
SAR Test Report

Report No.: AGC05198160101FH01

FCC ID : NMCAMP

APPLICATION PURPOSE : Original Equipment

PRODUCT DESIGNATION : Bluetooth headset

BRAND NAME : UCLEAR-DIGITAL

MODEL NAME : AMP,AMP PLUS, AMP PRO

CLIENT : BITwave Private Limited

DATE OF ISSUE : Feb. 02,2016

STANDARD(S) : IEEE Std. 1528:2013
FCC 47CFR § 2.1093
IEEE/ANSI C95.1:1992

REPORT VERSION : V1.0

Attestation of Global Compliance(Shenzhen) Co., Ltd.

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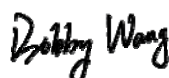


Report Revise Record

Report Version	Revise Time	Issued Date	Valid Version	Notes
V1.0	/	Feb. 02,2016	Valid	Original Report

Test Report Certification

Applicant Name	BITwave Private Limited
Applicant Address	11, Serangoon North Ave 5 , #05-03 Singapore 554809
Manufacturer Name	BITwave Private Limited
Manufacturer Address	11, Serangoon North Ave 5 , #05-03 Singapore 554809
Product Designation	Bluetooth headset
Brand Name	UCLEAR-DIGITAL
Model Name	AMP, AMP PLUS, AMP PRO
Different Description	All the same, except for the model name, software and headset cable.The test model is AMP.
EUT Voltage	DC3.7V by battery
Applicable Standard	IEEE Std. 1528:2013 FCC 47CFR § 2.1093 IEEE/ANSI C95.1:1992
Test Date	Jan. 28,2016
Performed Location	Attestation of Global Compliance(Shenzhen) Co., Ltd. 2 F, Building 2, No.1-No.4, Chaxi Sanwei Technical Industrial Park, Gushu, Xixiang Street, Bao'an District, Shenzhen, China
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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 Reported SAR Summary

Exposure Position	Test Mode	Highest Reported 1g-SAR(W/Kg)
Body	BT(communication)	0.346

This device is compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (1.6W/Kg) specified in IEEE Std. 1528:2013;FCC 47CFR § 2.1093; IEEE/ANSI C95.1:1992 and the following specific FCC Test Procedures:

- KDB 447498 D01 General RF Exposure Guidance v06
- KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04

2. GENERAL INFORMATION

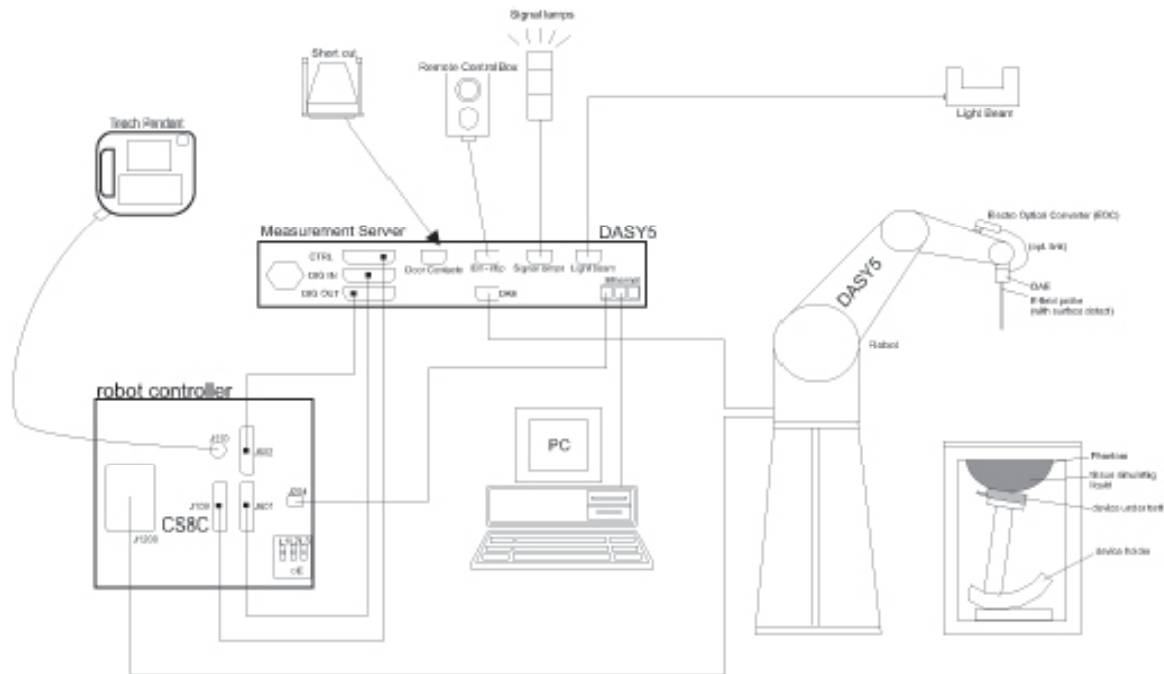
2.1. EUT Description

General Information	
Product Designation	Bluetooth headset
Test Model	AMP
Hardware Version	1.0
Software Version	0.28
Device Category	Portable
RF Exposure Environment	Uncontrolled
Antenna Type	Internal
Bluetooth	
Bluetooth Version	<input type="checkbox"/> V2.0 <input type="checkbox"/> V2.1 <input type="checkbox"/> V2.1+EDR <input type="checkbox"/> V3.0 <input type="checkbox"/> V3.0+HS <input type="checkbox"/> V4.0 <input type="checkbox"/> V4.1 <input checked="" type="checkbox"/> V4.2
Operation Frequency	2402~2480MHz
Type of modulation	<input checked="" type="checkbox"/> GFSK <input checked="" type="checkbox"/> π/4-DQPSK <input checked="" type="checkbox"/> 8-DPSK
Avg. Burst Power	14.79dBm
Antenna Gain	5.22dBi
Li-ion Battery	
Brand Name	A&S Power
Model Name	602535
Manufacturer Name	A&S Power
Manufacturer Address	NO.11,Yinhu Industrial Park,JiaoYiTang Village, TangXia, DongGuan,China
Capacitance	500mAh
Rated Voltage	DC3.7V
Charging Voltage	DC4.2V

Note: The sample used for testing is end product.

3. SAR MEASUREMENT SYSTEM

3.1. The DASY5 system used for performing compliance tests consists of following items




- A standard high precision 6-axis robot with controller, teach pendant and software.
- 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. Transmission to the measurement server is accomplished through an optical downlink for data and status information, as well as an optical uplink for commands and the clock
- A dosimetric probe equipped with an optical surface detector system.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital Communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- A Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- Phantoms, device holders and other accessories according to the targeted measurement.

3.2. 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 and relevant KDB files.) The calibration data are in Appendix D.

Isotropic E-Field Probe Specification


Model	ES3DV3	
Manufacture	SPEAG	
frequency	0.15GHz-3 GHz Linearity:±0.2dB(150 MHz-3 GHz)	
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 3 GHz with precision of better 30%.	

3.3. Data Acquisition Electronics description

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

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

DAE4

Input Impedance	200MOhm	
The Inputs	Symmetrical and floating	
Common mode rejection	above 80 dB	

3.4. 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



3.5. 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.1 mm, even if the other probe has different dimensions. During probe rotations, the probe tip will keep its actual position. e, the same position will be reached with another aligned probe within 0



3.6. 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 $\epsilon=3$ and loss tangent $\delta = 0.02$. 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.



3.7. 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.



3.8. PHANTOM

SAM Twin Phantom

The SAM twin phantom is a fiberglass shell phantom with 2mm shell thickness (except the ear region where shell thickness increases to 6mm). It has three measurement areas:

- Left head
- Right head
- 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.

ELI4 Phantom

Flat phantom a fiberglass shell flat phantom with 2mm \pm 0.2 mm shell thickness. It has only one measurement area for Flat phantom



4. SAR MEASUREMENT PROCEDURE

4.1. 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 element (dv) of given mass density (ρ). The equation description is as below:

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

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

SAR can be obtained using either of the following equations:

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

$$SAR = c_h \left. \frac{dT}{dt} \right|_{t=0}$$

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;
$\left. \frac{dT}{dt} \right _{t=0}$	is the initial time derivative of temperature in the tissue in kelvins per second

4.2. SAR Measurement Procedure

Step 1: Power Reference Measurement

The Power Reference Measurement and Power Drift Measurement are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface is 2.7mm This distance cannot be smaller than the distance os sensor calibration points to probe tip as `defined in the probe properties,

Step 2: Area Scan

The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum locations even in relatively coarse grids. When an Area Scan has measured all reachable points, it computes the field maximal 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 2db range is required in IEEE Standard 1528 and IEC62209 standards, whereby 3db is a requirement when compliance is assessed in accordance with the ARIB standard (Japan) If one Zoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. For cases where multiple maximum are detected, the number of Zoom Scan has to be increased accordingly.

Area Scan Parameters extracted from KDB 865664 D01 SAR Measurement 100MHz to 6GHz

	$\leq 3 \text{ GHz}$	$> 3 \text{ GHz}$
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	$5 \pm 1 \text{ mm}$	$\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5 \text{ mm}$
Maximum probe angle from probe axis to phantom surface normal at the measurement location	$30^\circ \pm 1^\circ$	$20^\circ \pm 1^\circ$
Maximum area scan spatial resolution: $\Delta x_{\text{Area}}, \Delta y_{\text{Area}}$	$\leq 2 \text{ GHz: } \leq 15 \text{ mm}$ $2 - 3 \text{ GHz: } \leq 12 \text{ mm}$	$3 - 4 \text{ GHz: } \leq 12 \text{ mm}$ $4 - 6 \text{ GHz: } \leq 10 \text{ mm}$
	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 \leq the corresponding x or y dimension of the test device with at least one measurement point on the test device.	

Step 3: Zoom Scan

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

Zoom Scan Parameters extracted from KDB865664 d01 SAR Measurement 100MHz to 6GHz

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

Step 4: Power Drift Measurement

The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the same settings. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

5. 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 5.2

5.1. The composition of the tissue simulating liquid

Ingredients	2450MHz	2450MHz
(% Weight)	Head	Body
Water	62.7%	73.2%
Sugar	0.0	0.0
HEC	0.0	0.0
Bactericide	0.0	0.0
DGBE	0.0	26.7%
NaCl	0.5%	0.1%
Triton X-100	36.8%	0.0
TOTAL	100.0%	100.0%

5.2. Tissue Dielectric Parameters for Head and Body Phantoms

The head tissue dielectric parameters recommended by the IEEE 1528 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 IEEE 1528 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 IEEE 1528.

Target Frequency (MHz)	head		body	
	ϵ_r	σ (S/m)	ϵ_r	σ (S/m)
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	1.01	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

(ϵ_r = relative permittivity, σ = conductivity and ρ = 1000 kg/m³)

5.3. 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 2450MHz				
Fr. (MHz)	Dielectric Parameters (±5%)		Tissue Temp [°C]	Test time
	head			
	εr 39.2 37.24-41.16	δ[s/m] 1.80 1.71-1.89		
2402	40.82	1.75	20.3	Jan. 28,2016
2441	40.53	1.77		
2450	40.14	1.80		
2480	39.61	1.73		

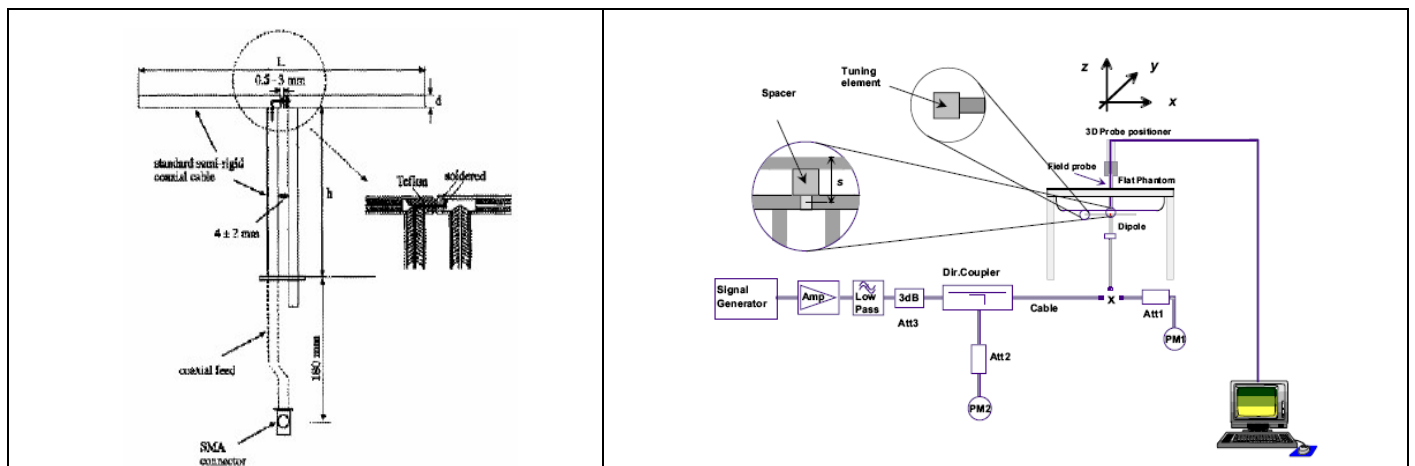
6. SAR SYSTEM CHECK PROCEDURE

6.1. SAR System Check Procedures

SAR system check is required to confirm measurement accuracy, according to the tissue dielectric media, probe calibration points and other system operating parameters required for measuring the SAR of a test device. The system verification must be performed for each frequency band and within the valid range of each probe calibration point required for testing the device. The same SAR probe(s) and tissue-equivalent media combinations used with each specific SAR system for system verification must be used for device testing. When multiple probe calibration points are required to cover substantially large transmission bands, independent system verifications are required for each probe calibration point. A system verification must be performed before each series of SAR measurements using the same probe calibration point and tissue-equivalent medium. Additional system verification should be considered according to the conditions of the tissue-equivalent medium and measured tissue dielectric parameters, typically every three to four days when the liquid parameters are remeasured or sooner when marginal liquid parameters are used at the beginning of a series of measurements.

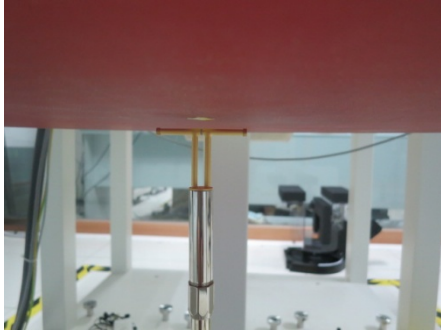
Each DASY system is equipped with one or more system check kits. These units, together with the predefined measurement procedures within the DASY software, enable the user to conduct the system check and system validation. System kit includes a dipole, and dipole device holder.

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 check setup is shown as below.



6.2. SAR System Check

6.2.1. Dipoles



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

Frequency	L (mm)	h (mm)	d (mm)
2450MHz	51.5	30.4	3.6

6.2.2. System Check Result

System Performance Check at 2450MHz for Head								
Validation Kit: D2450V2-SN:968								
Frequency [MHz]	Target Value(W/Kg)		Reference Result ($\pm 10\%$)		Normalized to 1W(W/Kg)		Tissue Temp. [°C]	Test time
	1g	10g	1g	10g	1g	10g		
2450	53.8	25.4	48.42-59.18	22.86-27.94	53.12	24.48	20.3	Jan. 28,2016

Note:

(1) We use a CW signal of 18dBm for system check, and then all SAR value are normalized to 1W forward power. The result must be within $\pm 10\%$ of target value.

7. EUT TEST POSITION

This EUT was tested in **Body back**.

7.1. 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 **10mm**.

According to FCC Response on 07/22/2013:

Please provide SAR test data for the side that will face the user's head during operation. Apply the following guidance:

- i. Use the flat phantom for testing.
- ii. Use a test separation distance of 10 mm away from the phantom (This separation distance was chosen based on the information you provided regarding the minimum separation distance between the device and the user during operation).
- iii. Use Head Tissue Simulating Liquid for the test.
- iv. Do not use the mounting bracket during the tests (Since the mounting bracket does not contain any metal it should not significantly affect the SAR results).

8. SAR EXPOSURE LIMITS

SAR assessments have been made in line with the requirements of IEEE-1528, and comply with ANSI/IEEE C95.1-1992 “Uncontrolled Environments” limits. These limits apply to a location which is deemed as “Uncontrolled 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 General Population/Uncontrolled Exposure (W/kg)

Type Exposure	Uncontrolled Environment Limit (W/kg)
Spatial Peak SAR (1g cube tissue for brain or body)	1.60
Spatial Average SAR (Whole body)	0.08
Spatial Peak SAR (Limbs)	4.0

9. 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
Robot Controller	Stäubli-CS8	139522	N/A	N/A
TISSUE Probe	SATIMO	SN 45/11 OCPG45	12/02/2015	12/01/2016
E-Field Probe	Speag- ES3DV3	SN:3337	10/01/2015	09/30/2016
SAM Twin Phantom	Speag-SAM	1790	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	03/11/2015	03/10/2016
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	03/06/2015	03/05/2016
Dipole	D2450V2	SN968	06/12/2015	06/11/2018
Signal Generator	Agilent-E4438C	MY44260051	03/06/2015	03/05/2016
Spectrum Analyzer E4440	Agilent	US41421290	07/23/2015	07/22/2016
Network Analyzer	Rhode & Schwarz ZVL6	SN100132	03/06/2015	03/05/2016
Attenuator	Warison /WATT-6SR1211	N/A	N/A	N/A
Attenuator	Mini-circuits / VAT-10+	N/A	N/A	N/A
Amplifier	EM30180	SN060552	03/06/2015	03/05/2016
Directional Couple	Werlatone/ C5571-10	SN99463	07/29/2015	07/28/2016
Directional Couple	Werlatone/ C6026-10	SN99482	07/29/2015	07/28/2016
Power Sensor	NRP-Z21	1137.6000.02	10/20/2015	10/19/2016
Power Sensor	NRP-Z23	US38261498	03/06/2015	03/05/2016
Power Viewer	R&S	V2.3.1.0	N/A	N/A

Note: Per KDB 865664 Dipole SAR Validation, 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.

10. MEASUREMENT UNCERTAINTY

The component of uncertainty may generally be categorized according to the methods used to evaluate them. The evaluation of uncertainty by the statistical analysis of a series of observations is termed a Type A 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 as follow.

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) k is the coverage factor

Table 13.1 Standard Uncertainty for Assumed Distribution (above table)

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.

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	6.53	Normal	1	1	1	6.53	6.53
Axial Isotropy	0.5	Rectangular	√3	1	1	0.29	0.29
Hemispherical Isotropy	2.6	Rectangular	√3	1	1	1.50	1.50
Linearity	0.6	Rectangular	√3	1	1	0.35	0.35
Probe Modulation Response	3.3	Rectangular	√3	1	1	1.91	1.91
System Detection Limits	0.9	Rectangular	√3	1	1	0.52	0.52
Boundary Effects	0.9	Rectangular	√3	0	0	0	0
Readout Electronics	0.2	Normal	√3	1	1	0.12	0.12
Response Time	0	Rectangular	√3	1	1	0	0
Integration Time	0	Rectangular	√3	1	1	0	0
RF Ambient Noise	0.9	Rectangular	√3	1	1	0.52	0.52
RF Ambient Reflection	0.9	Rectangular	√3	1	1	0.52	0.52
Probe Positioner	0.7	Rectangular	√3	1	1	0.40	0.40
Probe Positioning	6.5	Rectangular	√3	1	1	3.75	3.75
Post-processing	3.8	Rectangular	√3	1	1	2.19	2.19
Test Sample Related							
Device Positioning	3.6	Normal	1	1	1	3.6	3.6
Device Holder	2.9	Normal	1	1	1	2.9	2.9
Measurement SAR Drift	5.0	Rectangular	√3	1	1	2.89	2.89
Power Scaling	0.0	Rectangular	√3	1	1	0	0
Phantom and Setup							
Phantom Uncertainty	3.9	Rectangular	√3	1	1	2.25	2.25
Liquid Conductivity(Meas.)	2.4	Normal	1	0.78	0.71	1.87	1.70
Liquid Conductivity(Target)	4.9	Rectangular	√3	0.64	0.43	1.81	1.22
Liquid Permittivity(Meas.)	2.4	Normal	1	0.26	0.26	0.62	0.62
Liquid Permittivity((Target)	4.9	Rectangular	√3	0.6	0.49	1.70	1.39
Liquid Conductivity-temperature uncertainty	1.6	Rectangular	√3	0.78	0.71	0.72	0.66
Liquid Permittivity-temperature uncertainty	0.2	Rectangular	√3	0.23	0.26	0.026	0.03
Combined Standard Uncertainty						10.40	10.29
Coverage Factor for 95%						K=2	
Expanded Uncertainty						±20.80%	±20.57%

DAYS5 System Check Uncertainty for 30 MHz to 3GHz 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	6.53	Normal	1	1	1	6.53	6.53	∞
Axial Isotropy	0.5	Rectangular	$\sqrt{3}$	1	1	0.29	0.29	∞
Hemispherical Isotropy	2.6	Rectangular	$\sqrt{3}$	1	1	1.50	1.50	∞
Boundary Effects	0.9	Rectangular	$\sqrt{3}$	0	0	0.00	0.00	∞
Linearity	0.6	Rectangular	$\sqrt{3}$	1	1	0.35	0.35	∞
System Detection Limits	0.9	Rectangular	$\sqrt{3}$	1	1	0.52	0.52	∞
Modulation Response	3.3	Rectangular	$\sqrt{3}$	1	1	1.91	1.91	∞
Readout Electronics	0.2	Normal	1	1	1	0.2	0.2	∞
Response Time	0	Rectangular	$\sqrt{3}$	1	1	0	0	∞
Integration Time	0	Rectangular	$\sqrt{3}$	1	1	0	0	∞
RF Ambient Noise	0.9	Rectangular	$\sqrt{3}$	1	1	0.52	0.52	∞
RF Ambient Reflection	0.9	Rectangular	$\sqrt{3}$	1	1	0.52	0.52	∞
Probe Positioner	0.7	Rectangular	$\sqrt{3}$	1	1	0.402	0.402	∞
Probe Positioning	6.5	Rectangular	$\sqrt{3}$	1	1	3.752	3.752	∞
Max. SAR Eval.	1.9	Rectangular	$\sqrt{3}$	1	1	1.10	1.10	∞
Dipole Related								
Deviation of exp. dipole	5.3	Rectangular	$\sqrt{3}$	1	1	3.06	3.06	∞
Dipole Axis to Liquid Dist.	2.0	Rectangular	$\sqrt{3}$	1	1	1.15	1.15	∞
Input power & SAR drift	3.3	Rectangular	$\sqrt{3}$	1	1	1.91	1.91	∞
Phantom and Setup								
Phantom Uncertainty	3.9	Rectangular	$\sqrt{3}$	1	1	2.25	2.25	∞
SAR correction	1.8	Rectangular	$\sqrt{3}$	1	0.84	1.04	0.87	∞
Liquid Conductivity(Meas.)	2.4	Normal	1	0.78	0.71	1.87	1.70	∞
Liquid Permittivity(Meas.)	2.4	Normal	1	0.26	0.26	0.62	0.62	∞
Temp. unc. - Conductivity	1.6	Rectangular	$\sqrt{3}$	0.78	0.71	0.72	0.66	∞
Temp. unc. - Permittivity	0.2	Rectangular	$\sqrt{3}$	0.23	0.26	0.026	0.03	∞
Combined Std. Uncertainty						9.38	9.31	
Expanded STD Uncertainty						±18.76%	±18.62%	

11. CONDUCTED POWER MEASUREMENT

Bluetooth_V4.2

Modulation	Channel	Frequency(MHz)	Peak Power (dBm)
GFSK	0	2402	11.27
	39	2441	13.61
	78	2480	14.79
$\pi/4$ -DQPSK	0	2402	11.24
	39	2441	13.40
	78	2480	14.36
8-DPSK	0	2402	11.23
	39	2441	13.35
	78	2480	14.23

12. TEST RESULTS

12.1. SAR Test Results Summary

12.1.1. Test position and configuration

This is a BT equipment. According the user's manual, which will install a helmet mounted, and may implement on phone or music during clothing helmet mounted;

A non-standard setup was used for SAR testing based on guidance from the FCC. The operational description contains additional information.

According to KDB 447498 D01 General RF Exposure Guidance v06, due to the Max peak power for Bluetooth is less than 2Pref, which have to be tested. Using the head liquid with a separation of 10mm at flat phantom to test . achieving actual usage.

12.1.2. Antenna Location: (internal view)



12.1.3. SAR Test Results Summary

SAR MEASUREMENT									
Depth of Liquid (cm):>15					Relative Humidity (%):58.6				
Product: Bluetooth headset									
Test Mode: BT(communication) with GMSK modulation									
Position	Mode	Ch.	Fr. (MHz)	Power Drift (<±0.2db)	SAR (1g) (W/kg)	Max. Turn-up Power (dBm)	Meas. output Power (dBm)	Scaled SAR (W/Kg)	Limit (W/Kg)
Body back	DH1	78	2480	-0.12	0.149	15.0	14.79	0.156	1.6
Body back	2DH3	78	2480	0.05	0.181	14.5	14.36	0.187	1.6
Body back	3DH5	0	2402	-0.03	0.163	14.5	11.23	0.346	1.6
Body back	3DH5	39	2441	0.08	0.187	14.5	13.35	0.244	1.6
Body back	3DH5	78	2480	0.13	0.240	14.5	14.23	0.255	1.6

Note:

- When the 1-g SAR is ≤ 0.8 W/kg, testing for low and high channel is optional.
- The test separation of all above table(body part) is 10mm.

APPENDIX A. SAR SYSTEM CHECK DATA

Test Laboratory: AGC Lab

Date: Jan. 28,2016

System Check Head 2450 MHz

DUT: Dipole 2450 MHz Type: SID 2450

Communication System: CW; Communication System Band: D2450 (2450.0 MHz); Duty Cycle: 1:1;

Frequency: 2450 MHz; Medium parameters used: $f = 2450$ MHz; $\sigma = 1.80$ mho/m; $\epsilon_r = 40.14$; $\rho = 1000$ kg/m³ ;

Phantom section: Flat Section; Input Power=18dBm

Ambient temperature (°C): 20.5, Liquid temperature (°C): 20.3

DASY Configuration:

- Probe: ES3DV3 – SN3337; ConvF(4.66,4.66, 4.66); Calibrated:10/01/2015
Sensor-Surface: 3mm (Mechanical Surface Detection), $z = 1.0, 31.0$
- Electronics: DAE4 Sn1398; Calibrated: 03/11/2015
- Phantom: SAM (20deg probe tilt) with CRP v5.0; Type: QD000P40CD;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

Configuration/System Check 2450MHz Head/ Area Scan (9x12x1): Area Scan (9x12x1): Measurement grid:

$dx=10$ mm, $dy=10$ mm

Maximum value of SAR (measured) = 4.25 W/kg

Configuration/System Check 2450MHz Head/Zoom Scan (7x7x7)/Cube 0: Zoom Scan (7x7x7)/Cube 0:

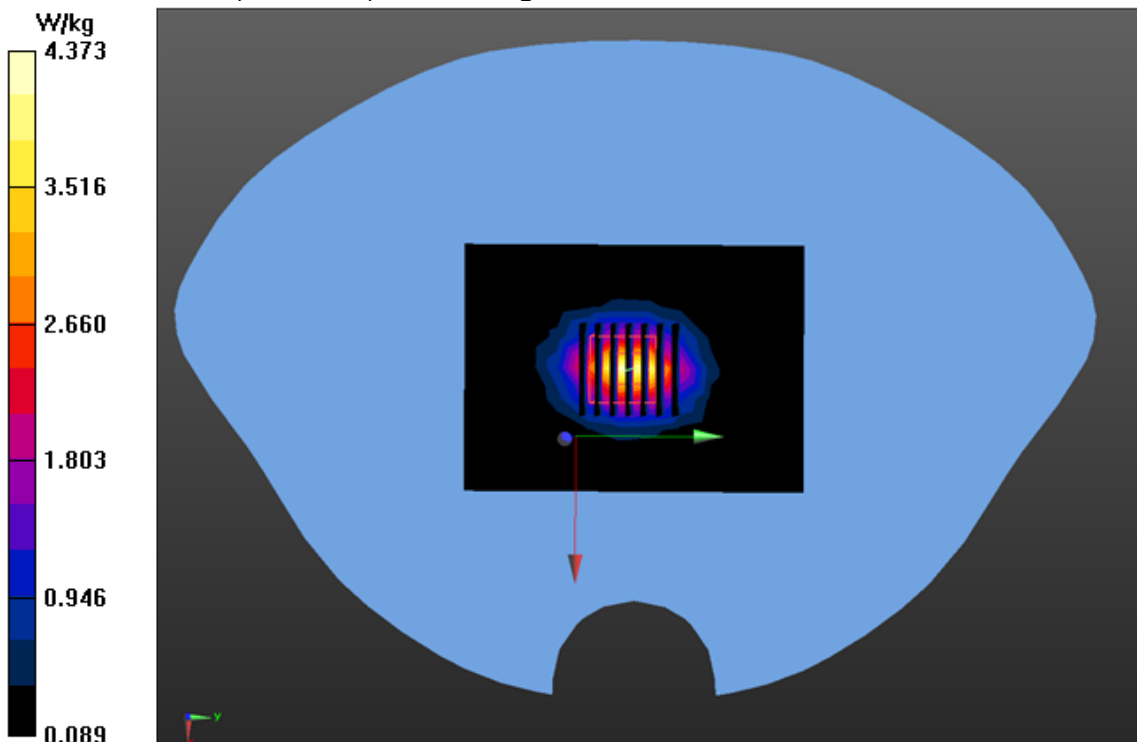
Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 51.571 V/m; Power Drift = 0.08 dB

Peak SAR (extrapolated) = 6.96 W/kg

SAR(1 g) = 3.32 W/kg; SAR(10 g) = 1.53 W/kg

Maximum value of SAR (measured) = 4.37 W/kg



APPENDIX B. SAR MEASUREMENT DATA

Test Laboratory: AGC Lab
Bluetooth High-Body- Back (DH1)
DUT: Bluetooth headset ; Type: AMP

Date: Jan. 28,2016

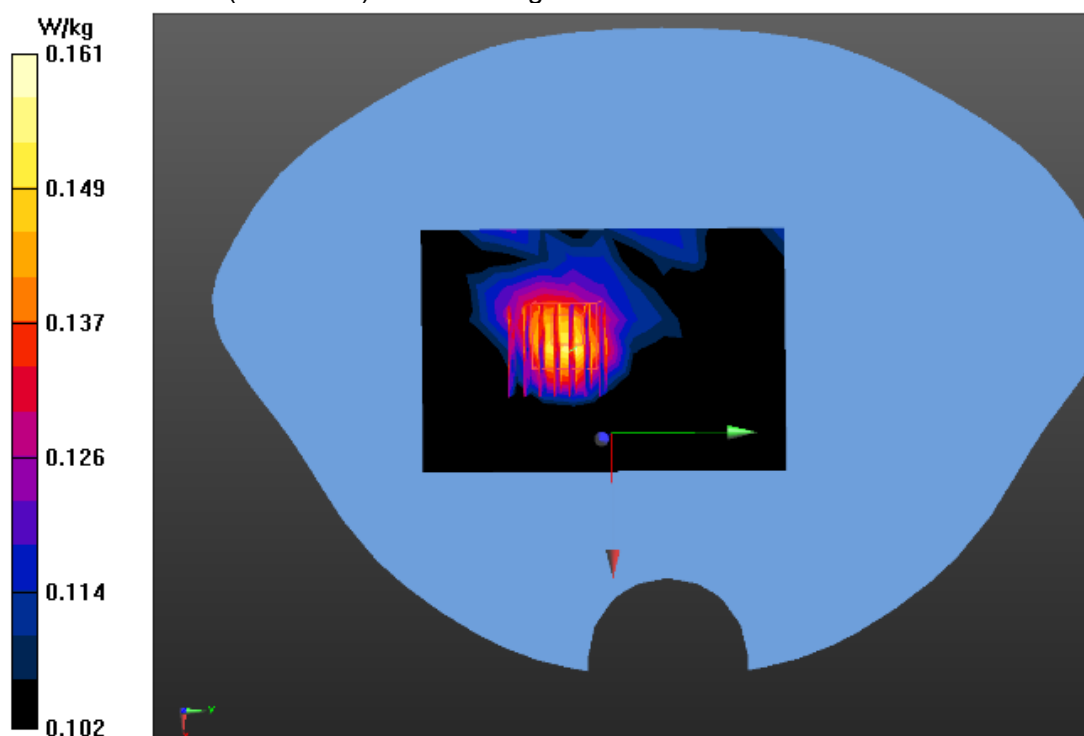
Communication System: Bluetooth; Communication System Band: 2.4G; Frequency: 2480 MHz;
Medium parameters used: $f = 2450$ MHz; $\sigma = 1.73$ mho/m; $\epsilon_r = 39.61$; $\rho = 1000$ kg/m³ ;
Phantom section: Flat Section
Ambient temperature (°C): 20.5, Liquid temperature (°C): 20.3

DASY Configuration:

- Probe: ES3DV3 – SN3337; ConvF(4.66, 4.66, 4.66); Calibrated:10/01/2015
- Sensor-Surface: 3mm (Mechanical Surface Detection), $z = 1.0, 31.0$
- Electronics: DAE4 Sn1398; Calibrated: 03/11/2015
- Phantom: SAM (20deg probe tilt) with CRP v5.0; Type: QD000P40CD;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

FRONT/DH1/Area Scan (9x13x1): Measurement grid: $dx=10$ mm, $dy=10$ mm
Maximum value of SAR (measured) = 0.156 W/kg

FRONT/DH1/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm
Reference Value = 8.479 V/m; Power Drift = -0.12 dB
Peak SAR (extrapolated) = 0.164 W/kg
SAR(1 g) = 0.149 W/kg; SAR(10 g) = 0.136 W/kg
Maximum value of SAR (measured) = 0.161 W/kg



Test Laboratory: AGC Lab
Bluetooth Mid-Body- Back (2DH3)
DUT: Bluetooth headset ; Type: AMP

Date: Jan. 28,2016

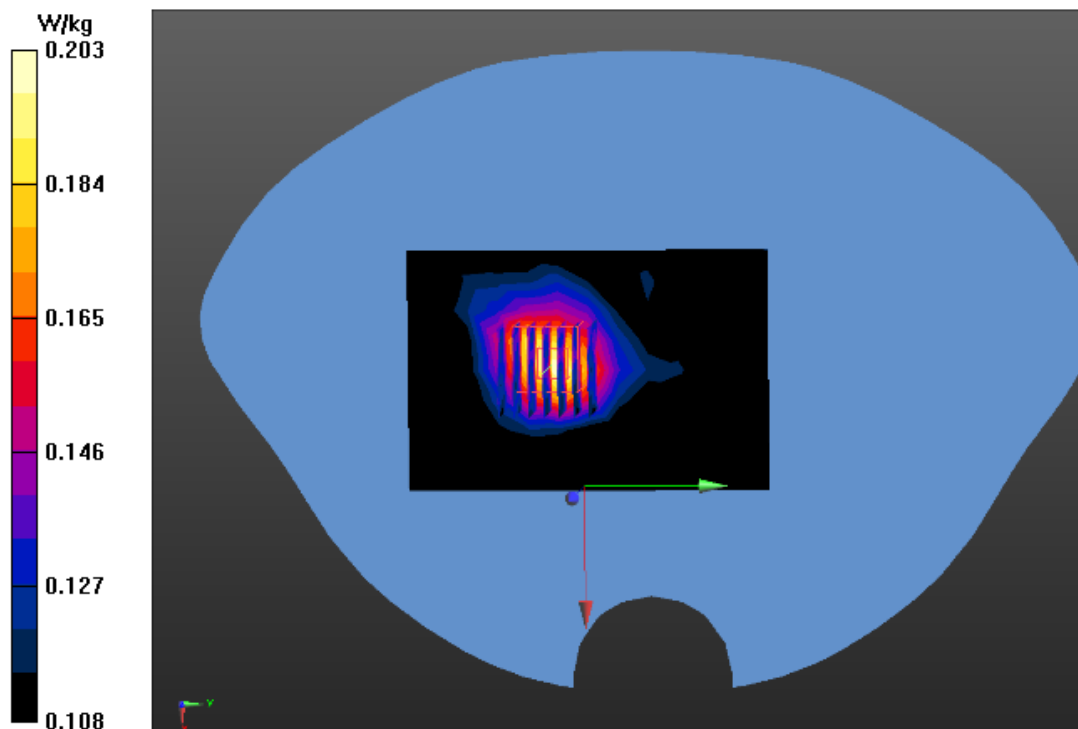
Communication System: Bluetooth; Communication System Band: 2.4G; Frequency: 2480 MHz;
Medium parameters used: $f = 2450$ MHz; $\sigma = 1.73$ mho/m; $\epsilon_r = 39.61$; $\rho = 1000$ kg/m³ ;
Phantom section: Flat Section
Ambient temperature (°C): 20.5, Liquid temperature (°C): 20.3

DASY Configuration:

- Probe: ES3DV3 – SN3337; ConvF(4.66, 4.66, 4.66); Calibrated:10/01/2015
- Sensor-Surface: 3mm (Mechanical Surface Detection), $z = 1.0, 31.0$
- Electronics: DAE4 Sn1398; Calibrated: 03/11/2015
- Phantom: SAM (20deg probe tilt) with CRP v5.0; Type: QD000P40CD;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

FRONT/2DH3/Area Scan (9x13x1): Measurement grid: $dx=10$ mm, $dy=10$ mm
Maximum value of SAR (measured) = 0.204 W/kg

FRONT/2DH3/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm
Reference Value = 8.944 V/m; Power Drift = 0.05 dB
Peak SAR (extrapolated) = 0.218 W/kg
SAR(1 g) = 0.181 W/kg; SAR(10 g) = 0.149 W/kg
Maximum value of SAR (measured) = 0.203 W/kg



Test Laboratory: AGC Lab
Bluetooth Low-Body- Back (3DH5)
DUT: Bluetooth headset ; Type: AMP

Date: Jan. 28,2016

Communication System: Bluetooth; Communication System Band: 2.4G; Frequency: 2402 MHz;
Medium parameters used: $f = 2450$ MHz; $\sigma = 1.75$ mho/m; $\epsilon_r = 40.82$; $\rho = 1000$ kg/m³ ;
Phantom section: Flat Section
Ambient temperature (°C): 20.5, Liquid temperature (°C): 20.3

DASY Configuration:

- Probe: ES3DV3 – SN3337; ConvF(4.66, 4.66, 4.66); Calibrated:10/01/2015
- Sensor-Surface: 3mm (Mechanical Surface Detection), $z = 1.0, 31.0$
- Electronics: DAE4 Sn1398; Calibrated: 03/11/2015
- Phantom: SAM (20deg probe tilt) with CRP v5.0; Type: QD000P40CD;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

FRONT/3DH5-L/Area Scan (9x13x1): Measurement grid: $dx=10$ mm, $dy=10$ mm
Maximum value of SAR (measured) = 0.176 W/kg

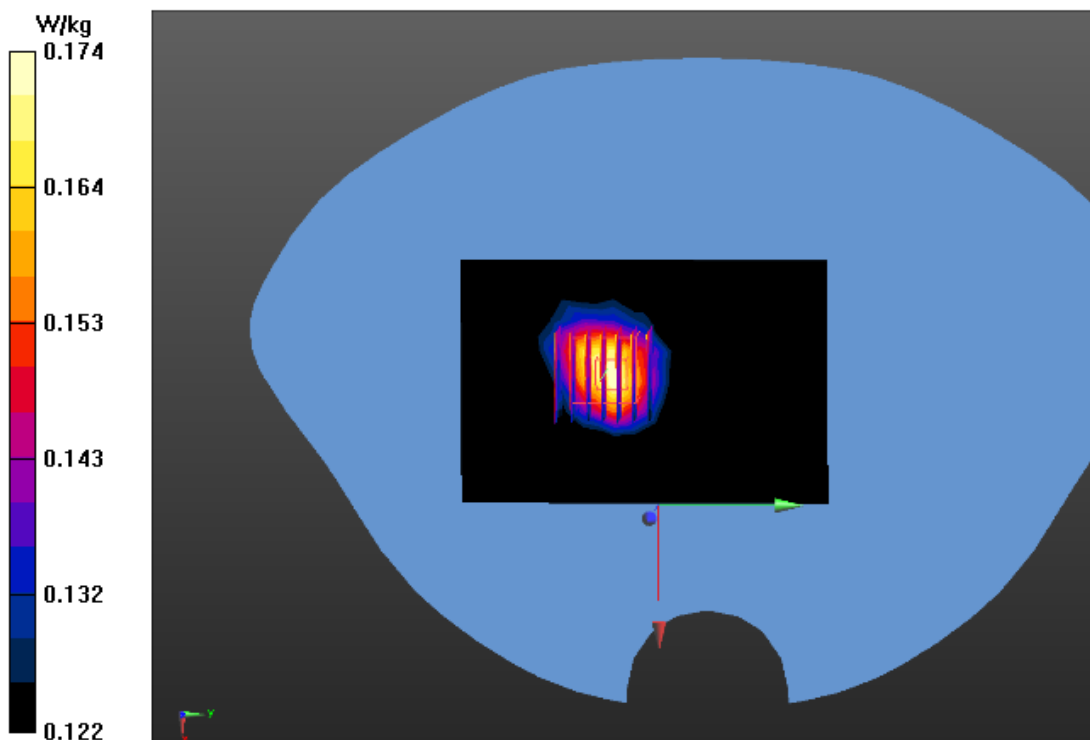
FRONT/3DH5-L/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm

Reference Value = 8.815 V/m; Power Drift = -0.03 dB

Peak SAR (extrapolated) = 0.177 W/kg

SAR(1 g) = 0.163 W/kg; SAR(10 g) = 0.147 W/kg

Maximum value of SAR (measured) = 0.174 W/kg



Test Laboratory: AGC Lab
Bluetooth Mid-Body- Back (3DH5)
DUT: Bluetooth headset ; Type: AMP

Date: Jan. 28,2016

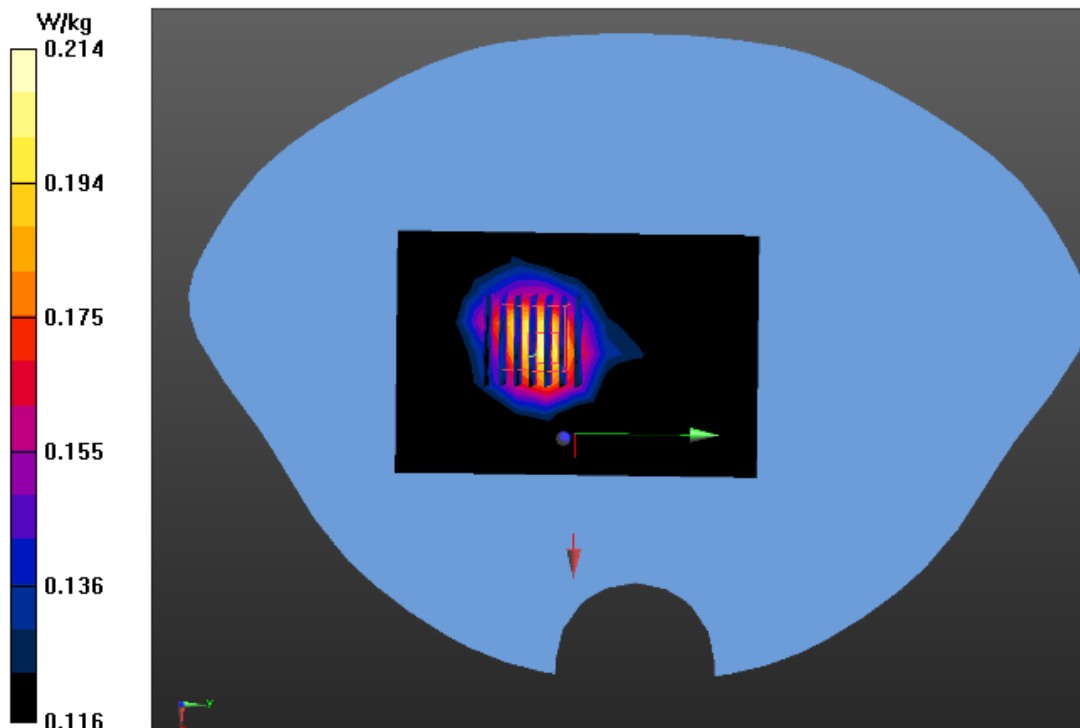
Communication System: Bluetooth; Communication System Band: 2.4G; Frequency: 2441 MHz;
Medium parameters used: $f = 2450$ MHz; $\sigma = 1.77$ mho/m; $\epsilon_r = 40.53$; $\rho = 1000$ kg/m³ ;
Phantom section: Flat Section
Ambient temperature (°C): 20.5, Liquid temperature (°C): 20.3

DASY Configuration:

- Probe: ES3DV3 – SN3337; ConvF(4.66, 4.66, 4.66); Calibrated:10/01/2015
- Sensor-Surface: 3mm (Mechanical Surface Detection), $z = 1.0, 31.0$
- Electronics: DAE4 Sn1398; Calibrated: 03/11/2015
- Phantom: SAM (20deg probe tilt) with CRP v5.0; Type: QD000P40CD;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

FRONT/3DH5/Area Scan (9x13x1): Measurement grid: $dx=10$ mm, $dy=10$ mm
Maximum value of SAR (measured) = 0.207 W/kg

FRONT/3DH5/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm
Reference Value = 8.586 V/m; Power Drift = 0.08 dB
Peak SAR (extrapolated) = 0.239 W/kg
SAR(1 g) = 0.187 W/kg; SAR(10 g) = 0.154 W/kg
Maximum value of SAR (measured) = 0.214 W/kg



Test Laboratory: AGC Lab
Bluetooth High-Body- Back (3DH5)
DUT: Bluetooth headset ; Type: AMP

Date: Jan. 28,2016

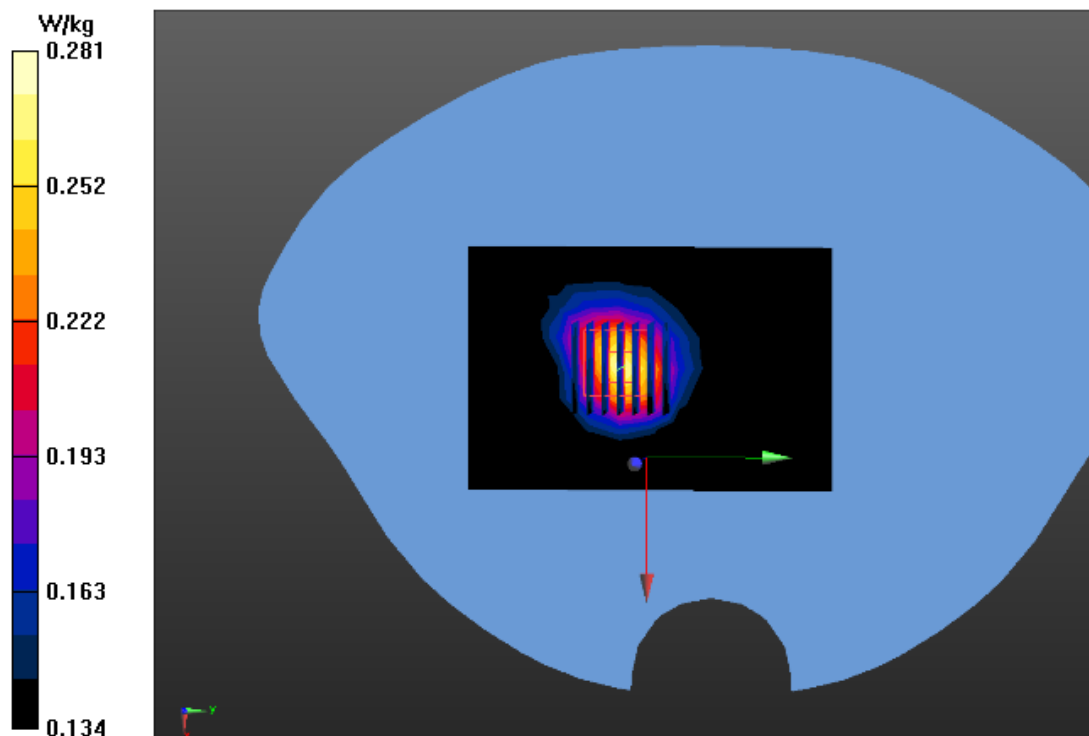
Communication System: Bluetooth; Communication System Band: 2.4G; Frequency: 2441 MHz;
Medium parameters used: $f = 2450$ MHz; $\sigma = 1.73$ mho/m; $\epsilon_r = 39.61$; $\rho = 1000$ kg/m³ ;
Phantom section: Flat Section
Ambient temperature (°C): 20.5, Liquid temperature (°C): 20.3

DASY Configuration:

- Probe: ES3DV3 – SN3337; ConvF(4.66, 4.66, 4.66); Calibrated:10/01/2015
- Sensor-Surface: 3mm (Mechanical Surface Detection), $z = 1.0, 31.0$
- Electronics: DAE4 Sn1398; Calibrated: 03/11/2015
- Phantom: SAM (20deg probe tilt) with CRP v5.0; Type: QD000P40CD;
- DASY52 52.8.7(1137); SEMCAD X 14.6.10(7164)

FRONT/3DH5-H/Area Scan (9x13x1): Measurement grid: $dx=10$ mm, $dy=10$ mm
Maximum value of SAR (measured) = 0.279 W/kg

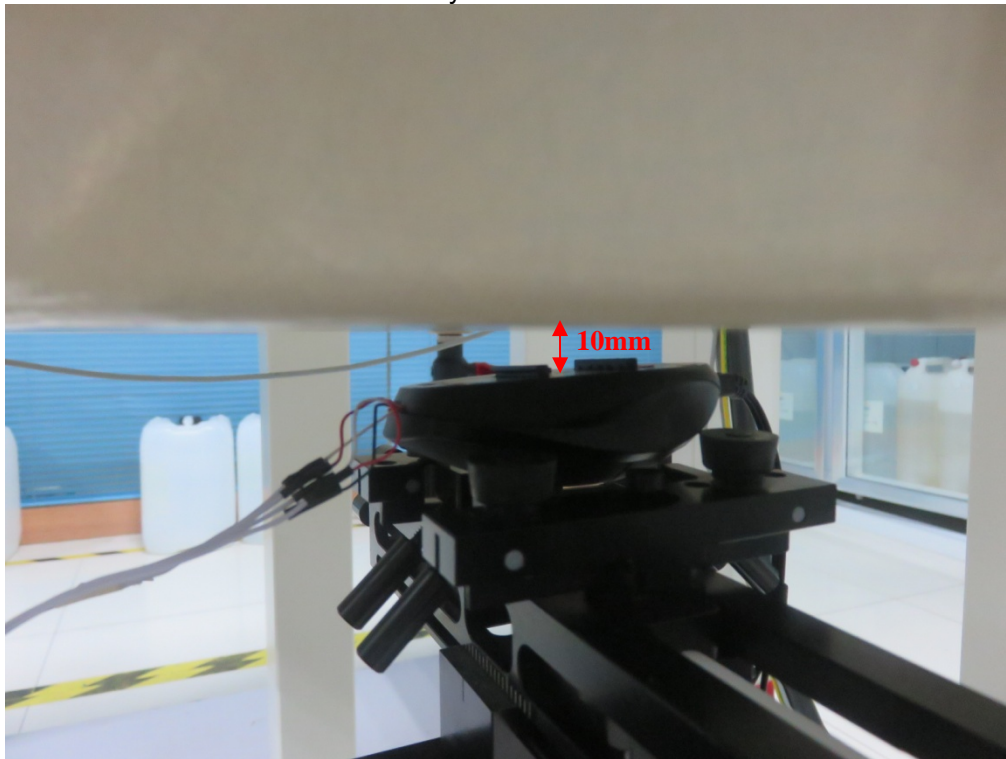
FRONT/3DH5-H/Zoom Scan (7x7x7)/Cube 0: Measurement grid: $dx=5$ mm, $dy=5$ mm, $dz=5$ mm
Reference Value = 9.368 V/m; Power Drift = 0.13 dB
Peak SAR (extrapolated) = 0.312 W/kg
SAR(1 g) = 0.240 W/kg; SAR(10 g) = 0.189 W/kg
Maximum value of SAR (measured) = 0.281 W/kg



APPENDIX C. TEST SETUP PHOTOGRAPHS & EUT PHOTOGRAPHS

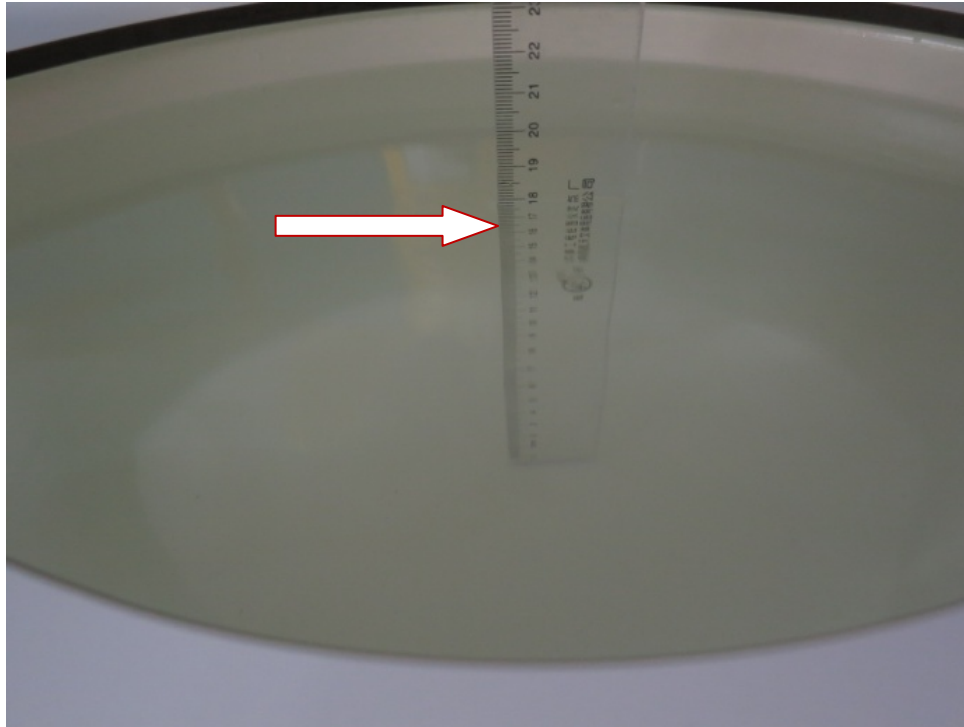
Test Setup Photographs

Body back 10mm



DEPTH OF THE LIQUID IN THE PHANTOM—ZOOM IN

Note : The position used in the measurement were according to IEEE1528-2013



EUT PHOTOGRAPHS

All VIEW OF EUT



SERIES VIEW OF EUT



TOP VIEW OF EUT



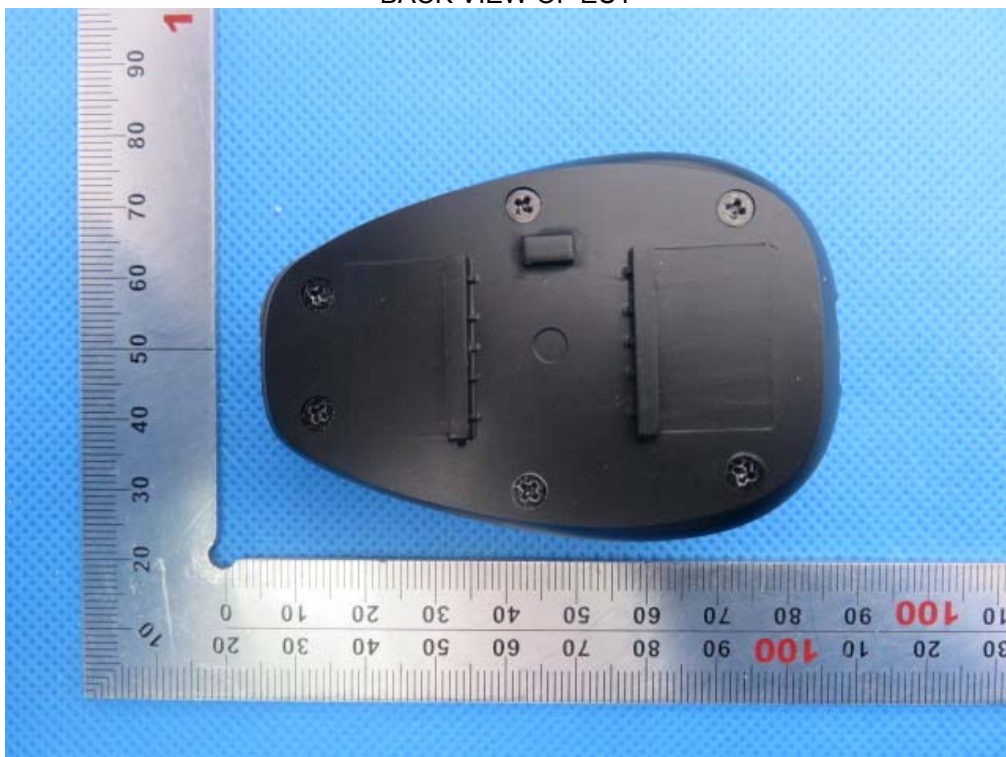
BOTTOM VIEW OF EUT



FRONT VIEW OF EUT



BACK VIEW OF EUT



LEFT VIEW OF EUT



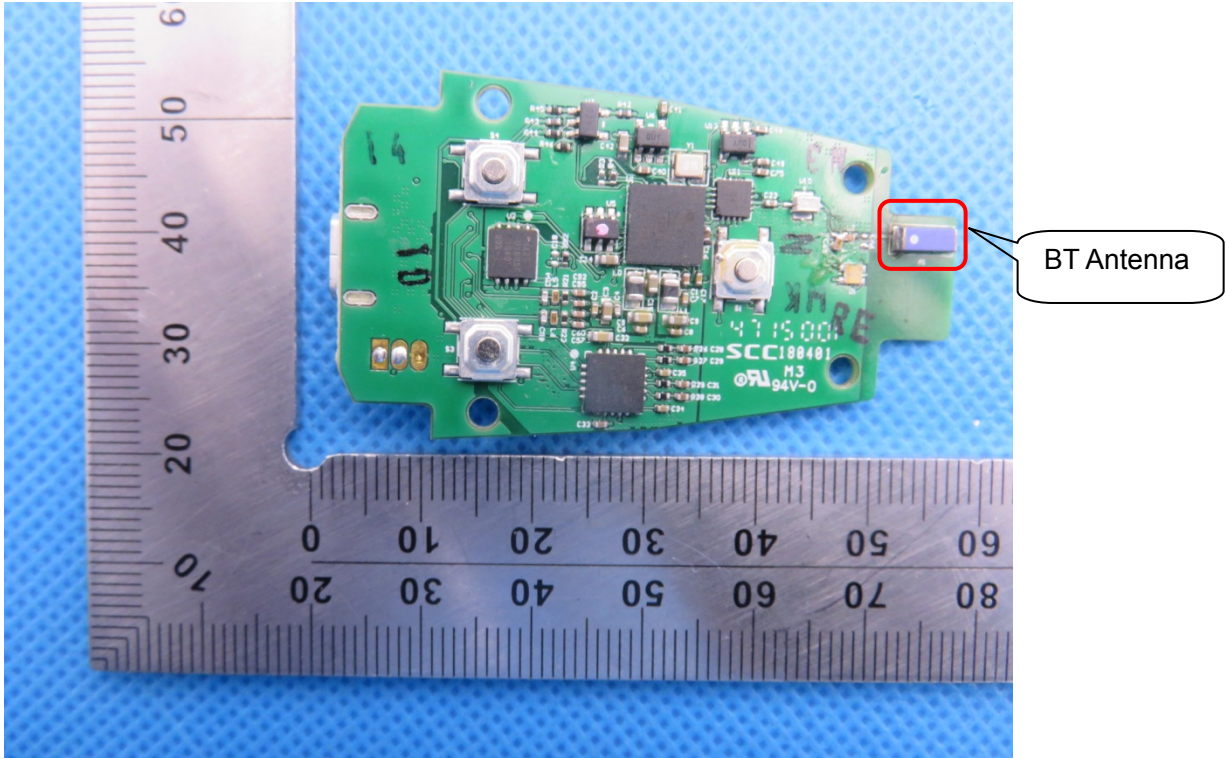
RIGHT VIEW OF EUT



OPEN VIEW OF EUT-1



INTERNAL VIEW OF EUT-1



INTERNAL VIEW OF EUT-2

