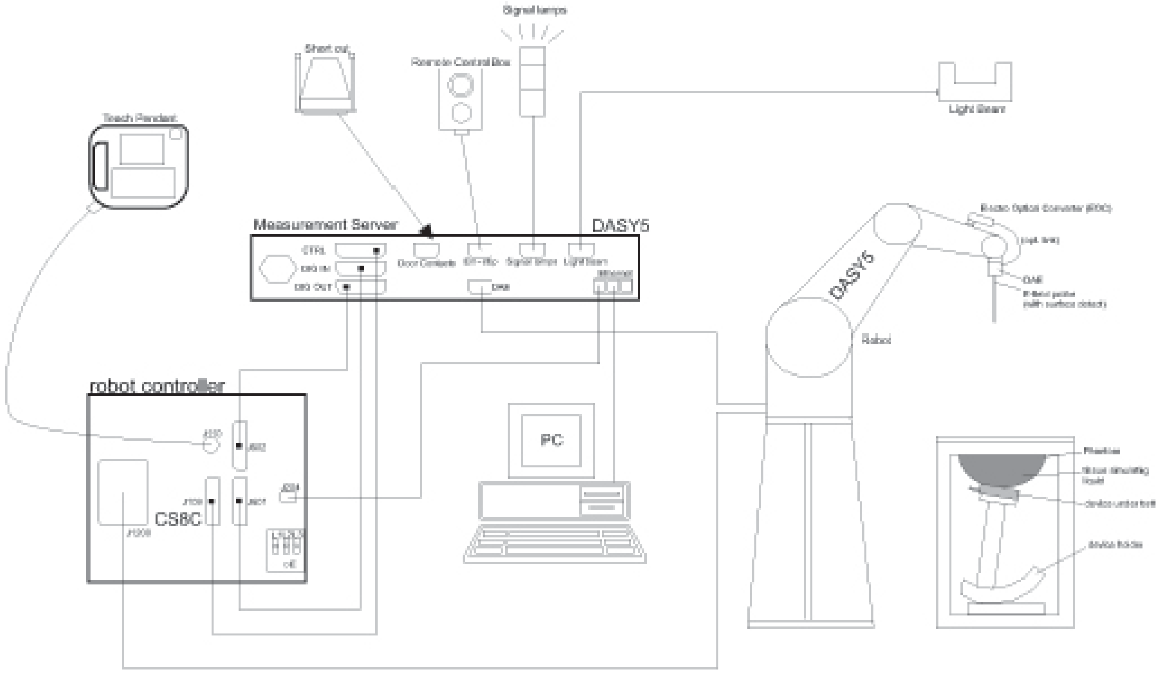
Pre-scans are made on the device to establish the location for the transmitting antenna, using a large area scan in either air or tissue simulation fluid.

The EUT is placed against the Flat Phantom where the maximum area scan dimensions are larger than the physical size of the resonating antenna. When the scan size is not large enough to cover the peak SAR distribution, it is modified by either extending the area scan size in both the X and Y directions, or the device is shifted within the predefined area.

The area scan is then run to establish the peak SAR location (interpolated resolution set at $1mm^2$) which is then used to orient the center of the zoom scan. The zoom scan is then executed and the 1g and 10g averages are derived from the zoom scan volume (interpolated resolution set at $1mm^3$).

When multiple peak SAR location were found during the same configuration or test mode, Zoom scan shall performed on each peak SAR location, only the peak point with maximum SAR value will be reported for the configuration or test mode.

3.3. DASY SAR System Description



DASY5 System Configurations

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

(1)A standard high precision 6-axis robot with controller, teach pendant and software.

(2)A data acquisition electronics (DAE) which attached to the robot arm extension. The DAE consist of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder with a control logic unit.

The mechanical probe mounting device includes two different sensor systems frontal and side-ways probe contacts. They are used for mechanical surface detection and probe collision detection.

(3) Mechanical surface detection uses the probe collision detector built into the DAE box. It is extremely accurate if the probe is normal to the surface

(4) A Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.

(5) A computer running WinXP .

(6) DASY software.

(7)Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.

(8) Phantoms, device holders and other accessories according to the targeted measurement.

3.3.1. Applications

Predefined procedures and evaluations for automated compliance testing with all worldwide standards, e.g., IEEE 1528, Reference KDB files, and others.

3.3.2. Area Scans

Area scans are defined prior to the measurement process being executed with a user defined variable spacing between each measurement point (integral) allowing low uncertainty measurements to be conducted. Scans defined for FCC applications utilize a 10mm² step integral, with 1mm interpolation used to locate the peak SAR area used for zoom scan assessments. When an Area Scan has measured all reachable points, it computes the field maxima found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE 1528-2003, Reference KDB files standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan).

3.3.3. Zoom Scan (Cube Scan Averaging)

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. A density of 1000 kg/m³ is used to represent the head and body tissue density and not the phantom liquid density, in order to be consistent with the definition of the liquid dielectric properties, i.e. the side length of the 1 g cube is 10mm, with the side length of the 10 g cube 21,5mm. The zoom scan integer steps can be user defined so as to reduce uncertainty, but normal practice for typical test applications utilize a physical step of 7x7x7 (5mmx5mmx5mm) providing a volume of 30mm in the X & Y axis, and 30mm in the Z axis.

3.3.4. Uncertainty of Inter-/Extrapolation and Averaging

In order to evaluate the uncertainty of the interpolation, extrapolation and averaged SAR calculation algorithms of the Post processor, DASY allows the generation of measurement grids which are artificially predefined by analytically based test functions. Therefore, the grids of area scans and zoom scans can be filled with uncertainty test data, according to the SAR benchmark functions of IEEE 1528.The three analytical functions shown in equations as below are used to describe the possible range of the expected SAR distributions for the tested handsets. The field gradients are covered by the spatially flat distribution f1, the spatially steep distribution f3 and f2 accounts for H-field cancellation on the phantom/tissue surface.

$$f_1(x,y,z) = Ae^{-\frac{z}{2a}}\cos^2\left(\frac{\pi}{2}\frac{\sqrt{x'^2+y'^2}}{5a}\right)$$

$$f_2(x,y,z) = Ae^{-\frac{z}{a}}\frac{a^2}{a^2+x'^2}\left(3-e^{-\frac{2z}{a}}\right)\cos^2\left(\frac{\pi}{2}\frac{y'}{3a}\right)$$

$$f_3(x,y,z) = A\frac{a^2}{\frac{a^2}{4}+x'^2+y'^2}\left(e^{-\frac{2z}{a}}+\frac{a^2}{2(a+2z)^2}\right)$$

3.4. DASY5 E-Field Probe

The SAR measurement is conducted with the dosimetric probe manufactured by SPEAG. The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency. SPEAG conducts the probe calibration in compliance with international and national standards (e.g. IEEE 1528, Reference KDB files, etc.). The calibration data are in Appendix D.

3.5. Isotropic E-Field Probe Specification

Model	ES3DV3	
Manufacture	SPEAG	
frequency	0.03GHz-3GHz Linearity:±0.2dB(30MHz-3GHz)	
Dynamic Range	0.01W/Kg-100W/Kg Linearity:±0.2dB	
Dimensions	Overall length:337mm Tip diameter:4mm Typical distance from probe tip to dipole centers:2mm	
Application	High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.	

3.6. Robot

The DASY system uses the high precision robots (DASY5:TX60) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version from is used.
The XL robot series have many features that are important for our application:
High precision (repeatability 0.02 mm)
High reliability (industrial design)
Jerk-free straight movements
Low ELF interference (the closed metallic construction shields against motor control fields)
6-axis controller

3.7. Light Beam Unit

The light beam switch allows automatic "tooling" of the probe. During the process, the actual position of the probe tip with respect to the robot arm is measured, as well as the probe length and the horizontal probe offset. The software then corrects all movements, such that the robot coordinates are valid for the probe tip.
The repeatability of this process is better than 0.1 mm. If a position has been taught with an aligned probe, the same position will be reached with another aligned probe within 0.1 mm, even if the other probe has different dimensions. During probe rotations, the probe tip will keep its actual position.

3.8. Device Holder

The DASY device holder is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear reference points). The rotation center for both scales is the ear reference point (EPR).
Thus the device needs no repositioning when changing the angles.
The DASY device holder has been made out of low-loss POM material having the following dielectric parameters: relative permittivity ε=3 and loss tangent δ = 0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

3.9. Measurement Server

The measurement server is based on a PC/104 CPU board with CPU (DASY5: 400 MHz, Intel Celeron), chip-disk (DASY5: 128MB), RAM (DASY5: 128MB). The necessary circuits for communication with the DAE electronic box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DAYS I/O board, which is directly connected to the PC/104 bus of the CPU board.
The measurement server performs all the real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operations.

3.10. ELI4 Phantom

Flat phantom a fiberglass shell flat phantom with 2mm+/- 0.2 mm shell thickness. It has only one measurement area for Flat phantom	

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

4. TISSUE SIMULATING LIQUID

For SAR measurement of the field distribution inside the phantom, the phantom must be filled with homogeneous tissue simulating liquid to a depth of at least 15cm. For head SAR testing the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15cm For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15cm.The nominal dielectric values of the tissue simulating liquids in the phantom and the tolerance of 5% are listed in 4.2

4.1. The composition of the tissue simulating liquid

The 150MHz liquid has been provided by SPEAG and they do not provide the composition as it is a secret issue.

4.2. Tissue Calibration Result

The dielectric parameters of the liquids were verified prior to the SAR evaluation using DASY5 Dielectric Probe Kit and R&S Network Analyzer ZVL6.

Tissue Stimulant Measurement for 150MHz						
Fr. (MHz)	Dielectric Parameters (±5%)				Tissue Temp [^{o}C]	Test time
	head		body			
	εr 52.3 49.685 to 54.915	δ[s/m] 0.76 0.722to 0.798	εr 61.9 58.805 to 64.995	δ[s/m] 0.80 0.76 to 0.84		
136.025	51.91	0.75	59.40	0.78	21	Dec. 19,2014
144.500	52.08	0.78	59.28	0.79	21	Dec. 19,2014
150.000	52.51	0.77	61.02	0.81	21	Dec. 19,2014
163.500	52.34	0.75	60.99	0.80	21	Dec. 19,2014
173.975	53.77	0.74	60.17	0.82	21	Dec. 19,2014

4.3. Tissue Dielectric Parameters for Head and Body Phantoms

The head tissue dielectric parameters recommended by the IEEE SCC-34/SC-2 in P1528 have been incorporated in the following table. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in a human head. Other head and body tissue parameters that have not been specified in P1528 are derived from the tissue dielectric parameters computed from the 4-Cole-Cole equations described in Reference [12] and extrapolated according to the head parameters specified in P1528.

Target Frequency (MHz)	head		body	
	εr	σ (S/m)	εr	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	51.6	2.73
5800	35.3	5.27	48.2	6.00

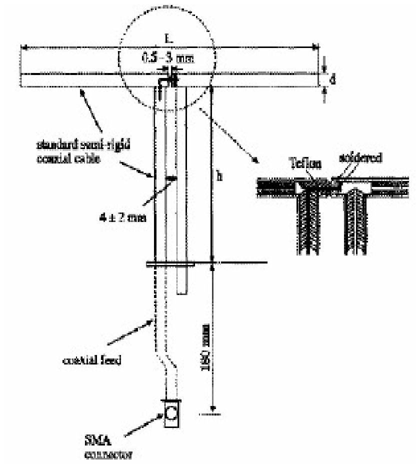
(ε_r = relative permittivity, σ = conductivity and ρ = 1000 kg/m^3)

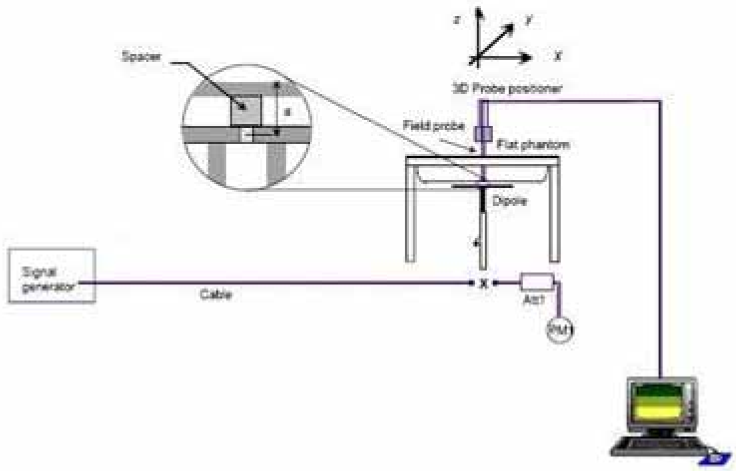
5. SAR MEASUREMENT PROCEDURE

5.1. SAR System Validation Procedures

Each DASY5 system is equipped with one or more system validation kits. These units, together with the predefined measurement procedures within the DASY5 software, enable the user to conduct the system performance check and system validation. System kit includes a dipole, and dipole device holder.

The system check verifies that the system operates within its specifications. It's performed daily or before every SAR measurement. The system check uses normal SAR measurement in the flat section of the phantom with a matched dipole at a specified distance. The system validation setup is shown as below.





5.2. SAR System Validation
5.2.1. Validation Loop Antenna

	The Loop Antenna used is based on the IEEE-1528 standard, and is complied with mechanical and electrical specifications in line with the requirements of both IEEE and FCC Supplement C. the table below provides details for the mechanical and electrical Specifications for the Loop Antenna.

Frequency	R/L (mm)	R/h (mm)	d (mm)
150MHz	222	222	97

5.2.2. Validation Result

System Performance Check at 150MHz									
Validation Kit: ES3DV3-SN:3337									
Frequency [MHz]	Target Value(W/Kg)		Reference Result (± 10%)		Tested Value(W/Kg)		Tissue Temp. [°C]	Test time
	1g	10g	1g	10g	1g	10g		
150 head	3.84	2.56	3.456-4.224	2.304-2.816	3.80	2.51	21	Dec. 19,2014
150 body	3.88	2.6	4.268-3.492	2.86-2.34	3.76	2.46	21	Dec. 19,2014

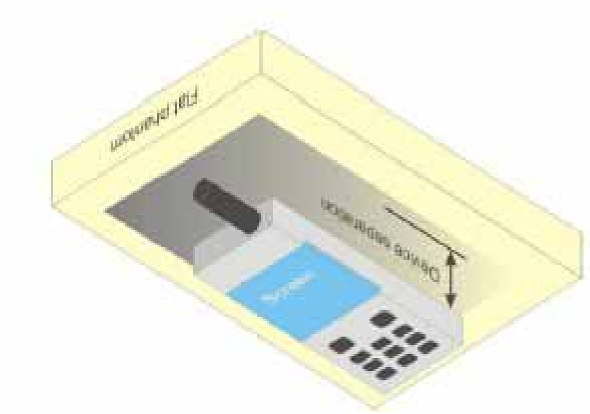
Note: The input power of system check is 30dBm.

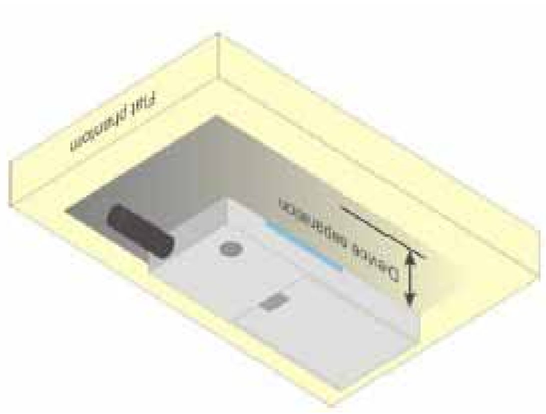
6. EUT TEST POSITION

This EUT was tested in **Front Face and Rear Face.**

6.1. Body Worn Position

(1) To position the EUT parallel to the phantom surface.
(2) To adjust the EUT parallel to the flat phantom.
(3) To adjust the distance between the EUT surface and the flat phantom to **25mm** while used in front of face, and body back touch with belt clip.





7. SAR EXPOSURE LIMITS

SAR assessments have been made in line with the requirements of IEEE-1528, FCC Supplement C, and comply with ANSI/IEEE C95.1-1992 “Controlled Exposure Environment” limits. These limits apply to a location which is deemed as “Controlled Exposure Environment” which can be described as a situation where the general public may be exposed to an RF source with no prior knowledge or control over their exposure.

Limits for Occupational / Controlled Exposure Environment

Type Exposure Limits	Occupational / Controlled Exposure Environment(W/Kg)
Spatial Average SAR (whole body)	8.0

8. TEST EQUIPMENT LIST

Equipment description	Manufacturer/ Model	Identification No.	Current calibration date	Next calibration date
Stäubli Robot	Stäubli-TX60	F13/5Q2UD1/A/01	N/A	N/A
TISSUE Probe	SATIMO	SN 45/11 OCPG45	11/14/2013	11/13/2015
Robot Controller	Stäubli-CS8	139522	N/A	N/A
E-Field Probe	ES3DV3	SN:3337	09/05/2014	09/04/2015
ELI4 Phantom	ELI V5.0	1210	N/A	N/A
Device Holder	Speag-SD 000 H01 KA	SD 000 H01 KA	N/A	N/A
DAE4	Speag-SD 000 D04 BM	1398	10/27/2014	10/26/2015
SAR Software	Speag-DASY5	DASY52.8	N/A	N/A
Liquid	SATIMO	-	N/A	N/A
Radio Communication Tester	R&S-CMU200	069Y7-158-13-712	02/17/2014	02/16/2015
Loop Antenna	Speag-CLA150	SN 4008	01/24/2014	01/24/2017
Signal Generator	Agilent-E4438C	MY44260051	02/23/2014	02/22/2015
Power Sensor	NRP-Z23	US38261498	02/17/2014	02/16/2015
Spectrum Analyzer E4440	Agilent	US41421290	05/27/2014	05/26/2015
Network Analyzer	Rhode & Schwarz ZVL6	SN100132	02/17/2014	02/16/2015

Note: Per KDB 865664 Dipole SAR Validation Verification, AGC Lab has adopted 3 years calibration intervals. On annual basis, every measurement dipole has been evaluated and is in compliance with the following criteria:
1. There is no physical damage on the dipole;
2. System validation with specific dipole is within 10% of calibrated value;
3. Return-loss is within 20% of calibrated measurement;
4. Impedance is within 5Ω of calibrated measurement.

9. MEASUREMENT UNCERTAINTY

The component of uncertainly may generally be categorized according to the methods used to evaluate them. The evaluation of uncertainly by the statistical analysis of a series of observations is termed a Type An evaluation of uncertainty. The evaluation of uncertainty by means other than the statistical analysis of a series of observation is termed a Type B evaluation of uncertainty. Each component of uncertainty, however evaluated, is represented by an estimated standard deviation, termed standard uncertainty, which is determined by the positive square root of the estimated variance.

A Type A evaluation of standard uncertainty may be based on any valid statistical method for treating data. This includes calculating the standard deviation of the mean of a series of independent observations; using the method of least squares to fit a curve to the data in order to estimate the parameter of the curve and their standard deviations; or carrying out an analysis of variance in order to identify and quantify random effects in certain kinds of measurement.

A type B evaluation of standard uncertainty is typically based on scientific judgment using all of the relevant information available. These may include previous measurement data, experience, and knowledge of the behavior and properties of relevant materials and instruments, manufacture's specification, data provided in calibration reports and uncertainties assigned to reference data taken from handbooks. Broadly speaking, the uncertainty is either obtained from an outdoor source or obtained from an assumed distribution, such as the normal distribution, rectangular or triangular distributions indicated in Table 12.1

Uncertainty Distributions	**Normal**	**Rectangular**	**Triangular**	**U-Shape**
Multi-plying Factor(a)	1/k(b)	$1/\sqrt{3}$	$1/\sqrt{6}$	$1/\sqrt{2}$

(a) standard uncertainty is determined as the product of the multiplying factor and the estimated range of variations in the measured quantity

(b) κ is the coverage factor

Table 13.1 Standard Uncertainty for Assumed Distribution

The combined standard uncertainty of the measurement result represents the estimated standard deviation of the result. It is obtained by combining the individual standard uncertainties of both Type A and Type B evaluation using the usual "root-sum-squares" (RSS) methods of combining standard deviations by taking the positive square root of the estimated variances.

Expanded uncertainty is a measure of uncertainty that defines an interval about the measurement result within which the measured value is confidently believed to lie. It is obtained by multiplying the combined standard uncertainty by a coverage factor. Typically, the coverage factor ranges from 2 to 3. Using a coverage factor allows the true value of a measured quantity to be specified with a defined probability within the specified uncertainty range. For purpose of this document, a coverage factor two is used, which corresponds to confidence interval of about 95 %. The DASY uncertainty Budget is shown in the following tables.

DAYS5 Measurement Uncertainty Measurement uncertainty for 30 MHz to 3GHz averaged over 1 gram / 10 gram.							
Error Description	Uncertainty value(±10%)	Probability Distribution	Divisor	(Ci) 1g	(Ci) 10g	Standard Uncertainty (1g)	Standard Uncertainty (10g)
Measurement System							
Probe Calibration	6.0	Normal	1	1	1	±6.0%	±6.0%
Axial Isotropy	4.7	Rectangular	$\sqrt{3}$	0.7	0.7	±1.9%	±1.9%
Hemispherical Isotropy	9.6	Rectangular	$\sqrt{3}$	0.7	0.7	±3.9%	±3.9%
Linearity	4.7	Rectangular	$\sqrt{3}$	1	1	±2.7%	±2.7%
Probe Modulation Response	2.4	Rectangular	$\sqrt{3}$	1	1	±1.4%	±1.4%
System Detection Limits	1.0	Rectangular	$\sqrt{3}$	1	1	±0.6%	±0.6%
Boundary Effects	2.0	Rectangular	$\sqrt{3}$	1	1	±1.2%	±1.2%
Readout Electronics	0.3	Normal	$\sqrt{3}$	1	1	±0.3%	±0.3%
Response Time	0.8	Rectangular	$\sqrt{3}$	1	1	±0.5%	±0.5%
Integration Time	2.6	Rectangular	$\sqrt{3}$	1	1	±1.5%	±1.5%
RF Ambient Noise	3.0	Rectangular	$\sqrt{3}$	1	1	±1.7%	±1.7%
RF Ambient Reflection	3.0	Rectangular	$\sqrt{3}$	1	1	±1.7%	±1.7%
Probe Positioner	0.8	Rectangular	$\sqrt{3}$	1	1	±0.5%	±0.5%
Probe Positioning	6.7	Rectangular	$\sqrt{3}$	1	1	±3.9%	±3.9%
Post-processing	4.0	Rectangular	$\sqrt{3}$	1	1	±2.3%	±2.3%
Test Sample Related							
Device Positioning	3.6	Normal	1	1	1	±3.6%	±2.3%
Device Holder	2.9	Normal	1	1	1	±2.9%	±2.3%
Measurement SAR Drift	5.0	Rectangular	$\sqrt{3}$	1	1	±2.9%	±2.3%
Power Scaling	0.0	Rectangular	$\sqrt{3}$	1	1	±0.0%	±2.3%
Phantom and Setup							
Phantom Uncertainty	4.0	Rectangular	$\sqrt{3}$	1	1	±2.3%	±2.3%
Liquid Conductivity(Meas.)	2.5	Normal	1	0.78	0.71	±2.0%	±2.0%
Liquid Conductivity(Target)	5.0	Rectangular	$\sqrt{3}$	0.64	0.43	±1.8%	±1.8%
Liquid Permittivity(Meas.)	2.5	Normal		0.26	0.26	±0.7%	±0.7%
Liquid Permittivity((Target)	5.0	Rectangular	$\sqrt{3}$	0.6	0.49	±1.7%	±1.4%
Liquid Conductivity-temperature uncertainty	1.7	Rectangular	$\sqrt{3}$	0.78	0.71	±0.8%	±0.7%
Liquid Permittivity-temperature uncertainty	0.3	Rectangular	$\sqrt{3}$	0.23	0.26	±0.0%	±0.0%
Combined Standard Uncertainty						±12.2%	±11.9%
Coverage Factor for 95%						K=2	
Expanded Uncertainty						±22.0%	±21.5%

DAYS5 System Cheek Uncertainty for 30 MHz to 6GHz averaged range								
Error Description	Uncer. value (±10%)	Prob. Dist.	Div.	(Ci) 1g	(Ci) 10g	Std. Unc. (1g)	Std. Unc. (10g)	(v_i) V_{eff}
Measurement System								
Probe Calibration	6.55	Normal	1	1	1	±6.55%	±6.55%	∞
Axial Isotropy	4.7	Rectangular	$\sqrt{3}$	1	1	±2.7%	±2.7%	∞
Hemispherical Isotropy	9.6	Rectangular	$\sqrt{3}$	1	1	±0%	±0%	∞
Boundary Effects	1.0	Rectangular	$\sqrt{3}$	0	0	±0.6%	±0.6%	∞
Linearity	4.7	Rectangular	$\sqrt{3}$	1	1	±2.7%	±2.7%	∞
System Detection Limits	1.0	Rectangular	$\sqrt{3}$	1	1	±0.6%	±0.6%	∞
Modulation Response	0	Rectangular	$\sqrt{3}$	1	1	±0%	±0%	∞
Readout Electronics	0.3	Normal	1	1	1	±0.3%	±0.3%	∞
Response Time	0	Rectangular	$\sqrt{3}$	1	1	±0%	±0%	∞
Integration Time	0	Rectangular	$\sqrt{3}$	1	1	±0%	±0%	∞
RF Ambient Noise	1.0	Rectangular	$\sqrt{3}$	1	1	±0.6%	±0.6%	∞
RF Ambient Reflection	1.0	Rectangular	$\sqrt{3}$	1	1	±0.6%	±0.6%	∞
Probe Positioner	0.8	Rectangular	$\sqrt{3}$	1	1	±0.5%	±0.5%	∞
Probe Positioning	6.7	Rectangular	$\sqrt{3}$	1	1	±3.9%	±3.9%	∞
Max. SAR Eval.	2.0	Rectangular	$\sqrt{3}$	1	1	±1.2%	±1.2%	∞
Dipole Related								
Deviation of exp. dipole	5.5	Rectangular	$\sqrt{3}$	1	1	±3.2%	±3.2%	∞
Dipole Axis to Liquid Dist.	2.0	Rectangular	$\sqrt{3}$	1	1	±1.2%	±1.2%	∞
Input power & SAR drift	3.4	Rectangular	$\sqrt{3}$	1	1	±2.0%	±2.0%	∞
Phantom and Setup								
Phantom Uncertainty	4.0	Rectangular	$\sqrt{3}$	1	1	±2.3%	±2.3%	∞
SAR correction	1.9	Rectangular	$\sqrt{3}$	1	0.84	±1.1%	±0.9%	∞
Liquid Conductivity(Meas.)	2.5	Normal	1	0.78	0.71	±2.0%	±1.8%	∞
Liquid Permittivity(Meas.)	2.5	Normal	1	0.26	0.26	±0.6%	±0.7%	∞
Temp. unc. - Conductivity	1.7	Rectangular	$\sqrt{3}$	0.78	0.71	±0.8%	±0.7%	∞
Temp. unc. - Permittivity	0.3	Rectangular	$\sqrt{3}$	0.23	0.26	±0.0%	±0.0%	∞
Combined Std. Uncertainty						±10.1%	±10.1%	
Expanded STD Uncertainty						±20.2%	±20.1%	

10. CONDUCTED POWER MEASUREMENT

Frequency (MHz)	Channel Spacing	Measured Conducted Output power	
		Max. Peak Power (dBm)	Avg. Power (dBm)
136.025	12.5KHz	36.72	36.56
144.500		36.80	36.62
150.000		36.81	**36.64**
163.500		36.78	36.60
173.975		36.75	36.59

11. TEST RESULTS

11.1. SAR Test Results Summary

11.1.1. Test position and configuration

Head SAR was performed with the device configured in the positions according to KDB 643646 and Body SAR was performed with the device configurated with all accessories close to the Flat Phantom.

11.1.2. Operation Mode

· Set the EUT to maximum output power level and transmit on lower, middle and top channel with 100% duty cycle individually during SAR measurement.

· Per KDB 447498D01 v05r02 Chapter 4.1 6) the number of channels to be assessed is 5.

· Per KDB 643646 D01, 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.

When testing antennas with the default battery:

a. When the SAR≤ 3.5 W/kg, testing of all other required channels is not necessary for that antenna;
b. When the SAR > 3.5 W/kg and ≤ 4.0 W/kg, testing of the required immediately channel(s) is not necessary; testing of the other required channels may still be required.
c. When the SAR > 4.0 W/kg and ≤ 6.0 W/kg, SAR should be measured for that antenna on the all required channels;
d. When the highest measured SAR is ≤ 6.0 W/kg, PBA is not required

· Per KDB 643646 D01, 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.

When testing antennas with the default battery: the same test measurement with head part.

11.1.4. Test Result

SAR MEASUREMENT									
Ambient Temperature (°C) : 21 ±2				Relative Humidity (%): 55					
Liquid Temperature (°C) : 21 ±2				Depth of Liquid (cm):>15					
Product: Handheld Two Way Radio									
Test Mode: Hold to Face with 2.5 cm separation & Body worn with all accessories (VHF)									
Position	**Freq. (MHz)**	**Separation (KHz)**	**Power Drift (<±0.2)**	**SAR 1g with 100% duty Cycle (W/kg)*1**	**SAR 1g with 50% duty cycle (W/Kg)*2**	**Max. Turn-up Power (dBm)**	**Meas. output Power (dBm)**	**Scaled SAR (W/Kg)**	**Limit W/kg**
Face Up	150.000	12.5	-0.12	4.38	**2.190**	37	36.64	**2.379**	8.0
Back Touch	136.025	12.5	0.14	5.60	2.800	37	36.56	3.099	8.0
Back Touch	150.000	12.5	-0.15	6.57	**3.285**	37	36.64	**3.569**	8.0
Back Touch	173.975	12.5	0.07	5.41	2.705	37	36.59	2.973	8.0

Note:
1 During the test, EUT power is 5 W with 100% duty cycle;
2.There is just default battery and antenna in this project;
3 According to KDB 643646 D01, when testing antennas with the default battery:
a. When the SAR≤ 3.5 W/kg, testing of all other required channels is not necessary for that antenna;
b. When the SAR > 3.5 W/kg and ≤ 4.0 W/kg, testing of the required immediately channel(s) is not necessary; testing of the other required channels may still be required.
c. When the SAR > 4.0 W/kg and ≤ 6.0 W/kg, SAR should be measured for that antenna on the all required channels;
d. When the highest scaled SAR is ≤ 6.0 W/kg, PBA is not required

Repeated SAR								
Ambient Temperature (°C) : 21 ±2				Relative Humidity (%): 55				
Liquid Temperature (°C) : 21 ±2				Depth of Liquid (cm):>15				
Product: Handheld Two Way Radio								
Test Mode: Body worn with all accessories(VHF)								
Position	**Freq. (MHz)**	**Separation (KHz)**	**Power Drift (<±0.2)**	**Once SAR 1g with 100% duty cycle (W/kg)**	**Once SAR 1g with 50% duty cycle (W/Kg)**	**Twice SAR 1g with 100% duty cycle (W/kg)**	**Twice SAR 1g with 50% duty cycle (W/kg)**	**Limit W/kg**
Back Touch	150.000	12.5	0.15	6.29	3.145	--	--	8.0

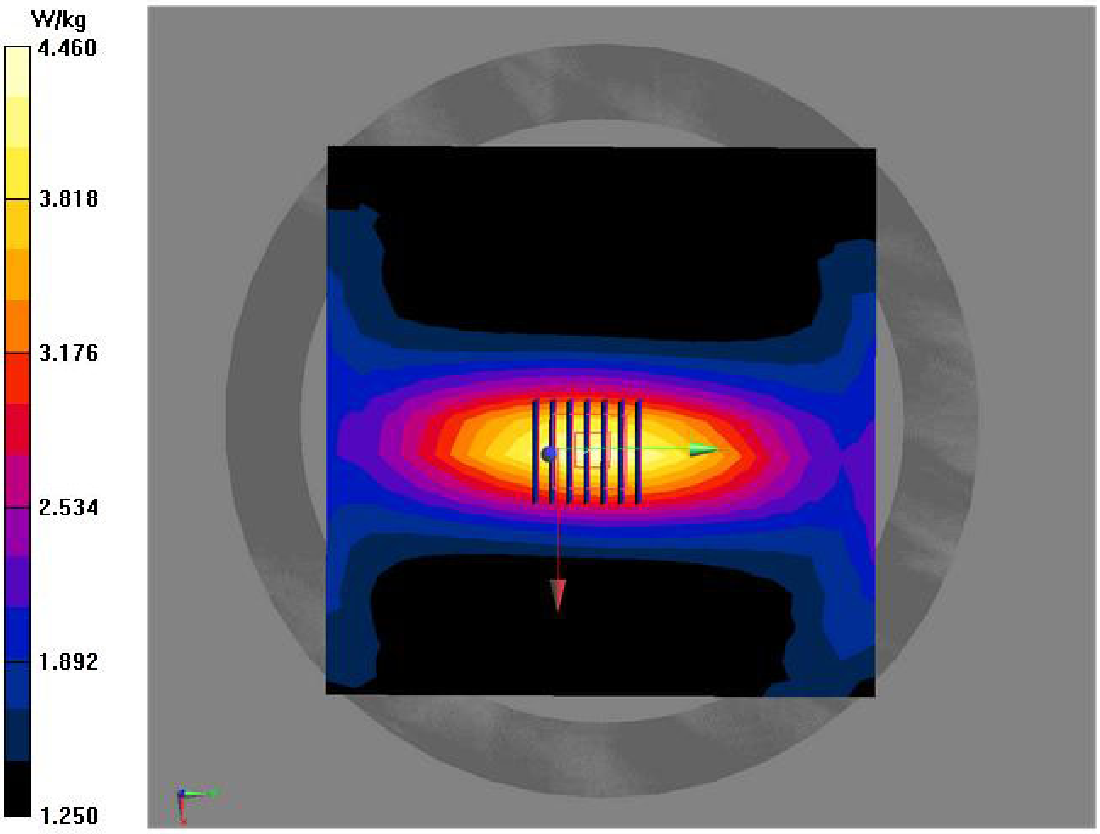
APPENDIX A. SAR SYSTEM VALIDATION DATA

Test Laboratory: AGC Lab **Test date: Dec. 19,2014**
System Check Head 150MHz
DUT: Dipole 150 MHz Type: SID 150
Communication System: CW; Communication System Band: CW; Duty Cycle: 1:1;
Frequency: 150MHz; Medium parameters used: f = 150MHz; σ=0.77 mho/m; εr = 52.51 ; ρ = 1000 kg/m³ ;
Phantom Type: Elliptical Phantom; Input Power=30 dBm
Ambient temperature (°C): 21.0, Liquid temperature (°C): 21.0

DASY Configuration:

- Probe: ES3DV3-SN:3337; ConvF(7.56,7.56,7.56);Calibrated: 09/05/2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection), z = 1.0,
- Electronics: DAE4 Sn1398; Calibrated: 10/27/2014
- Phantom: ELI4 (20deg probe tilt) with CRP v5.0; Type: QD000P40CD;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

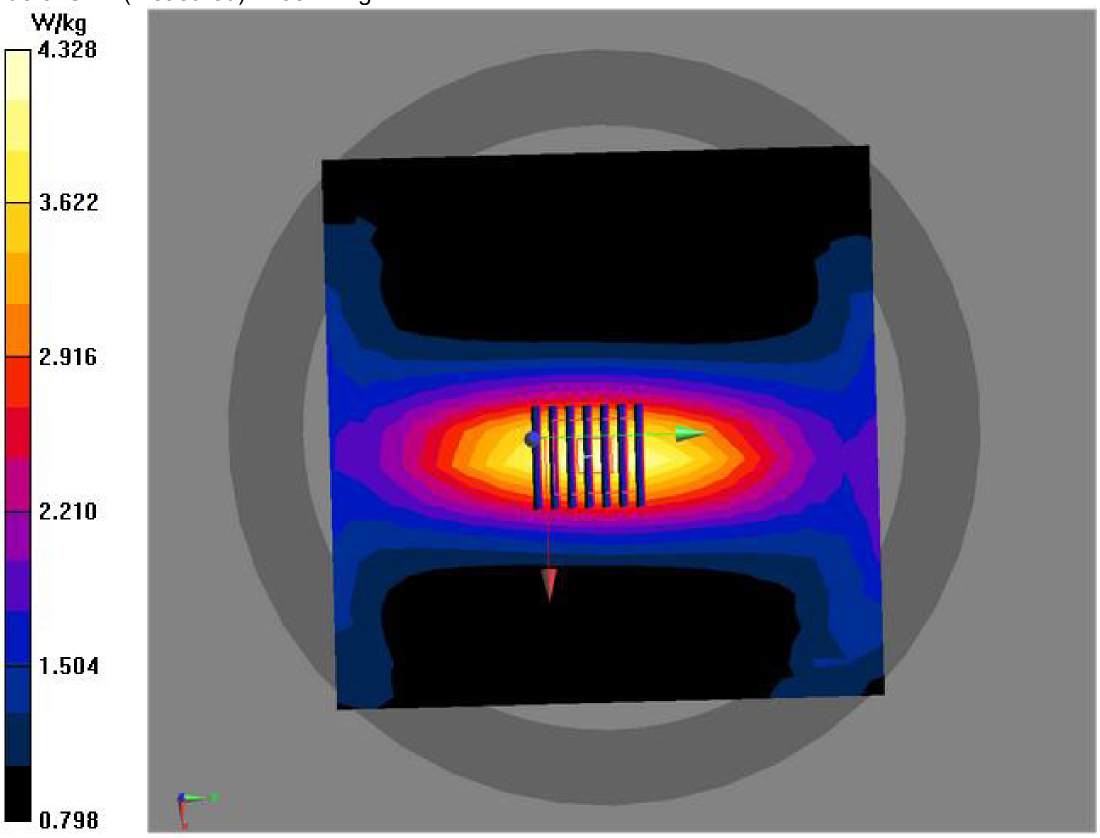
Configuration/System Check 150MHz Head/Area Scan (17×17×1): Measurement grid: dx=10.000mm, dy=10.000mm,
Maximum value of SAR (measured)=4.40 W/Kg
Configuration/System Check 150MHz Head/Zoom Scan (7×7×7)/Cube 0: Measurement grid: dx=5mm, dy =5mm, dz=5mm,
Reference Value=69.77 V/m; Power Drift=-0.02 dB
Peak SAR (extrapolated) =5.90 W/kg
SAR (1g) =3.80 W/Kg; SAR (10g) =2.51 W/Kg
Maximum value of SAR (measured)=4.46 W/Kg



Test Laboratory: AGC Lab **Test date: Dec. 19,2014**
System Check Body150MHz
DUT: Dipole 150 MHz Type: SID 150
Communication System: CW; Communication System Band: CW; Duty Cycle: 1:1;
Frequency: 150MHz; Medium parameters used: f = 150MHz; σ=0.81mho/m; εr = 61.02 ; ρ = 1000 kg/m³ ;
Phantom Type: Elliptical Phantom; Input Power=30 dBm
Ambient temperature (°C): 21.0, Liquid temperature (°C): 21.0

DASY Configuration:
- Probe: ES3DV3-SN:3337; ConvF(7.17,7.17,7.17); Calibrated: 09/05/2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection), z = 1.0,
- Electronics: DAE4 Sn1398; Calibrated: 10/27/2014
- Phantom: ELI4 (20deg probe tilt) with CRP v5.0; Type: QD000P40CD;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

Configuration/System Check 150MHz Body/Area Scan (17×17×1): Measurement grid: dx=10.000mm, dy=10.000mm,
Maximum value of SAR (measured)=4.32 W/Kg
Configuration/System Check 150MHz Body/Zoom Scan (7×7×7)/Cube 0: Measurement grid: dx=5mm, dy =5mm, dz=5mm,
Reference Value=66.145 V/m; Power Drift=0.11dB
Peak SAR (extrapolated) =5.78 W/kg
SAR (1g) =3.76 W/Kg; SAR (10g) =2.46 W/Kg
Maximum value of SAR (measured)=4.33 W/Kg



APPENDIX B. SAR MEASUREMENT DATA

Test Laboratory: AGC Lab **Date: Dec. 19,2014**
CW150Mid- face up 2.5cm (12.5 KHz)
DUT: Handheld Two Way Radio; Type: HLT-5199V

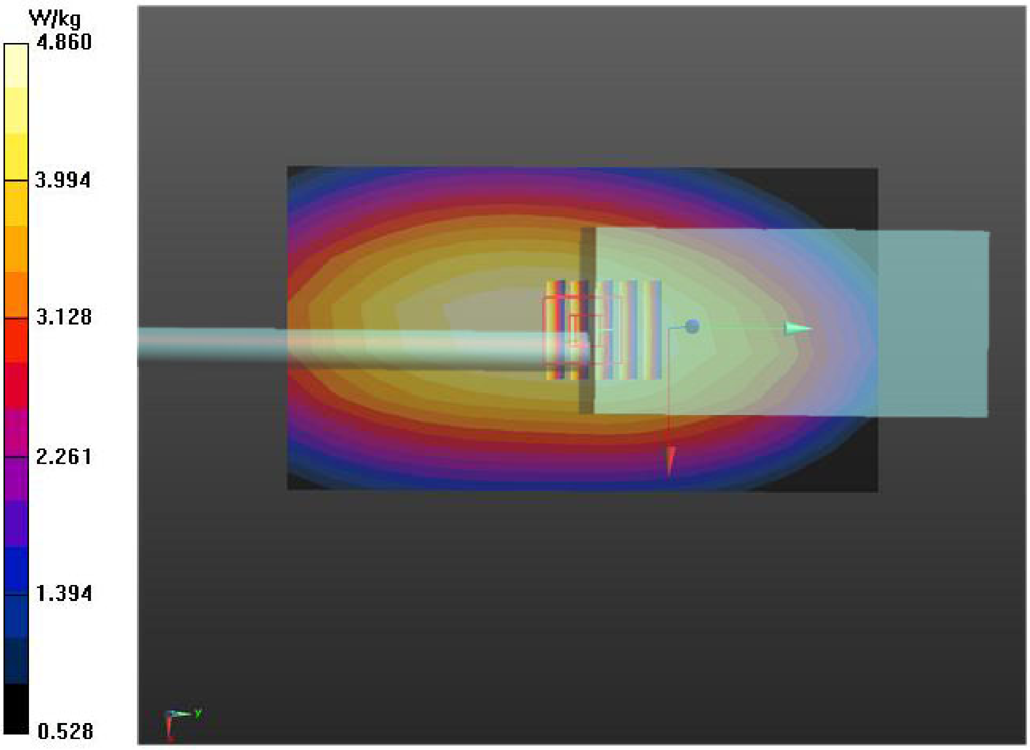
Communication System: CW; Communication System Band: CW 150MHz; Duty Cycle: 1:1;
Frequency:150.000 MHz; Medium parameters used: f = 150MHz; σ=0.77 mho/m; εr =52.51; ρ= 1000 kg/m³ ;
Phantom Type: Elliptical Phantom
Ambient temperature (°C): 21.5, Liquid temperature (°C): 21.0

DASY Configuration:

- Probe: ES3DV3-SN:3337; ConvF(7.56,7.56,7.56); Calibrated: 09/05/2014;;
- Sensor-Surface: 3mm (Mechanical Surface Detection), z = 1.0,
- Electronics: DAE4 Sn1398; Calibrated: 10/27/2014
- Phantom: ELI4 (20deg probe tilt) with CRP v5.0; Type: QD000P40CD;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

FRONT/1/Area Scan (8x14x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 4.84 W/kg

FRONT/1/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 77.322 V/m; Power Drift = -0.12 dB
Peak SAR (extrapolated) = 5.83 W/kg
SAR(1 g) = 4.38 W/kg; SAR(10 g) = 3.23 W/kg
Maximum value of SAR (measured) = 4.86W/kg



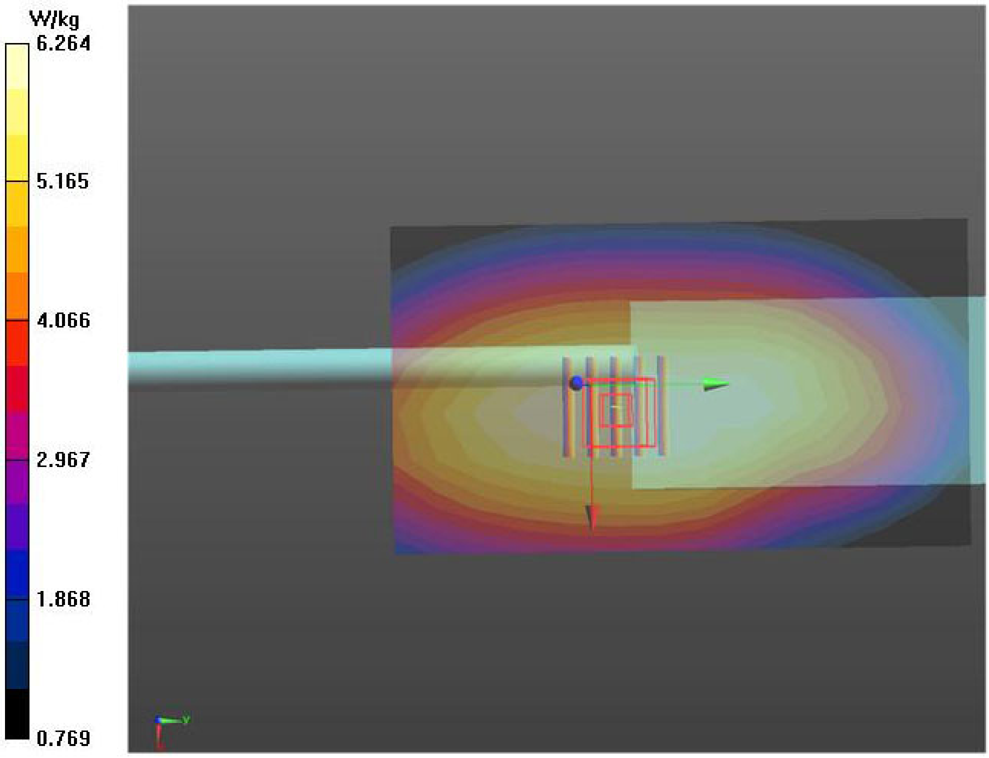
Test Laboratory: AGC Lab **Date: Dec. 19,2014**
CW150 Low -Body -Touch (12.5 KHz)
DUT: Handheld Two Way Radio; Type: HLT-5199V

Communication System: CW; Communication System Band: CW 150 MHz; Duty Cycle: 1:1;
Frequency:136.025MHz; Medium parameters used: f = 150 MHz; σ=0.78 mho/m; εr =59.40; ρ= 1000 kg/m³ ;
Phantom Type: Elliptical Phantom
Ambient temperature (°C): 21.5, Liquid temperature(°C): 21.0

DASY Configuration:
- Probe: ES3DV3-SN:3337; ConvF(7.17,7.17,7.17); Calibrated: 09/05/2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection), z = 1.0,
- Electronics: DAE4 Sn1398; Calibrated: 10/27/2014
- Phantom: ELI4 (20deg probe tilt) with CRP v5.0; Type: QD000P40CD;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

BACK/1/Area Scan (8x14x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 6.48 W/kg

BACK/1/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 88.646V/m; Power Drift = 0.14 dB
Peak SAR (extrapolated) = 7.56 W/kg
SAR(1 g) = 5.60 W/kg; SAR(10 g) = 4.20 W/kg
Maximum value of SAR (measured) = 6.26 W/kg



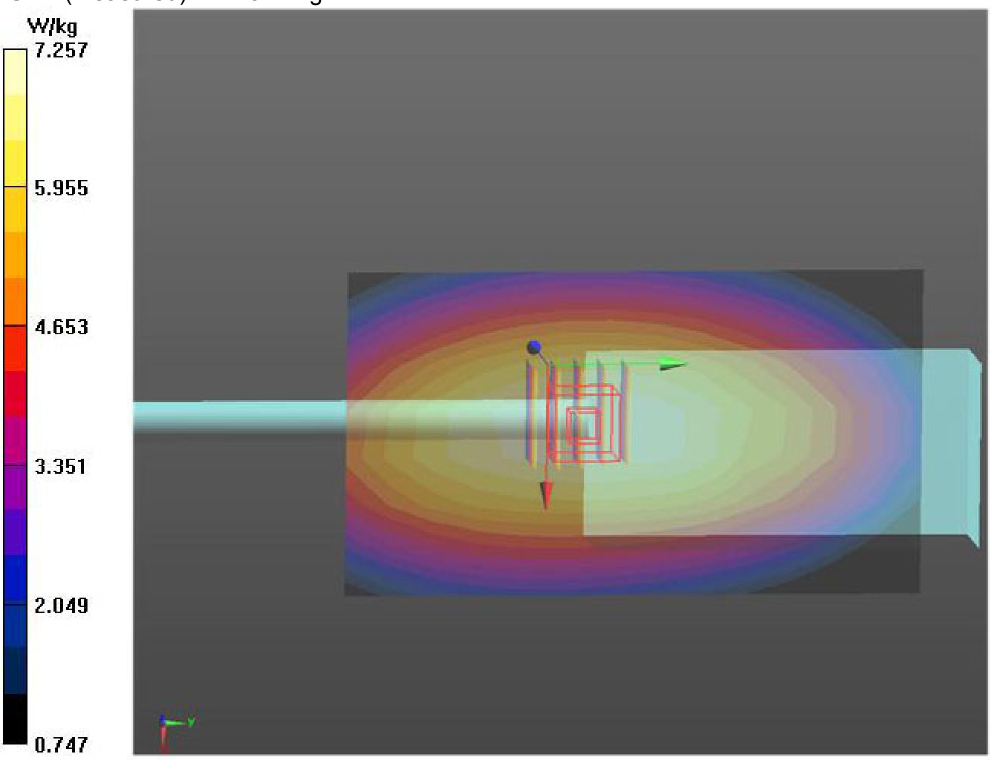
Test Laboratory: AGC Lab **Date: Dec. 19,2014**
CW150 Mid -Body –Touch (12.5 KHz)
DUT: Handheld Two Way Radio; Type: HLT-5199V

Communication System: CW; Communication System Band: CW 150 MHz; Duty Cycle: 1:1;
Frequency:150.000 MHz; Medium parameters used: f = 150 MHz; σ=0.81 mho/m; εr =61.02; ρ= 1000 kg/m³ ;
Phantom Type: Elliptical Phantom
Ambient temperature (°C): 21.5, Liquid temperature(°C): 21.0

DASY Configuration:
- Probe: ES3DV3-SN:3337; ConvF(7.17,7.17,7.17); Calibrated: 09/05/2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection), z = 1.0,
- Electronics: DAE4 Sn1398; Calibrated: 10/27/2014
- Phantom: ELI4 (20deg probe tilt) with CRP v5.0; Type: QD000P40CD; ;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

BACK/2/Area Scan (8x14x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 7.09 W/kg

BACK/2/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 94.840V/m; Power Drift = -0.15 dB
Peak SAR (extrapolated) = 8.78 W/kg
SAR(1 g) = 6.57 W/kg; SAR(10 g) = 4.90 W/kg
Maximum value of SAR (measured) = 7.26 W/kg



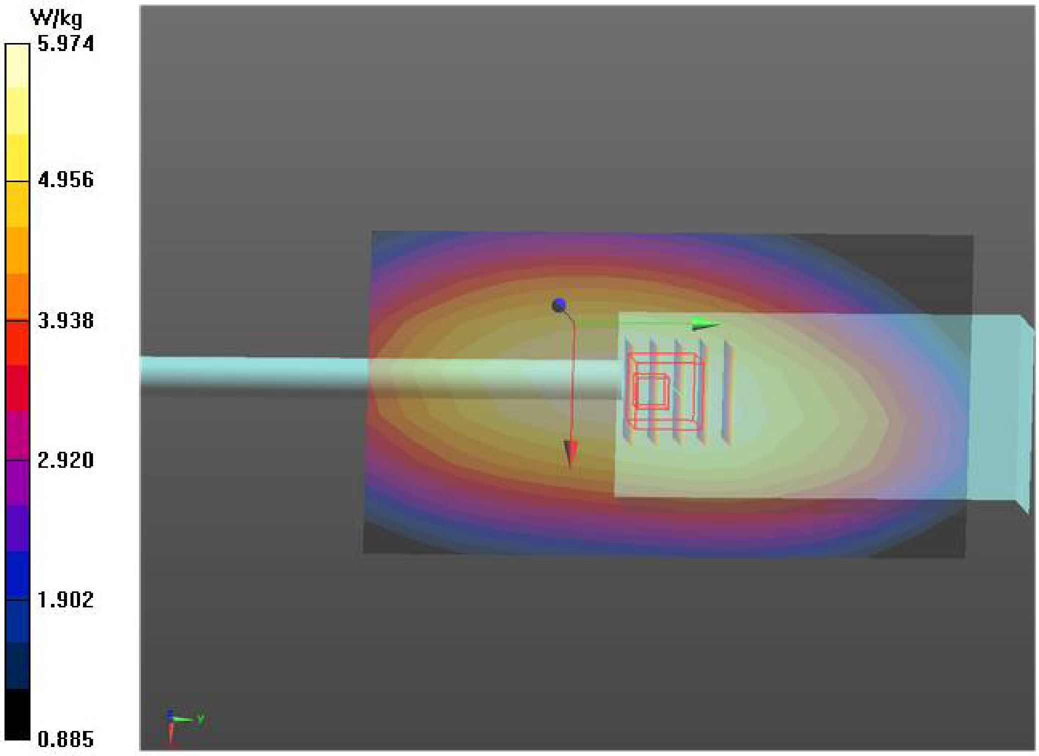
Test Laboratory: AGC Lab **Date: Dec. 19,2014**
CW150 High -Body –Touch (12.5 KHz)
DUT: Handheld Two Way Radio; Type: HLT-5199V

Communication System: CW; Communication System Band: CW 150 MHz; Duty Cycle: 1:1;
Frequency: 173.975MHz; Medium parameters used: f = 150 MHz; σ=0.0.82 mho/m; εr =60.17; ρ= 1000 kg/m³ ;
Phantom Type: Elliptical Phantom
Ambient temperature (°C): 21.5, Liquid temperature(°C): 21.0

DASY Configuration:
- Probe: ES3DV3-SN:3337; ConvF (7.17,7.17,7.17); Calibrated: 01/28/2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection), z = 1.0,
- Electronics: DAE4 Sn1398; Calibrated: 10/27/2014
- Phantom: ELI4 (20deg probe tilt) with CRP v5.0; Type: QD000P40CD;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

BACK/3/Area Scan (8x14x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 5.94 W/kg

BACK/3/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 86.068 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 7.40 W/kg
SAR(1 g) = 5.41 W/kg; SAR(10 g) = 4.03 W/kg
Maximum value of SAR (measured) = 5.97 W/kg



Repeated SAR
Test Laboratory: AGC Lab **Date: Dec. 19,2014**
CW150 Mid -Body –Touch (12.5 KHz)
DUT: Handheld Two Way Radio; Type: HLT-5199V

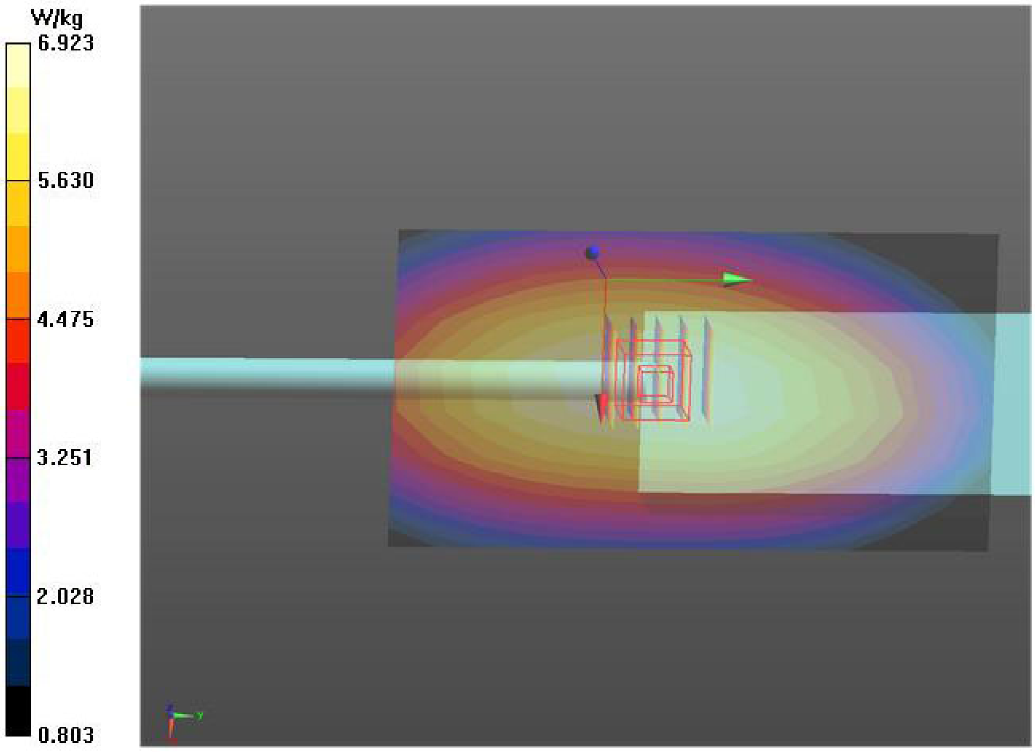
Communication System: CW; Communication System Band: CW 150 MHz; Duty Cycle: 1:1;
Frequency:150.000 MHz; Medium parameters used: f = 150 MHz; σ=0.81 mho/m; εr =61.02; ρ= 1000 kg/m³;
Phantom Type: Elliptical Phantom
Ambient temperature (℃): 21.5, Liquid temperature(℃): 21.0

DASY Configuration:

- Probe: ES3DV3-SN:3337; ConvF(7.17,7.17,7.17); Calibrated: 09/05/2014;
- Sensor-Surface: 3mm (Mechanical Surface Detection), z = 1.0,
- Electronics: DAE4 Sn1398; Calibrated: 10/27/2014
- Phantom: ELI4 (20deg probe tilt) with CRP v5.0; Type: QD000P40CD; ;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

BACK/2/Area Scan (8x14x1): Measurement grid: dx=15mm, dy=15mm
Maximum value of SAR (measured) = 6.64 W/kg

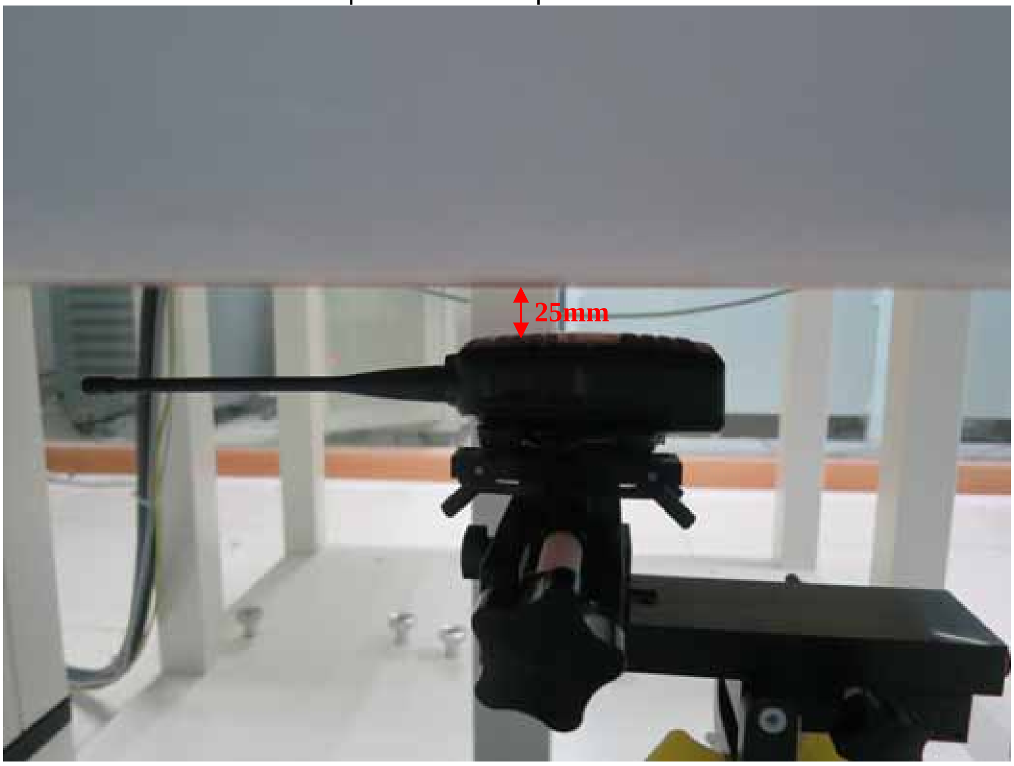
BACK/2/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm
Reference Value = 92.715 V/m; Power Drift = 0.15 dB
Peak SAR (extrapolated) = 8.37 W/kg
SAR(1 g) = 6.29 W/kg; SAR(10 g) = 4.72 W/kg
Maximum value of SAR (measured) = 6.92 W/kg



APPENDIX C. TEST SETUP PHOTOGRAPHS &EUT PHOTOGRAPHS

Test Setup Photographs

Face Up with 25mm Separation Distance.



Body Back Touch with all accessories

Note : The headset is just for testing. This tested and electrically similar headsets may be used

DEPTH OF THE LIQUID IN THE PHANTOM—ZOOM IN

Note：The position used in the measurement were according to IEEE 1528-2003

150-Head Liquid	150-Body Liquid
	

EUT PHOTOGRAPHS

TOTAL VIEW OF EUT

TOP VIEW OF EUT

BOTTOM VIEW OF EUT

FRONT VIEW OF EUT

BACK VIEW OF EUT

LEFT VIEW OF EUT

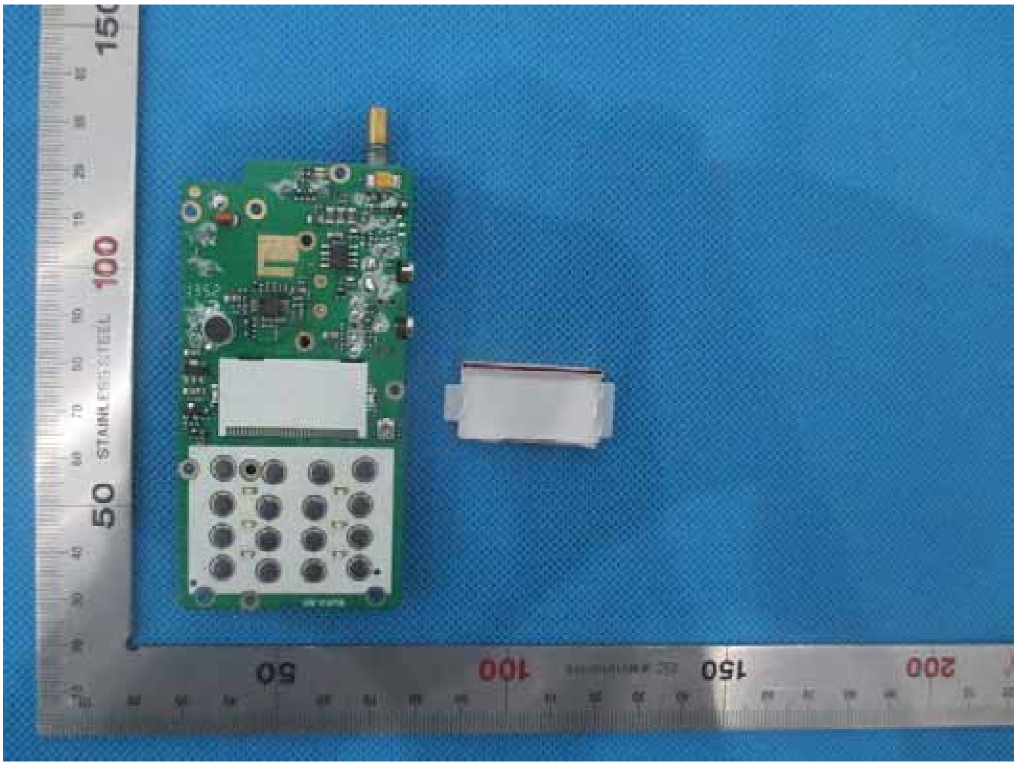
RIGHT VIEW OF EUT

OPEN VIEW-1 OF EUT

OPEN VIEW-2 OF EUT

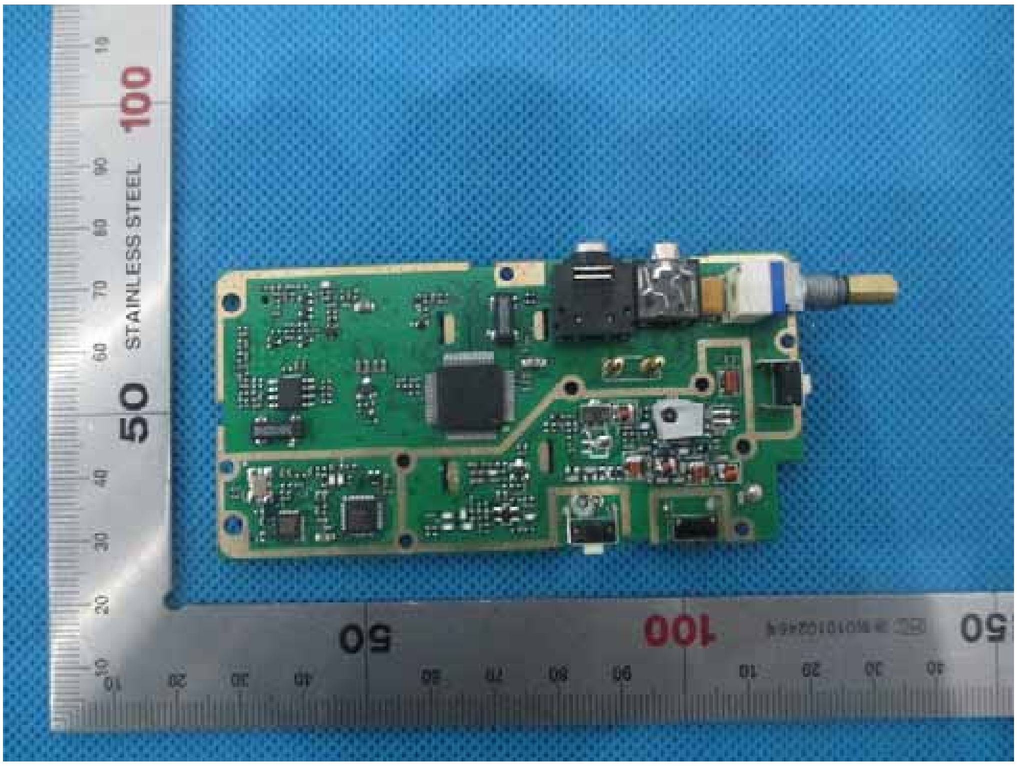
INTERNAL VIEW-1 OF EUT

INTERNAL VIEW-2 OF EUT



INTERNAL VIEW-3 OF EUT

INTERNAL VIEW-4 OF EUT



APPENDIX D. PROBE CALIBRATION DATA

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 108**

Client **AGC-CERT (Auden)**

Certificate No: **ES3-3337_Sep14**

CALIBRATION CERTIFICATE

Object: ES3DV3 - SN:3337

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 5, 2014

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 E4419B	GB41293874	03-Apr-14 (No. 217-01911)	Apr-15
Power sensor E4412A	MY41498087	03-Apr-14 (No. 217-01911)	Apr-15
Reference 3 dB Attenuator	SN: S5054 (3c)	03-Apr-14 (No. 217-01915)	Apr-15
Reference 20 dB Attenuator	SN: S5277 (20x)	03-Apr-14 (No. 217-01919)	Apr-15
Reference 30 dB Attenuator	SN: S5129 (30b)	03-Apr-14 (No. 217-01920)	Apr-15
Reference Probe ES3DV2	SN: 3013	30-Dec-13 (No. ES3-3013_Dec13)	Dec-14
DAE4	SN: 660	13-Dec-13 (No. DAE4-660_Dec13)	Dec-14
Secondary Standards	ID	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	4-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

	Name	Function	Signature
Calibrated by:	Jeton Kastrati	Laboratory Technician	
Approved by:	Katja Pokovic	Technical Manager	

Issued: September 6, 2014

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

Accreditation No.: **SCS 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEEE Std 1528-2013, "IEEE Recommended Practice for Determining the Peak Spatial-Averaged Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques", June 2013

b) IEC 62209-1, "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

Methods Applied and Interpretation of Parameters:

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

Probe ES3DV3

SN:3337

Manufactured: January 24, 2012
Repaired: August 25, 2014
Calibrated: September 5, 2014

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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3337

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc (k=2)
Norm ($\mu V/(V/m)^2$)[A]	1.11	0.97	1.00	± 10.1 %
DCP (mV)[B]	104.8	103.8	103.8	

Modulation Calibration Parameters

UID	Communication System Name		A dB	B dB√μV	C	D dB	VR mV	Unc[E] (k=2)
0	CW	X	0.0	0.0	1.0	0.00	168.6	±3.8 %
		Y	0.0	0.0	1.0		183.6	
		Z	0.0	0.0	1.0		184.7	

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 NormX,Y,Z do not affect the E^2-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.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3337

Calibration Parameter Determined in Head Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
150	52.3	0.76	7.56	7.56	7.56	0.07	1.20	± 13.3 %
450	43.5	0.87	6.71	6.71	6.71	0.21	1.90	± 13.3 %

[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.

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3337

Calibration Parameter Determined in Body Tissue Simulating Media

f (MHz) [C]	Relative Permittivity [F]	Conductivity (S/m) [F]	ConvF X	ConvF Y	ConvF Z	Alpha [G]	Depth [G] (mm)	Unct. (k=2)
150	61.9	0.80	7.17	7.17	7.17	0.07	1.20	± 13.3 %
450	56.7	0.94	7.08	7.08	7.08	0.12	1.50	± 13.3 %

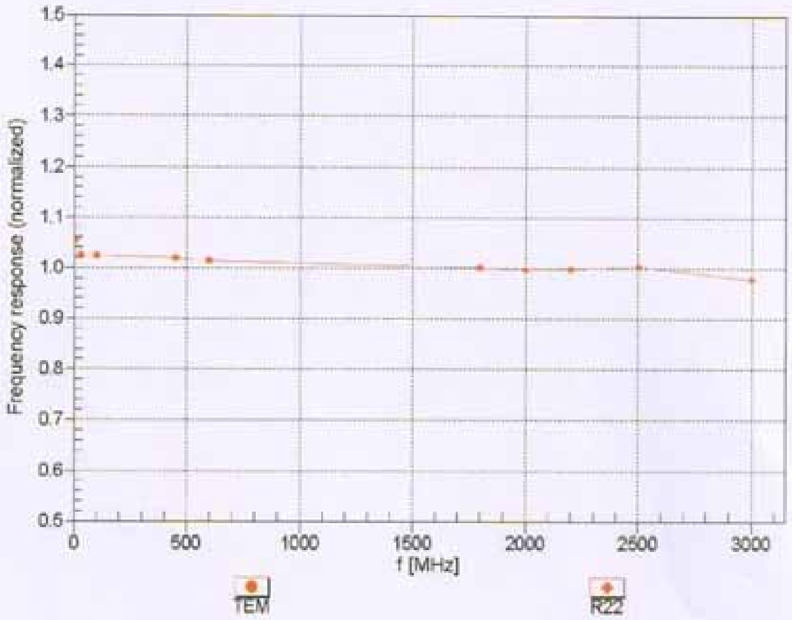
[C] Frequency validity above 300 MHz of ± 100 MHz only applies for DASY v4.4 and higher (see Page 2), else it is restricted to ± 50 MHz. The uncertainty is the RSS of the ConvF uncertainty at calibration frequency and the uncertainty for the indicated frequency band. Frequency validity below 300 MHz 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.

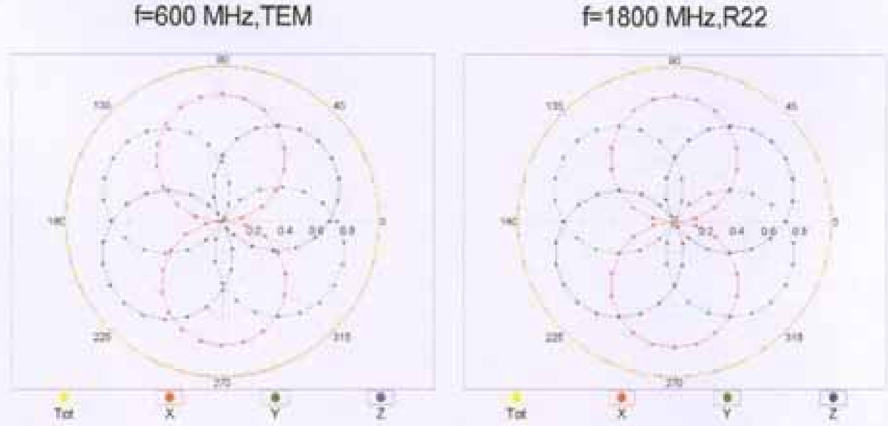
Frequency Response of E-Field

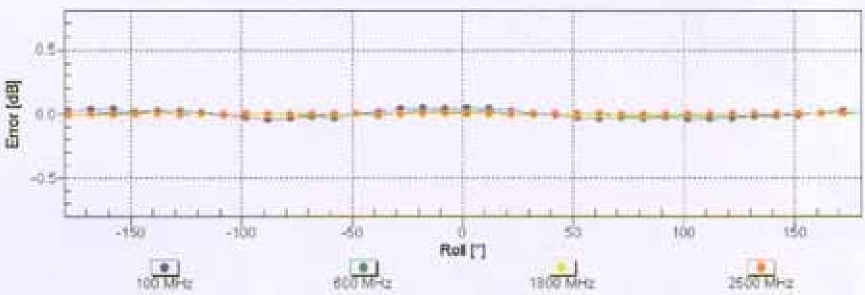
(TEM-Cell:ifi110 EXX, Waveguide: R22)



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

Receiving Pattern (ϕ), ϑ = 0°

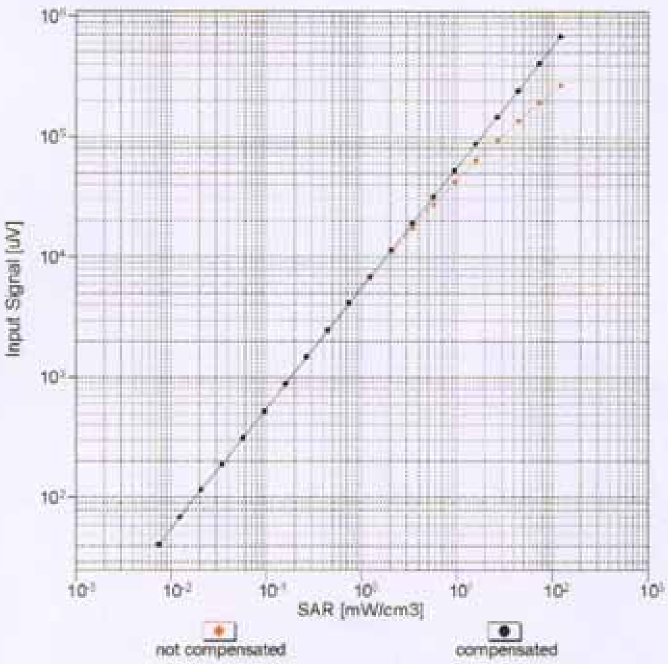


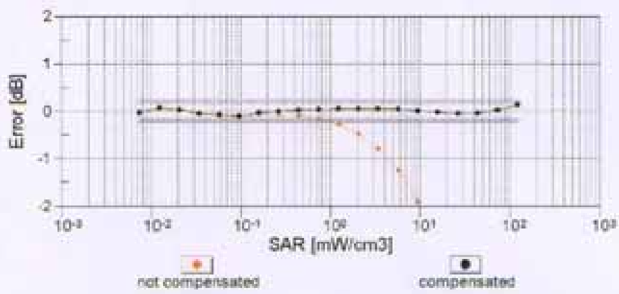


Uncertainty of Axial Isotropy Assessment: ± 0.5% (k=2)

Dynamic Range f(SAR_{head})

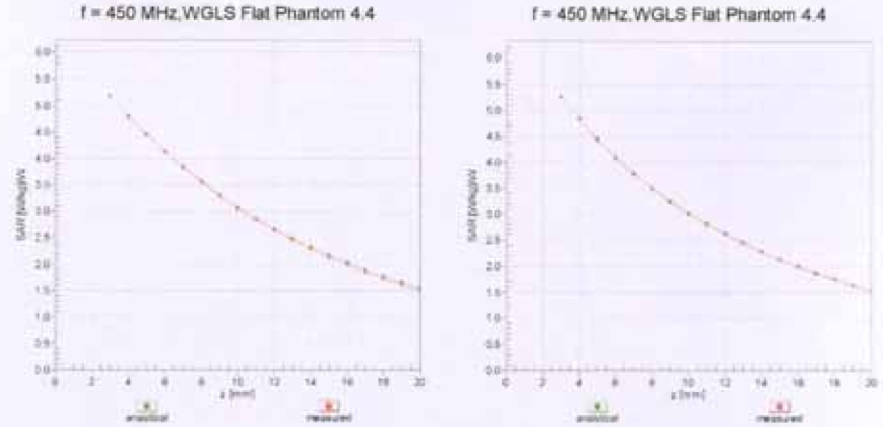
(TEM cell , f_{eval}= 1900 MHz)





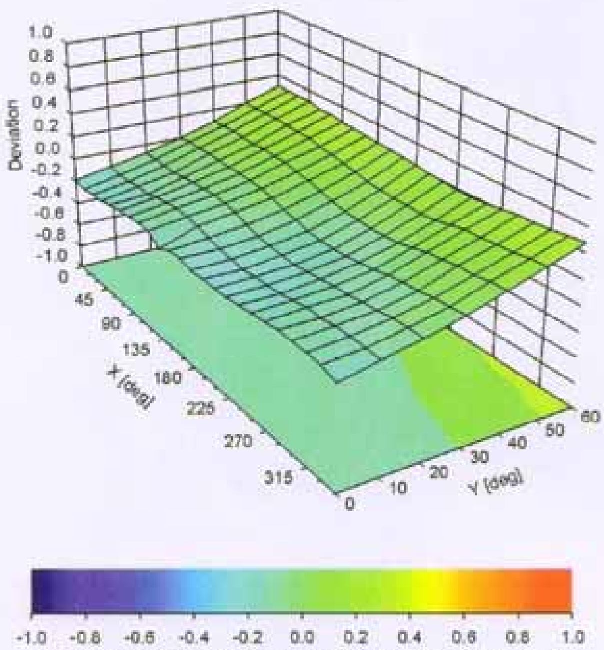
Uncertainty of Linearity Assessment: ± 0.6% (k=2)

Conversion Factor Assessment



Deviation from Isotropy in Liquid

Error (ϕ, ϑ), f = 900 MHz



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

DASY/EASY - Parameters of Probe: ES3DV3 - SN:3337

Other Probe Parameters

Sensor Arrangement	Triangular
Connector Angle (°)	-8.1
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	2 mm

APPENDIX E. DAE CALIBRATION DATA

In Collaboration with
s p e a g
CALIBRATION LABORATORY

Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504
E-mail: cttl@chinattl.com Http://www.chinattl.cn

CALIBRATION No. L0570

Client : agc-cert(鑫宇环) Certificate No: Z14-97132

CALIBRATION CERTIFICATE

Object	DAE4 - SN: 1398
Calibration Procedure(s)	TMC-OS-E-01-198 Calibration Procedure for the Data Acquisition Electronics (DAEx)
Calibration date:	October 27, 2014

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

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

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID #	Cal Date(Calibrated by, Certificate No.)	Scheduled Calibration
Process Calibrator 753	1971018	01-July-14 (CTTL, No:J14X02147)	July-15

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

Issued: October 28, 2014

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

In Collaboration with
speag
CALIBRATION LABORATORY
Add: No.51 Xueyuan Road, Haidian District, Beijing, 100191, China
Tel: +86-10-62304633-2079 Fax: +86-10-62304633-2504
E-mail: cttl@chinatll.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.

In Collaboration with
s p e a g
CALIBRATION LABORATORY

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E-mail: cttl@chinattl.com Http://www.chinattl.cn

DC Voltage Measurement

A/D - Converter Resolution nominal
High Range: 1LSB = 6.1μV , full range = -100...+300 mV
Low Range: 1LSB = 61nV , full range = -1.......+3mV
DASY measurement parameters: Auto Zero Time: 3 sec; Measuring time: 3 sec

Calibration Factors	X	Y	Z
High Range	404.206 ± 0.15% (k=2)	404.186 ± 0.15% (k=2)	403.648 ± 0.15% (k=2)
Low Range	3.97611 ± 0.7% (k=2)	3.99334 ± 0.7% (k=2)	3.97121 ± 0.7% (k=2)

Connector Angle

Connector Angle to be used in DASY system	196° ± 1 °

APPENDIX F LOOP ANTENNA CALIBRATION DATA

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

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
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 108

Client **AGC-CERT (Auden)**

Certificate No: **CLA150-4008_Jan14**

CALIBRATION CERTIFICATE

Object: CLA150 - SN: 4008

Calibration procedure(s): QA CAL-15.v8
Calibration procedure for system validation sources below 700 MHz

Calibration date: January 24, 2014

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 E4419B	GB41293874	04-Apr-13 (No. 217-01733)	Apr-14
Power sensor E4412A	MY41498087	04-Apr-13 (No. 217-01733)	Apr-14
Reference 3 dB Attenuator	SN: S5054 (3c)	04-Apr-13 (No. 217-01737)	Apr-14
Reference 20 dB Attenuator	SN: S5058 (20k)	04-Apr-13 (No. 217-01736)	Apr-14
Type-N mismatch combination	SN: 5047.3 / 06327	04-Apr-13 (No. 217-01739)	Apr-14
Reference Probe EX3DV4	SN: 3877	06-Jan-14 (No. EX3-3877_Jan14)	Jan-15
DAE4	SN: 654	18-Jul-13 (No. DAE4-654_Jul13)	Jul-14

Secondary Standards	ID #	Check Date (in house)	Scheduled Check
RF generator HP 8648C	US3642U01700	04-Aug-99 (in house check Apr-13)	In house check: Apr-16
Network Analyzer HP 8753E	US37390585 S4206	18-Oct-01 (in house check Oct-13)	In house check: Oct-14

	Name	Function	Signature
Calibrated by:	Israe El-Naouq	Laboratory Technician	Israe El-Naouq
Approved by:	Katja Pokovic	Technical Manager	[signature]

Issued: January 29, 2014

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 108**

Glossary:

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

Calibration is Performed According to the Following Standards:

a) IEC 62209-2, "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 2013
b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Additional Documentation:

c) 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 source is mounted in a touch configuration below the center marking of the flat phantom.
- *Return Loss:* This parameter is measured with the source positioned under the liquid filled phantom (as described in the measurement condition clause). The Return Loss ensures low reflected power. 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	V52.8.7
Extrapolation	Advanced Extrapolation	
Phantom	ELI4 Flat Phantom	Shell thickness: 2 ± 0.2 mm
EUT Positioning	Touch Position	
Zoom Scan Resolution	dx, dy, dz = 5.0 mm	
Frequency	150 MHz ± 1 MHz	

Head TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Head TSL parameters	22.0 °C	52.3	0.76 mho/m
Measured Head TSL parameters	(22.0 ± 0.2) °C	50.5 ± 6 %	0.76 mho/m ± 6 %
Head TSL temperature change during test	< 0.5 °C	----	----

SAR result with Head TSL

SAR averaged over 1 cm³ (1 g) of Head TSL	Condition	
SAR measured	1 W input power	3.84 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**3.81 W/kg ± 18.4 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Head TSL	condition	
SAR measured	1 W input power	2.56 W/kg
SAR for nominal Head TSL parameters	normalized to 1W	**2.54 W/kg ± 18.0 % (k=2)**

Body TSL parameters

The following parameters and calculations were applied.

	Temperature	Permittivity	Conductivity
Nominal Body TSL parameters	22.0 °C	61.9	0.80 mho/m
Measured Body TSL parameters	(22.0 ± 0.2) °C	62.8 ± 6 %	0.80 mho/m ± 6 %
Body TSL temperature change during test	< 0.5 °C	----	----

SAR result with Body TSL

SAR averaged over 1 cm³ (1 g) of Body TSL	Condition	
SAR measured	1 W input power	3.88 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**3.89 W/kg ± 18.4 % (k=2)**

SAR averaged over 10 cm³ (10 g) of Body TSL	condition	
SAR measured	1 W input power	2.60 W/kg
SAR for nominal Body TSL parameters	normalized to 1W	**2.61 W/kg ± 18.0 % (k=2)**

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	44.0 Ω - 6.9 jΩ
Return Loss	- 20.3 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.4 Ω - 9.3 jΩ
Return Loss	- 20.1 dB

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	December 16, 2013

Appendix

Antenna Parameters with Head TSL

Impedance, transformed to feed point	44.0 Ω - 6.9 jΩ
Return Loss	- 20.3 dB

Antenna Parameters with Body TSL

Impedance, transformed to feed point	47.4 Ω - 9.3 jΩ
Return Loss	- 20.1 dB

Additional EUT Data

Manufactured by	SPEAG
Manufactured on	December 16, 2013

DASY5 Validation Report for Head TSL

Date: 24.01.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: CLA150; Type: CLA150; Serial: CLA150 - SN: 4008

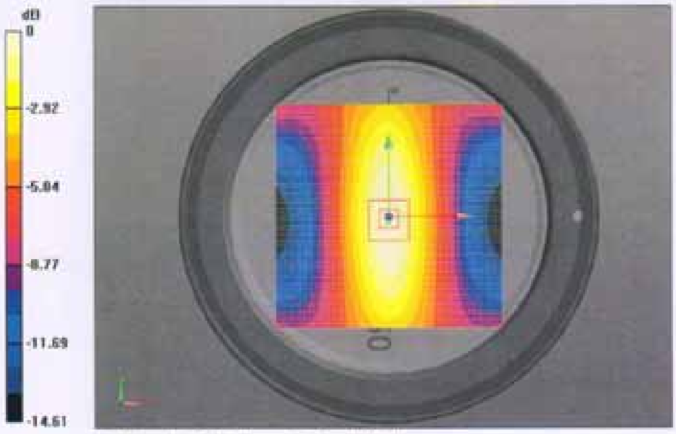
Communication System: UID 0 - CW; Frequency: 150 MHz
Medium parameters used: f = 150 MHz; $\sigma = 0.76$ S/m; $\varepsilon_r = 50.5$; $\rho = 1000$ kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(11.76, 11.76, 11.76); Calibrated: 06.01.2014;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 18.07.2013
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

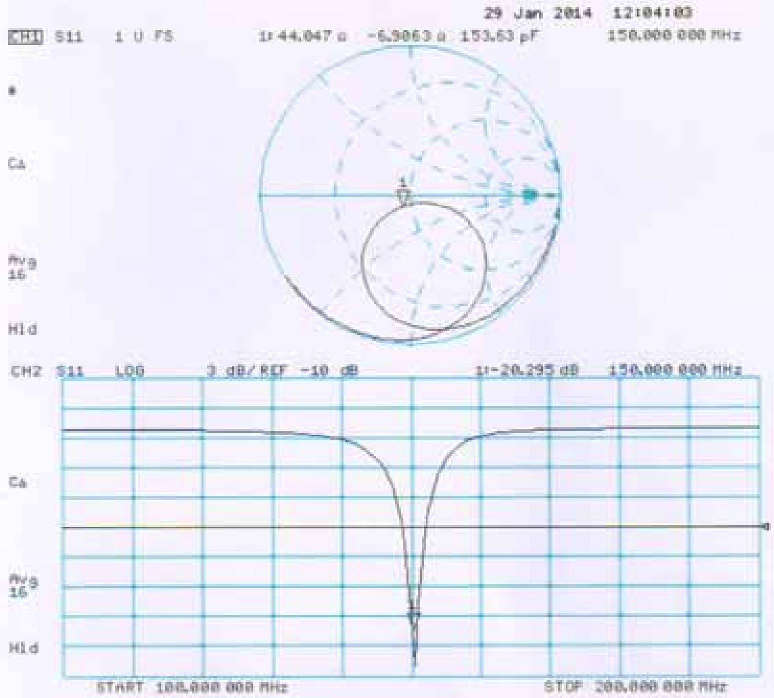
CLA Calibration for HSL-LF Tissue/CLA150, touch configuration, Pin=1W/Area Scan (81x81x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 4.92 W/kg

CLA Calibration for HSL-LF Tissue/CLA150, touch configuration, Pin=1W/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 80.503 V/m; Power Drift = -0.08 dB
Peak SAR (extrapolated) = 6.12 W/kg
SAR(1 g) = 3.84 W/kg; SAR(10 g) = 2.56 W/kg
Maximum value of SAR (measured) = 4.93 W/kg



0 dB = 4.92 W/kg = 6.92 dBW/kg

Impedance Measurement Plot for Head TSL



DASY5 Validation Report for Body TSL

Date: 24.01.2014

Test Laboratory: SPEAG, Zurich, Switzerland

DUT: CLA150; Type: CLA150; Serial: CLA150 - SN: 4008

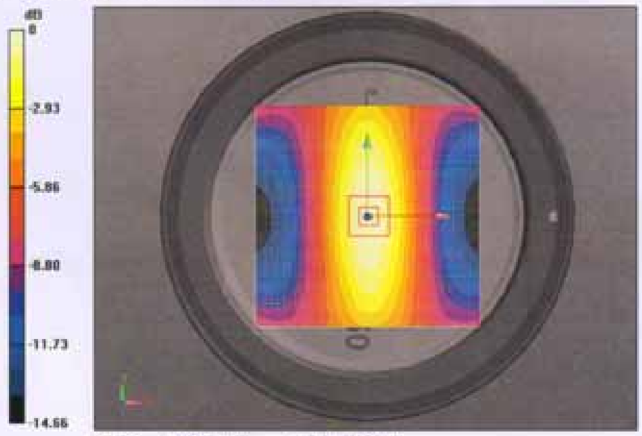
Communication System: UID 0 - CW; Frequency: 150 MHz
Medium parameters used: f = 150 MHz; σ = 0.799 S/m; ε_r = 62.757; ρ = 1000 kg/m^3
Phantom section: Flat Section
Measurement Standard: DASY5 (IEEE/IEC/ANSI C63.19-2007)

DASY52 Configuration:

- Probe: EX3DV4 - SN3877; ConvF(11.45, 11.45, 11.45); Calibrated: 06.01.2014;
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn654; Calibrated: 18.07.2013
- Phantom: ELI v4.0; Type: QDOVA001BB; Serial: TP:1003
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

CLA Calibration for MSL-LF Tissue/CLA150, touch configuration, Pin=1W/Area Scan (81x81x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 4.99 W/kg

CLA Calibration for MSL-LF Tissue/CLA150, touch configuration, Pin=1W/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 78.941 V/m; Power Drift = -0.04 dB
Peak SAR (extrapolated) = 6.21 W/kg
SAR(1 g) = 3.88 W/kg; SAR(10 g) = 2.6 W/kg
Maximum value of SAR (measured) = 5.00 W/kg



0 dB = 4.99 W/kg = 6.98 dBW/kg

Impedance Measurement Plot for Body TSL