TEST REPORT

Applicant:	HASHDOG PTE. LTD.
Address:	152 BEACH ROAD #11-05, GATEWAY EAST, 189721 SINGAPORE
Equipment Type:	Mini OBD2 Dongle
Model Name:	Macaron
Brand Name:	HashDog
FCC ID:	2BBAK-MACARON
Test Standard:	FCC 47 CFR Part 2.1093 (refer to section 3.1)
Maximum SAR:	Body (1 g@0mm): 1.00 W/kg
Sample Arrival Date:	Jul. 18, 2023
Test Date:	Jul. 18, 2023 - Jul. 19, 2023
Date of Issue:	Jul. 19, 2023

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ISSUED BY:

Shenzhen BALUN Technology Co., Ltd.

Tested by: Zhang Jiwei

Zhang Jiwei

Checked by: Xu Rui

Xu Rui

Approved by: Tolan Tu (Testing Director)

Tolan Tu

Revision History

Version	Issue Date	Revisions Content
Rev. 01	Jul. 19, 2023	Initial Issue

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1 GENERAL INFORMATION

1.1 Test Laboratory

Name	Shenzhen BALUN Technology Co., Ltd.
Address	Block B, 1/F, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Phone Number	+86 755 6685 0100

1.2 Test Location

Name	Shenzhen BALUN Technology Co., Ltd.
Location	☑ Block B, 1/F, Baisha Science and Technology Park, Shahe Xi Road, Nanshan District, Shenzhen, Guangdong Province, P. R. China
	☐ 1/F, Building B, Ganghongji High-tech Intelligent Industrial Park, No. 1008, Songbai Road, Yangguang Community, Xili Sub-district, Nanshan District, Shenzhen, Guangdong Province, P. R. China
Accreditation Certificate	The laboratory is a testing organization accredited by FCC as a accredited testing laboratory. The designation number is CN1196.

1.3 Test Environment Condition

Ambient Temperature	18℃ to 25℃
Ambient Relative Humidity	30% to 70%

2 PRODUCT INFORMATION

2.1 Applicant Information

Applicant	HASHDOG PTE. LTD.
Address	152 BEACH ROAD #11-05, GATEWAY EAST, 189721 SINGAPORE

2.2 Manufacturer Information

Manufacturer	HASHDOG PTE. LTD.
Address	152 BEACH ROAD #11-05, GATEWAY EAST, 189721 SINGAPORE

2.3 Factory Information

Factory	N/A
Address	N/A

2.4 General Description for Equipment under Test (EUT)

EUT Name	Mini OBD2 Dongle
Model Name Under Test	Macaron
Series Model Name	N/A
Description of Model name differentiation	N/A
Hardware Version	1.2
Software Version	1.1.0
Dimensions (Approx.)	N/A
Weight (Approx.)	N/A

2.5 Ancillary Equipment

Note: Not application.

2.6 Technical Information

Network and Wireless connectivity	LoRa, Bluetooth (BLE) GPS, GLONASS, BDS, Galileo

The requirement for the following technical information of the EUT was tested in this report:

Operating Mode	Bluetooth; LoRa	
Frequency Range	Bluetooth	2402 MHz ~ 2480 MHz
	LoRa	902 MHz ~ 928 MHz
Antenna Type	Bluetooth	PIFA Antenna
	LoRa	PIFA Antenna
Hotspot Function	N/A	
Exposure Category	General Population/Uncontrolled exposure	
Product Type	Portable Device	
EUT Type	☒ Production unit	☐ Identical prototype

3 SUMMARY OF TEST RESULT

3.1 Test Standards

No.	Identity	Document Title
1	47 CFR Part 2.1093	Radiofrequency radiation exposure evaluation: portable devices
2	ANSI/IEEE Std.C95.1-1992	IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz
3	FCC KDB 447498 D04 v01	447498 D04 Interim General RF Exposure Guidance v01
4	FCC KDB 865664 D01 v01r04	SAR Measurement 100 MHz to 6 GHz
5	FCC KDB 865664 D02 v01r02	RF Exposure Reporting

3.2 Device Category and SAR Limit

This device belongs to portable device category because its radiating structure is allowed to be used within 20 centimeters of the body of the user.

Limit for General Population/Uncontrolled exposure should be applied for this device, it is 1.6 W/kg as averaged over any 1 gram of tissue.

Table of Exposure Limits:

Body Position	SAR Value (W/Kg)	
	General Population/ Uncontrolled Exposure	Occupational/ ControlledExposure
Whole-Body SAR (averaged over the entire body)	0.08	0.4
Partial-Body SAR (averaged over any 1 gram of tissue)	1.60	8.0
SAR for hands, wrists, feet and ankles (averaged over any 10 grams of tissue)	4.0	20.0

NOTE:

General Population/Uncontrolled Exposure: Locations where there is the exposure of individuals who have no knowledge or control of their exposure. General population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

Occupational/Controlled Exposure: Locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

3.3 Test Result Summary

3.3.1 Highest SAR (1 g Value)

Equipment Class	Band	Maximum Scaled SAR (W/kg)	Maximum Report SAR (W/kg)
		Body (0mm)	Body (0mm)
DTS	LoRa	**1.00**	**1.00**
FHSS	LoRa	0.89	
DSS	Bluetooth	0.27	
Limit (W/kg)		1.60	
Verdict		Pass	

3.3.2 Highest Simultaneous Transmission SAR Values (1 g Value)

Equipment Class	Maximum Report SAR (W/kg)
	Body(0mm)
	1g SAR
DTS	**1.03**
DSS	**1.03**
Limit (W/Kg)	1.60
Verdict	Pass

Note: The highest simultaneous SAR please refer section 12.

3.4 Test Uncertainty

According to KDB 865664 D01, when the highest measured 1 g SAR within a frequency band is < 1.5 W/kg, the extensive SAR measurement uncertainty analysis is not required in SAR reports submitted for equipment approval.

The maximum 1 g SAR for the EUT in this report is 0.998 W/kg, which is lower than 1.5 W/kg, so the extensive SAR measurement uncertainty analysis is not required in this report.

4 MEASUREMENT SYSTEM

4.1 Specific Absorption Rate (SAR) Definition

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

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

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

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

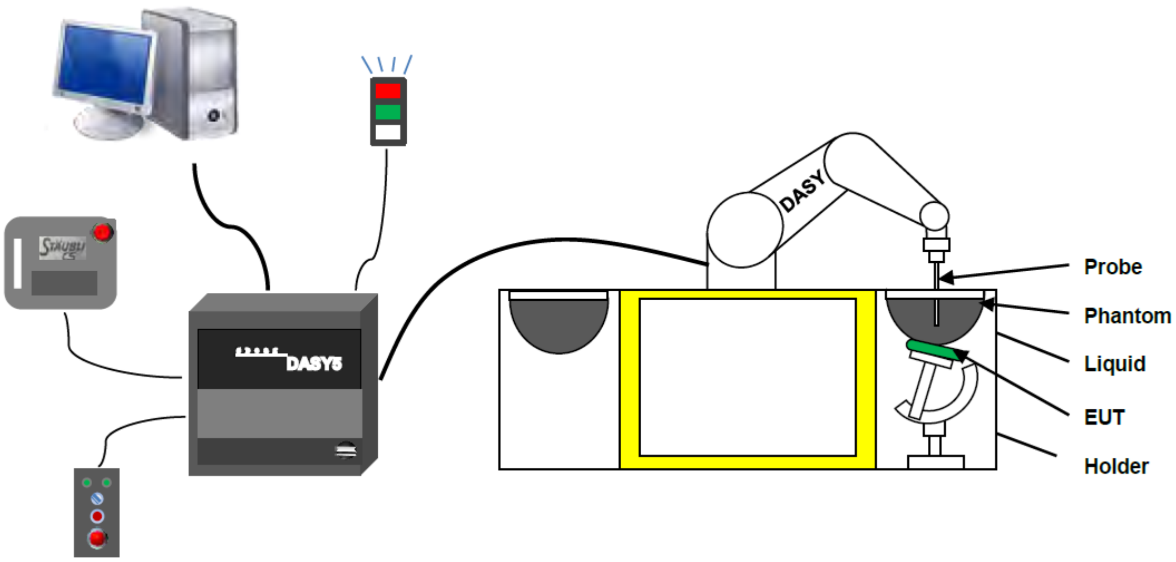
$$\mathbf{SAR} = \frac{\boldsymbol{\sigma}\mathbf{E}^2}{\boldsymbol{\rho}}$$

Where: σ is the conductivity of the tissue,

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

4.2 DASY SAR System

4.2.1 DASY SAR System Diagram



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

1. A standard high precision 6-axis robot (Stäubli RX family) with controller and software. An arm extension for accommodating the data acquisition electronics (DAE).
2. A dosimetric probe, i.e. an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.
3. A data acquisition electronic (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
4. A unit to operate the optical surface detector which is connected to the EOC.
5. The Electro-Optical Coupler (EOC) performs the conversion from the optical into a digital electric signal of the DAE. The EOC is connected to the DASY5 measurement server.
6. The DASY5 measurement server, which performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation.
7. DASY5 software and SEMCAD data evaluation software.
8. Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.
9. The generic twin phantom enabling the testing of left-hand and right-hand usage.
10. The device holder for handheld mobile phones.
11. Tissue simulating liquid mixed according to the given recipes.
12. System validation dipoles allowing to validate the proper functioning of the system.

4.2.2 Robot

The Dasy SAR system uses the high precision robots. Symmetrical design with triangular core Built-in optical fiber for surface detection system For the 6-axis controller system, Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents). The robot series have many features that are important for our application:

- High precision
  (repeatability ±0.02 mm)
- High reliability
  (industrial design)
- Low maintenance costs
  (virtually maintenance free due to direct drive gears; no belt drives)
- Jerk-free straight movements
  (brush less synchron motors; no stepper motors)
- Low ELF interference
  (motor control _elds shielded via the closed metallic construction shields)

4.2.3 E-Field Probe

The probe is specially designed and calibrated for use in liquids with high permittivities for the measurements the Specific Dosimetric E-Field Probe EX3DV4-SN:7510 with following specifications is used.

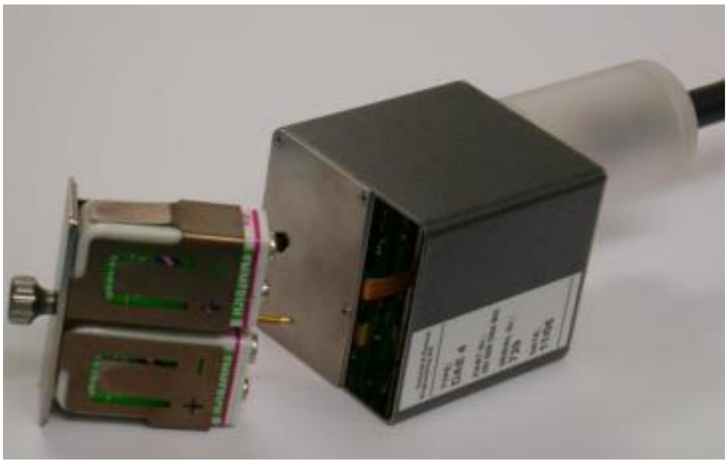
Construction	Symmetrical design with triangular core Built-in optical fiber for surface detection systemBuilt-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., glycolether)
Calibration	ISO/IEC 17025 calibration service available
Frequency	10 MHz to 6 GHz; Linearity: ± 0.2 dB (30 MHz to 6 GHz)
Directivity	± 0.2 dB in HSL (rotation around probe axis) ; ± 0.4 dB in HSL (rotation normal to probe axis)
Dynamic range	5 μW/g to > 100 mW/g; Linearity: ± 0.2 dB
Dimensions	Overall length: 337 mm (Tip: 9 mm) Tip diameter: 2.5 mm (Body: 10 mm) Distance from probe tip to dipole centers: 1.0 mm
Application	General dosimetry up to 3 GHz Compliance tests of mobile phones Fast automatic scanning in arbitrary phantoms (EX3DV4)

E-Field Probe Calibration Process

Probe calibration is realized, in compliance with CENELEC EN 62209-1/-2 and IEEE 1528 std, with CALISAR, Antennessa proprietary calibration system. The calibration is performed with the EN 62209-1/2 annexe technique using reference guide at the five frequencies.

4.2.4 Data Acquisition Electronics

The data acquisition electronics (DAE) consist of 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 server is accomplished through an optical downlink for data and status information, as well as an optical uplink for commands and the clock.



- Input Impedance: 200MOhm
- The Inputs: Symmetrical and Floating
- Commom Mode Rejection: Above 80dB

4.2.5 Phantoms

For the measurements the Specific Anthropomorphic Mannequin (SAM) defined by the IEEE SCC-34/SC2 group is used. The phantom is a polyurethane shell integrated in a wooden table. The thickness of the phantom amounts to 2mm +/- 0.2mm. It enables the dosimetric evaluation of left and right phone usage and includes an additional flat phantom part for the simplified performance check. The phantom set-up includes a cover, which prevents the evaporation of the liquid.

- Left hand
- Right hand
- Flat phantom

Photo of Phantom SN1857

Serial Number	Material	Length	Height
SN 1857 SAM	Vinylester, glass fiber reinforced	1000	500

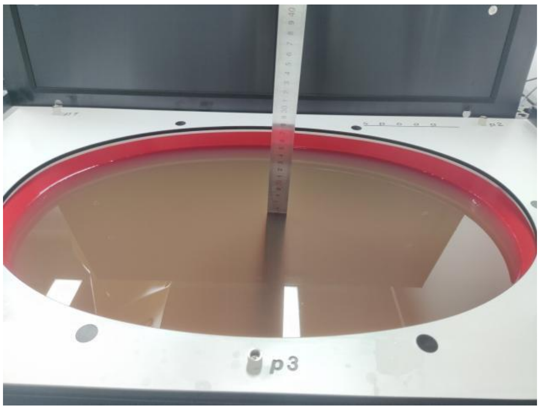
4.2.6 Device Holder

The DASY5 device holder has two scales for device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear openings). The plane between the ear openings and the mouth tip has a rotation angle of 65°. 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. This device holder is used for standard mobile phones or PDA‟s only. If necessary an additional support of polystyrene material is used. Larger DUT‟s (e.g. notebooks) cannot be tested using this device holder. Instead a support of bigger polystyrene cubes and thin polystyrene plates is used to position the DUT in all relevant positions to find and measure spots with maximum SAR values. Therefore those devices are normally only tested at the flat part of the SAM.

The positioning system allows obtaining cheek and tilting position with a very good accuracy. Incompliance with CENELEC, the tilt angle uncertainty is lower than 1°.

4.2.7 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 15 cm. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm. The nominal dielectric values of the tissue simulating liquids in the phantom and the tolerance of 5%.

Head Liquid Depth	Body Liquid Depth
	

The following table gives the recipes for tissue simulating liquid and the theoretical Conductivity/Permittivity.

The following table gives the recipes for tissue simulating liquid.

TSL	Manufacturer / Model	Freq Range (MHz)	Main Ingredients
Head WideBand	SPEAG HBBL600-10000V6	600-10000	Ethanediol, Sodium petroleum sulfonate, Hexylene Glycol / 2-Methyl-pentane-2.4-diol, Alkoxylated alcohol

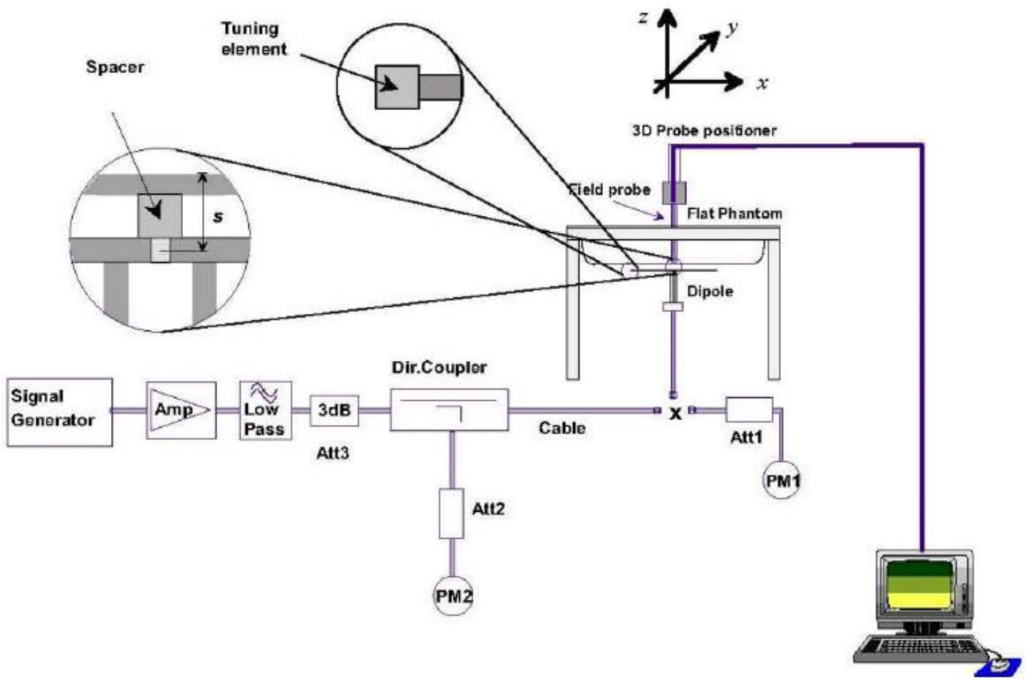
5 SYSTEM VERIFICATION

5.1 Purpose of System Check

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

5.2 System Check Setup

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



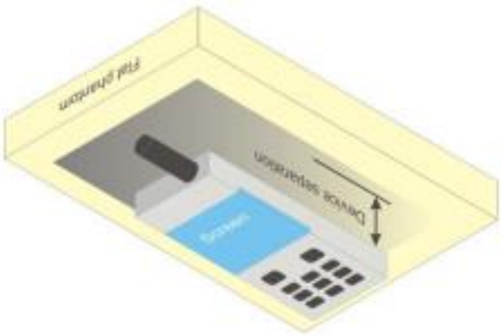
6 TEST POSITION CONFIGURATIONS

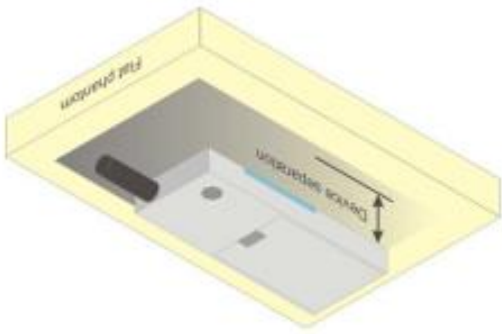
6.1 Body-worn Position Conditions

Body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in EN 62209-2 are used to test for body-worn accessory SAR compliance, without a headset connected to it. This enables the test results for such configuration to be compatible with that required for hotspot mode when the body-worn accessory test separation distance is greater than or equal to that required for hotspot mode. When the reported SAR for a body-worn accessory.

Body-worn accessories that do not contain metallic or conductive components may be tested according to worst-case exposure configurations, typically according to the smallest test separation distance required for the group of body-worn accessories with similar operating and exposure characteristics. All body-worn accessories containing metallic components are tested in conjunction with the host device.

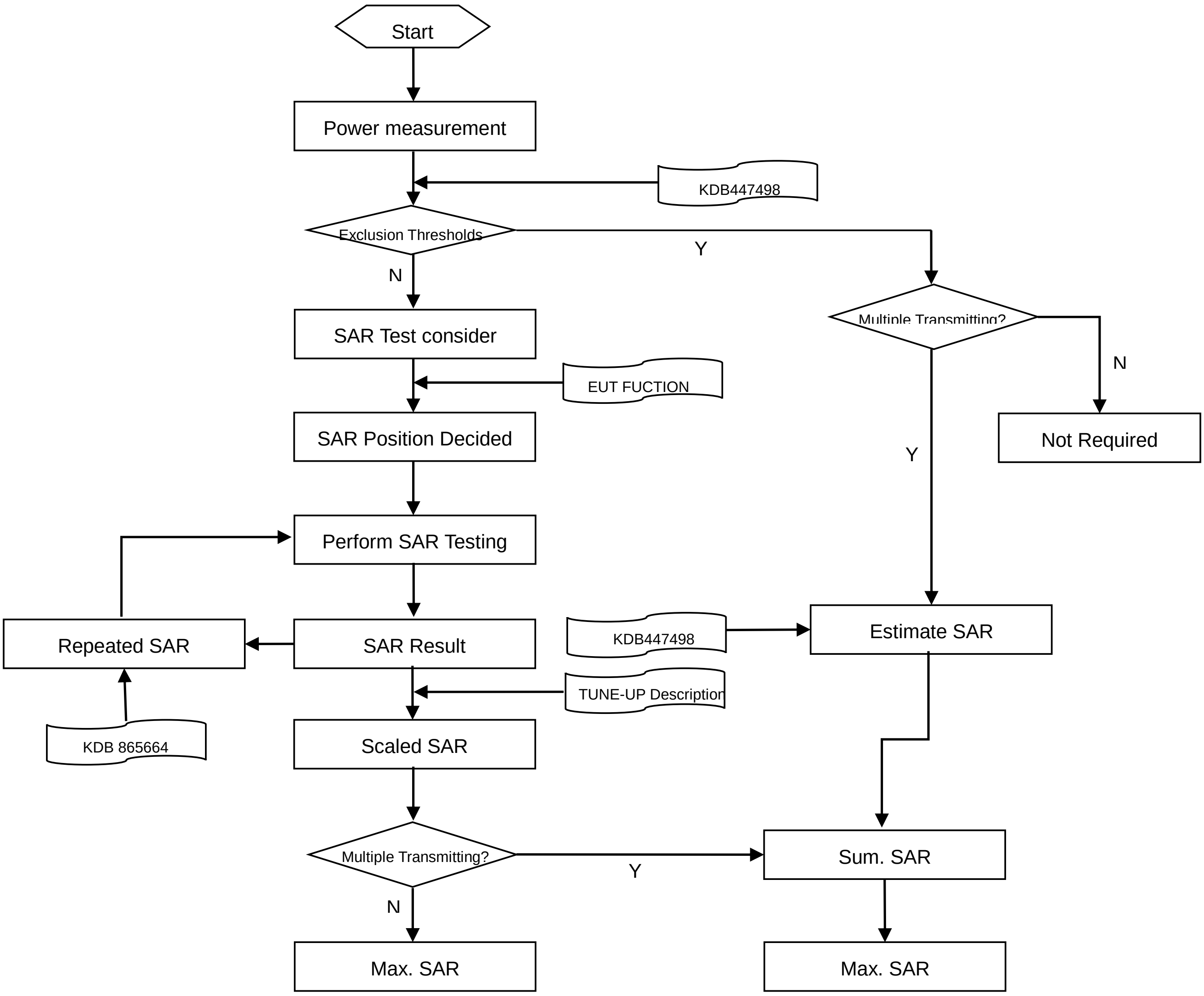
Body-worn accessory SAR compliance is based on a single minimum test separation distance for all wireless and operating modes applicable to each body-worn accessory used by the host, and according to the relevant voice and/or data mode transmissions and operations. If a body-worn accessory supports voice only operations in its normal and expected use conditions, testing of data mode for body-worn compliance is not required. A conservative minimum test separation distance for supporting off-the-shelf body-worn accessories that may be acquired by users of consumer handsets is used to test for body-worn accessory SAR compliance. This distance is determined by the handset manufacturer, according to the requirements of Supplement C 01-01. Devices that are designed to operate on the body of users using lanyards and straps, or without requiring additional body-worn accessories, will be tested using a conservative minimum test separation distance <= 5 mm to support compliance.





7 MEASUREMENT PROCEDURE

7.1 Measurement Process Diagram



7.2 SAR Scan General Requirement

Probe boundary effect error compensation is required for measurements with the probe tip closer than half a probe tip diameter to the phantom surface. Boththe probe tip diameter and sensor offset distance must satisfy measurement protocols; to ensure probe boundary effect errors are minimized and the higher fields closest to the phantom surface can be correctly measured and extrapolated to the phantom surface for computing 1 g SAR. Tolerances of the post-processing algorithms must be verified by the test laboratory for the scan resolutions used in the SAR measurements, according to the reference distribution functions specified in IEEE Std 1528-2013.

<table>
<tr><th colspan="3"></th><th>≤3GHz</th><th>>3GHz</th></tr>
<tr><td colspan="3">Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface</td><td>5±1 mm</td><td>½·δ·ln(2)±0.5 mm</td></tr>
<tr><td colspan="3">Maximum probe angle from probe axis to phantom surface normal at the measurement location</td><td>30°±1°</td><td>20°±1°</td></tr>
<tr><td colspan="3" rowspan="2">Maximum area scan spatial resolution: Δx Area , Δy Area</td><td>≤ 2 GHz: ≤ 15 mm
2 – 3 GHz: ≤ 12 mm</td><td>3–4 GHz: ≤ 12 mm
4 – 6 GHz: ≤ 10 mm</td></tr>
<tr><td colspan="2">When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.</td></tr>
<tr><td colspan="3">Maximum zoom scan spatial resolution: Δx Zoom , Δy Zoom</td><td>≤ 2 GHz: ≤ 8 mm
2 –3 GHz: ≤ 5 mm*</td><td>3–4 GHz: ≤ 5 mm*
4 – 6 GHz: ≤ 4 mm*</td></tr>
<tr><td rowspan="7">Maximum zoom scan spatial resolution, normal to phantom surface</td><td colspan="2" rowspan="3">uniform grid: Δz Zoom (n)</td><td rowspan="3">≤ 5 mm</td><td>3–4 GHz: ≤ 4 mm</td></tr>
<tr><td>4–5 GHz: ≤ 3 mm</td></tr>
<tr><td>5–6 GHz: ≤ 2 mm</td></tr>
<tr><td rowspan="4">graded grid</td><td rowspan="3">Δz Zoom (1): between 1st two points closest to phantom surface</td><td rowspan="3">≤ 4 mm</td><td>3–4 GHz: ≤ 3 mm</td></tr>
<tr><td>4–5 GHz: ≤ 2.5 mm</td></tr>
<tr><td>5–6 GHz: ≤ 2 mm</td></tr>
<tr><td>Δz Zoom (n>1): between subsequent points</td><td colspan="2">≤ 1.5·Δz Zoom (n-1)</td></tr>
<tr><td rowspan="3">Minimum zoom scan volume</td><td colspan="2" rowspan="3">x, y, z</td><td rowspan="3">≥30 mm</td><td>3–4 GHz: ≥ 28 mm</td></tr>
<tr><td>4–5 GHz: ≥ 25 mm</td></tr>
<tr><td>5–6 GHz: ≥ 22 mm</td></tr>
<tr><td colspan="5">Note:
1. δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.
2. * When zoom scan is required and the reported SAR from the area scan based 1 g SAR estimation procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.</td></tr>
</table>

7.3 Measurement Procedure

The following steps are used for each test position

a. Establish a call with the maximum output power with a base station simulator. The connection between the mobile and the base station simulator is established via air interface
b. Measurement of the local E-field value at a fixed location. This value serves as a reference value for calculating a possible power drift.
c. Measurement of the SAR distribution with a grid of 8 to 16mm * 8 to16 mm and a constant distance to the inner surface of the phantom. Since the sensors cannot directly measure at the inner phantom surface, the values between the sensors and the inner phantom surface are extrapolated. With these values the area of the maximum SAR is calculated by an interpolation scheme.
d. Around this point, a cube of 30 * 30 * 30 mm or 32 * 32 *32 mm is assessed by measuring 5 or 8 * 5 or 8*4 or 5 mm. With these data, the peak spatial-average SAR value can be calculated.

7.4 Area & Zoom Scan Procedure

First Area Scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an Area Scan is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, Zoom Scan is required. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution over 10 g. Area scan and zoom scan resolution setting follows KDB 865664 D01v01r04 quoted below.
When the 1 g SAR of the highest peak is within 2 dB of the SAR limit, additional zoom scans are required for other peaks within 2 dB of the highest peak that have not been included in any zoom scan to ensure there is no increase in SAR.

8 CONDUCTED RF OUPUT POWER

8.1 LoRa

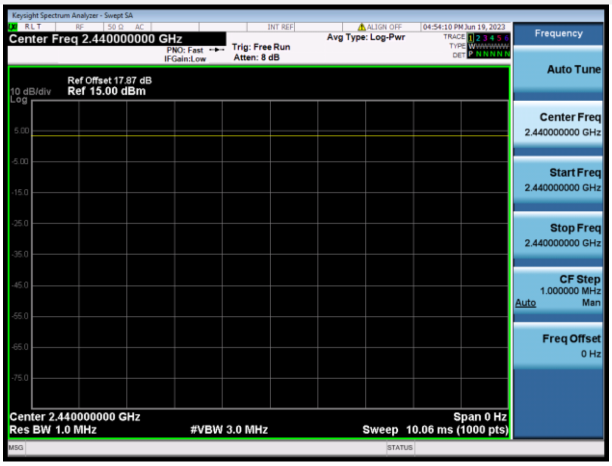
Mode	Channel	Freq. (MHz)	Conducted Power (dBm)	Tune-up Power Limit (dBm)	SAR Test Require.
DTS (BW 500kHz)	65	903	22.64	21.00	Yes
	68	907.8	**22.72**	21.00	Yes
	72	914.2	22.69	21.00	Yes
FHSS (BW 125kHz)	1	902.3	**22.81**	21.00	Yes
	32	908.5	22.67	21.00	Yes
	64	914.9	22.63	21.00	Yes

8.2 Bluetooth

Mode	BLE-1Mbps			BLE-2Mbps		
Channel	0	19	39	0	19	39
Frequency (MHz)	2402	2440	2480	2402	2440	2480
Conducted Power (dBm)	**3.70**	3.61	3.25	3.77	3.69	3.37
Tune-Up Limit (dBm)	4.00	4.00	4.00	4.00	4.00	4.00
SAR Test Require	Yes	Yes	Yes	No	No	No

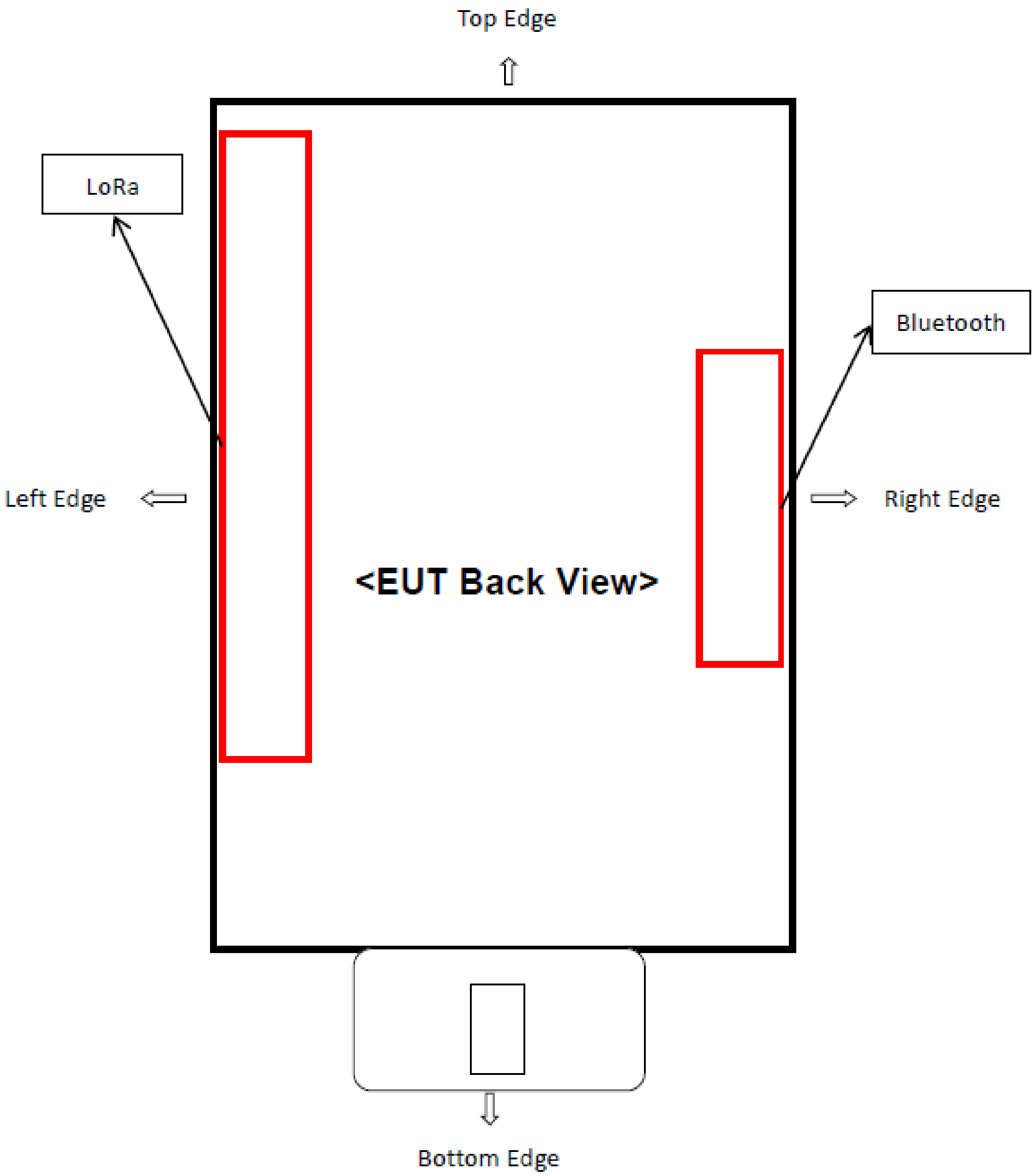
Duty Cycle

BLE-1Mbps



Note: The Bluetooth duty cycle BLE-1Mbps is 100 % as following figure, according to 2016 Oct. TCB workshop for Bluetooth SAR scaling need further consideration and the maximum duty cycle is 100%, therefore the actual duty cycle will be scaled up to 100% for Bluetooth reported SAR calculation.

9 TEST EXCLUSION CONSIDERATION



Antenna	Front Side (mm)	Back Side (mm)	Left Edge (mm)	Right Edge (mm)	Top Edge (mm)	Bottom Edge (mm)
LoRa	7.5	3.0	4.0	30.5	4.0	32.0
Bluetooth	7.5	3.0	38.5	4.0	15.5	29.0

9.1 SAR Test Consideration Table

According with FCC KDB 447498 D04, Appendix B, The SAR-based exemption formula applies for single fixed, mobile, and portable RF sources with available maximum time-averaged power or effective radiated power (ERP), whichever is greater, of less than or equal to the threshold Pth (mW).

This method shall only be used at separation distances from 0.5 cm to 40 cm and at frequencies from 0.3 GHz to 6 GHz (inclusive). The following table shows the power threshold from 5mm to 50mm.

Power Thresholds (mW)					
Frequency (MHz)	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
300	39 mW	65 mW	88 mW	110 mW	129 mW
450	22 mW	44 mW	67 mW	89 mW	112 mW
835	9 mW	25 mW	44 mW	66 mW	90 mW
1900	3 mW	12 mW	26 mW	44 mW	66 mW
2450	3 mW	10 mW	22 mW	38 mW	59 mW
3600	2 mW	8 mW	18 mW	32 mW	49 mW
5800	1 mW	6 mW	14 mW	25 mW	40 mW
Frequency (MHz)	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of 50 mm
300	148 mW	166 mW	184 mW	201 mW	217 mW
450	135 mW	158 mW	180 mW	203 mW	226 mW
835	116 mW	145 mW	175 mW	207 mW	240 mW
1900	92 mW	122 mW	157 mW	195 mW	236 mW
2450	83 mW	111 mW	143 mW	179 mW	219 mW
3600	71 mW	96 mW	125 mW	158 mW	195 mW
5800	58 mW	80 mW	106 mW	136 mW	169 mW

9.1.1 Laptop mode SAR Test Consideration

This host is a notebook computer, under normal use the RF exposure scenarios are shown in the table below:

The DUT under normal use the RF exposure scenarios are shown in the table below:

RF exposure Position	RF exposure scenarios
Front Side	Body
Back Side	Body
Left Edge	Body
Right Edge	Body
Top Edge	Body

Body RF exposure scenarios

Test Position Configurations	Mode	Bluetooth	LoRa
Calculated Frequency (GHz)		2.48	0.9149
Front Side	Distance to User (mm)	7.5	7.5
	Max. Peak Power (dBm)	4.00	23.00
	Max. Peak Power (mW)	2.51	199.53
	Exclusion Threshold (mW)	5.88	14.78
	SAR Test Required	Yes	Yes
Back Side	Distance to User (mm)	3	3
	Max. Peak Power (dBm)	4.00	23.00
	Max. Peak Power (mW)	2.51	199.53
	Exclusion Threshold (mW)	1.03	3.83
	SAR Test Required	Yes	Yes
Left Edge	Distance to User (mm)	38.5	4
	Max. Peak Power (dBm)	4.00	23.00
	Max. Peak Power (mW)	2.51	199.53
	Exclusion Threshold (mW)	132.65	5.85
	SAR Test Required	Yes	Yes
Right Edge	Distance to User (mm)	4	30.50
	Max. Peak Power (dBm)	4.00	23.00
	Max. Peak Power (mW)	2.51	199.53
	Exclusion Threshold (mW)	1.78	116.82
	SAR Test Required	Yes	Yes
Top Edge	Distance to User (mm)	15.5	4
	Max. Peak Power (dBm)	4.00	23.00
	Max. Peak Power (mW)	2.51	199.53
	Exclusion Threshold (mW)	23.45	5.85
	SAR Test Required	Yes	Yes

Note:

1. Maximum power is the source-based time-average power and represents the maximum RF output power including tune-up tolerance among production units
2. Per KDB 447498 D04, for larger devices, the test separation distance of adjacent edge configuration is determined by the closest separation between the antenna and the user.
3. Per KDB 447498 D04, standalone SAR test exclusion threshold is applied; If the distance of the antenna to the user is < 5mm, 5mm is used to determine SAR exclusion threshold
4. Per KDB 447498 D04, for separation distances from 0.5 cm to 40 cm and at frequencies from 0.3 GHz to 6 GHz (inclusive), the threshold Pth (mW) is given by Following:

$$P_{th}(mW) = \begin{cases} ERP_{20cm}(d/20cm)^{x} & d \le 20cm \\ ERP_{20cm} & 20cm < d \le 40cm \end{cases}$$

where

$$x = -log_{10}\left(\frac{60}{ERP_{20cm}\sqrt{f}}\right)$$

   a. f(GHz) is the RF channel transmit frequency in GHz
   b. d is the separation distance (cm), The result is rounded to one decimal place for comparison
   c. ERP_{20cm} are determined by:

$$ERP_{20cm}(mW) = f(x) = \begin{cases} 2040f & 0.3GHz \le f < 1.5GHz \\ 3060 & 1.5GHz \le f \le 6GHz \end{cases}$$

10 TEST RESULT

10.1 LoRa

Mode	Position	Dist. (mm)	Ch.	Freq. (MHz)	Power Drift (dB)	1g Meas SAR (W/kg)	Meas. Power (dBm)	Max. tune-power (dBm)	Scaling Factor	Duty cycle (%)	Duty cycle Factor	1g Meas SAR (W/kg)	Meas. No.
Body													
DTS (BW500K)	Front Side	0	68	907.8	0.07	0.481	22.72	23.00	1.067	100.00	1.000	0.513	/
	Back Side	0	68	907.8	0.01	0.254	22.72	23.00	1.067	100.00	1.000	0.271	/
	Left Edge	0	68	907.8	-0.07	0.935	22.72	23.00	1.067	100.00	1.000	**0.998**	1#
	Right Edge	0	68	907.8	-0.08	0.240	22.72	23.00	1.067	100.00	1.000	0.256	/
	Top Edge	0	68	907.8	-0.01	0.614	22.72	23.00	1.067	100.00	1.000	0.655	/
	Left Edge	0	65	903	0.05	0.740	22.64	23.00	1.086	100.00	1.000	0.804	/
	Left Edge	0	72	914.2	0.00	0.816	22.69	23.00	1.074	100.00	1.000	0.876	/
FHSS (BW125K)	Front Side	0	1	902.3	-0.16	0.442	22.81	23.00	1.045	100.00	1.000	0.462	/
	Back Side	0	1	902.3	0.07	0.235	22.81	23.00	1.045	100.00	1.000	0.246	/
	Left Edge	0	1	902.3	0.16	0.850	22.81	23.00	1.045	100.00	1.000	0.888	/
	Right Edge	0	1	902.3	-0.17	0.220	22.81	23.00	1.045	100.00	1.000	0.230	/
	Top Edge	0	1	902.3	0.06	0.555	22.81	23.00	1.045	100.00	1.000	0.580	/
	Left Edge	0	32	908.5	0.16	0.824	22.67	23.00	1.079	100.00	1.000	**0.889**	2#
	Left Edge	0	64	914.9	-0.02	0.814	22.63	23.00	1.089	100.00	1.000	0.886	/
Note: Refer to ANNEX C for the detailed test data for each test configuration.													

10.2 Bluetooth

Mode	Position	Dist. (mm)	Ch.	Freq. (MHz)	Power Drift (dB)	1g Meas SAR (W/kg)	Meas. Power (dBm)	Max. tune-power (dBm)	Scaling Factor	Duty cycle (%)	Duty cycle Factor	1g Meas SAR (W/kg)	Meas. No.
Body													
BLE 1M	Front Side	0	0	2402	0.06	0.040	3.70	4.00	1.072	100.00	1.000	0.043	/
	Back Side	0	0	2402	-0.08	0.036	3.70	4.00	1.072	100.00	1.000	0.039	/
	Left Edge	0	0	2402	-0.04	0.032	3.70	4.00	1.072	100.00	1.000	0.034	/
	Right Edge	0	0	2402	-0.19	0.091	3.70	4.00	1.072	100.00	1.000	**0.098**	3#
	Top Edge	0	0	2402	0.16	0.019	3.70	4.00	1.072	100.00	1.000	0.020	/
	Right Edge	0	19	2440	0.00	0.086	3.61	4.00	1.094	100.00	1.000	0.094	/
	Right Edge	0	39	2480	0.14	0.079	3.25	4.00	1.189	100.00	1.000	0.094	/
Note: Refer to ANNEX C for the detailed test data for each test configuration.													

11 SAR Measurement Variability

According to KDB 865664 D01, SAR measurement variability was assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. Alternatively, if the highest measured SAR for both head and body tissue-equivalent media are ≤ 1.45 W/kg and the ratio of these highest SAR values, i.e., largest divided by smallest value, is ≤ 1.10, the highest SAR configuration for either head or body tissue-equivalent medium may be used to perform the repeated measurement. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

SAR repeated measurement procedure:

1. When the highest measured SAR is < 0.80 W/kg, repeated measurement is not required.
2. When the highest measured SAR is >= 0.80 W/kg, repeat that measurement once.
3. If the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20, or when the original or repeated measurement is >= 1.45 W/kg, perform a second repeated measurement.
4. If the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20, and the original, first or second repeated measurement is >= 1.5 W/kg, perform a third repeated measurement.

Mode	Antenna	Test Position	Highest Measured SAR (W/kg)	Repeated SAR (Yes/No)	Repeated1th Measured SAR (W/kg)	Largest to Smallest SAR Radio
DTS (BW 500kHz)	LoRa	Left Edge	0.935	Yes	0.926	1.01
FHSS (BW 125kHz)	LoRa	Left Edge	0.850	Yes	0.832	1.02
Note: The ratio of largest to smallest SAR for the original and first repeated measurements is < 1.20, the second repeated measurement is not required.						

12 SIMULTANEOUS TRANSMISSION

Simultaneous transmission SAR test exclusion is determined for each operating configuration and exposure condition according to the reported standalone SAR of each applicable simultaneous transmitting antenna. When the sum of SAR 1g of all simultaneously transmitting antennas in an operating mode and exposure condition combination is within the SAR limit (SAR 1g 1.6 W/kg), the simultaneous transmission SAR is not required. When the sum of SAR 1g is greater than the SAR limit (SAR 1g 1.6 W/kg), SAR test exclusion is determined by the SAR to Peak Location Ratio (SPLSR).

12.1 Simultaneous Transmission Mode Considerations

No.	Simultaneous Tx Combination	Body
1	LoRa + Bluetooth	Yes

12.2 Sum SAR of Simultaneous Transmission

Test Mode	Position	Simultaneous Mode	Mode	Max. 1g SAR (W/kg)	1g Sum SAR (W/kg)	Limit 1g (W/Kg)
Body (0 mm)						
DTS (BW500K)	Front Side	LoRa +Bluetooth	LoRa	0.513	0.556	1.6
			Bluetooth	0.043		
	Back Side	LoRa +Bluetooth	LoRa	0.271	0.310	
			Bluetooth	0.039		
	Left Edge	LoRa +Bluetooth	LoRa	0.998	**1.032**	
			Bluetooth	0.034		
	Right Edge	LoRa +Bluetooth	LoRa	0.256	0.354	
			Bluetooth	0.098		
	Top Edge	LoRa +Bluetooth	LoRa	0.655	0.675	
			Bluetooth	0.020		
FHSS (BW125K)	Front Side	LoRa +Bluetooth	LoRa	0.462	0.505	
			Bluetooth	0.043		
	Back Side	LoRa +Bluetooth	LoRa	0.246	0.285	
			Bluetooth	0.039		
	Left Edge	LoRa +Bluetooth	LoRa	0.889	0.923	
			Bluetooth	0.034		
	Right Edge	LoRa +Bluetooth	LoRa	0.230	0.328	
			Bluetooth	0.098		
	Top Edge	LoRa +Bluetooth	LoRa	0.580	0.600	
			Bluetooth	0.020		

13 TEST EQUIPMENTS LIST

Description	Manufacturer	Model	Serial No./Version	Cal. Date	Cal. Due
PC	Dell	N/A	N/A	N/A	N/A
Test Software	Speag	DASY5	52.8.8.1222	N/A	N/A
835MHz Validation Dipole	Speag	D835V2	SN: 4d187	2021/05/17	2024/05/16
2450MHz Validation Dipole	Speag	D2450V2	SN: 952	2021/05/19	2024/05/18
E-Field Probe	Speag	EX3DV4	SN: 7510	2023/01/19	2024/01/18
Data Acquisition Electronicsr	Speag	DAE4	SN: 1454	2023/03/20	2024/03/19
Signal Generator	R&S	SMB100A	182396	2022/09/06	2023/09/05
Power Meter	R&S	NRVD-B2	7250BJ-0112/2011	2022/09/06	2023/09/05
Power Sensor	R&S	NRV-Z4	100381	2022/09/06	2023/09/05
Power Sensor	R&S	NRV-Z2	100211	2022/09/06	2023/09/05
Network Analyzer	Agilent	E5071C	MY46103472	2022/12/06	2023/12/05
Thermometer	Elitech	RC-4HC	EF7225003030	2022/08/31	2023/08/30
Thermometer	Elitech	RC-4HC	EF7225003029	2022/08/31	2023/08/30
Power Amplifier	SATIMO	6552B	22374	N/A	N/A
Dielectric Probe Kit	Speag	DAK3.5	SN: 1312	N/A	N/A
Phantom	Speag	SAM	SN: 1857	N/A	N/A
Attenuator	COM-MW	ZA-S1-31	1305003187	N/A	N/A
Directional coupler	AA-MCS	AAMCS-UDC	000272	N/A	N/A

Note: For dipole antennas, BALUN has adopted 3 years as calibration intervals, and 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 in within 20% of calibrated measurement.
4. Impedance (real or imaginary parts) in within 5 Ohms of calibrated measurement.

ANNEX A SIMULATING LIQUID VERIFICATION RESULT

The dielectric parameters of the liquids were verified prior to the SAR evaluation using a DAK3.5 Dielectric Probe Kit.

Head Liquid

Date	Liquid Type	Fre. (MHz)	Temp. (℃)	Meas. Conductivity (σ) (S/m)	Meas. Permittivity (ε)	Target Conductivity (σ) (S/m)	Target Permittivity (ε)	Conductivity Tolerance (%)	Permittivity Tolerance (%)
2023.07.18	Head	835	21.3	0.87	42.54	0.90	41.50	-3.33	2.51
2023.07.19	Head	2450	21.7	1.82	39.95	1.80	39.20	1.11	1.91
Note: The tolerance limit of Conductivity and Permittivity is± 5%.									

ANNEX B SYSTEM CHECK RESULT

Comparing to the original SAR value provided by SPEAG, the validation data should be within itsspecification of 10 %(for 1 g).

Head liquid 1g

Date	Liquid Type	Freq. (MHz)	Power (mW)	Measured SAR (W/kg)	Normalized SAR (W/kg)	Dipole SAR (W/kg)	Tolerance (%)
2023.07.18	Head	835	100	0.955	9.55	9.76	-2.15
2023.07.19	Head	2450	100	5.460	54.60	53.00	3.02
Note: The tolerance limit of System validation ±10%.							

System Performance Check Data (835MHz)

Date: 2023.07.18

Communication System Band: D835 (835.0 MHz); Frequency: 835 MHz;Duty Cycle: 1:1

Medium parameters used (interpolated): f = 835 MHz; σ = 0.874 S/m; ε_r = 42.538; ρ = 1000 kg/m^3

Phantom section: Flat Section

Ambient Temperature:22.1℃ Liquid Temperature:21.3℃

DASY5 Configuration:

- Probe: EX3DV4 - SN7510; ConvF(9.97, 9.97, 9.97); Calibrated: 2023.01.19;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454; Calibrated: 2023.03.20
- Phantom: SAM (20deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CC; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

CW 835 100mw/Area Scan (81x151x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 1.23 W/kg

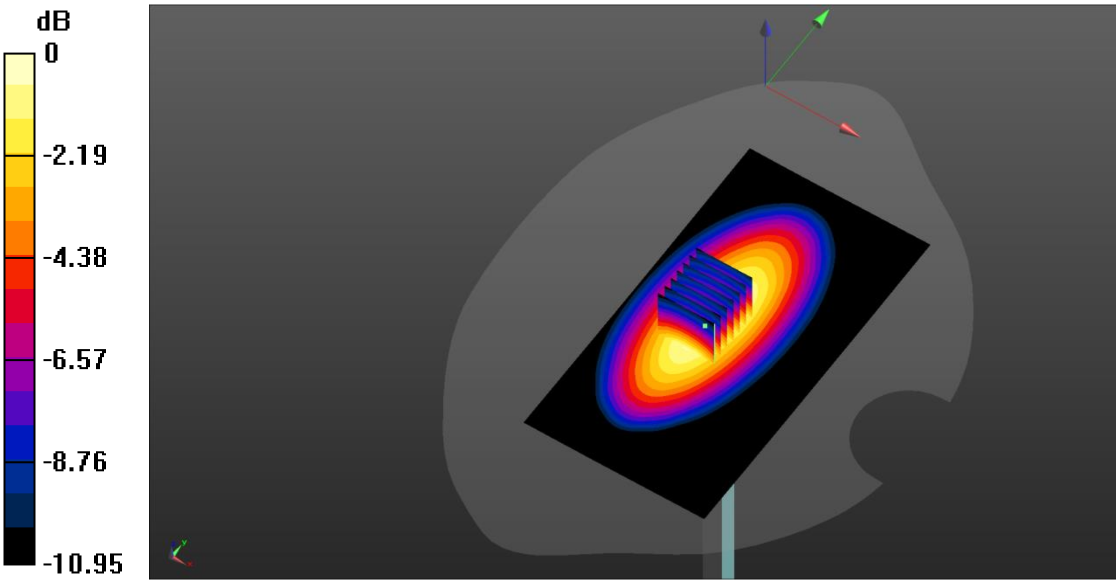
CW 835 100mw/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 36.79 V/m; Power Drift = -0.11 dB

Peak SAR (extrapolated) = 1.87 W/kg

SAR(1 g) = 0.955 W/kg; SAR(10 g) = 0.624 W/kg

Maximum value of SAR (measured) = 1.23 W/kg



System Performance Check Data (2450MHz)

Date: 2023.07.19

Communication System Band: D2450 (2450.0 MHz); Frequency: 2450 MHz;Duty Cycle: 1:1

Medium parameters used: f = 2450 MHz; σ = 1.82 S/m; ε_r = 39.951; ρ = 1000 kg/m^3

Phantom section: Flat Section

Ambient Temperature:22.8℃ Liquid Temperature:21.7℃

DASY5 Configuration:

- Probe: EX3DV4 - SN7510; ConvF(7.78, 7.78, 7.78); Calibrated: 2023.01.19;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454; Calibrated: 2023.03.20
- Phantom: SAM (20deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CC; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

CW 2450 100mw/Area Scan (81x81x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 6.39 W/kg

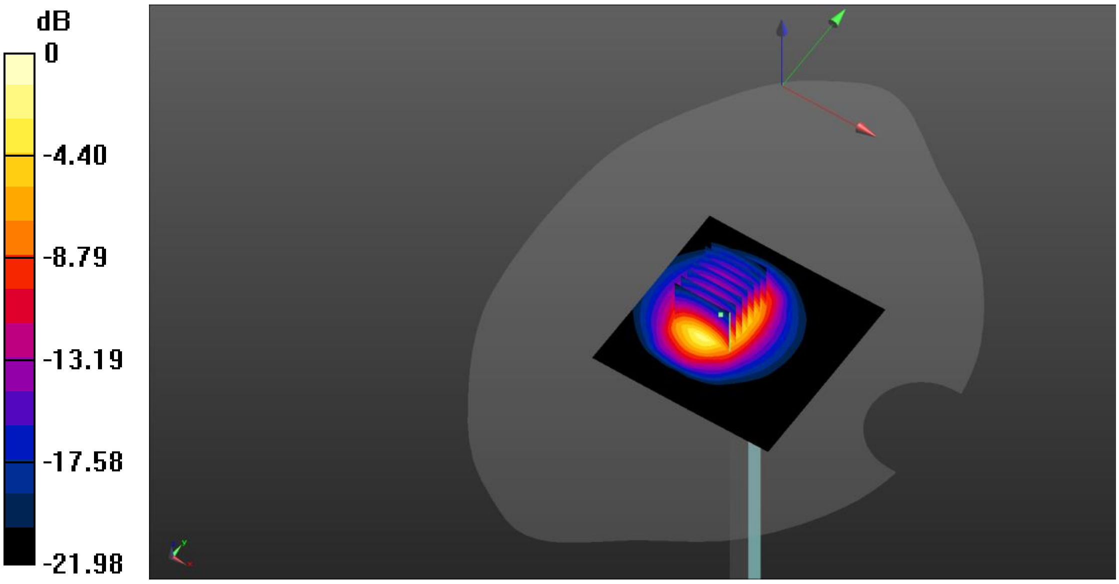
CW 2450 100mw/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 45.01 V/m; Power Drift = 0.07 dB

Peak SAR (extrapolated) = 11.3 W/kg

SAR(1 g) = 5.46 W/kg; SAR(10 g) = 2.48 W/kg

Maximum value of SAR (measured) = 6.11 W/kg



0 dB = 6.11 W/kg

ANNEX C TEST DATA

Meas.1 Body Plane with Left Edge 0mm on 68 Channel in Lora mode

Date: 2023.07.18

Communication System Band: DTS; Frequency: 907.8 MHz;Duty Cycle: 1:1

Medium parameters used (interpolated): f = 907.8 MHz; σ = 0.955 S/m; ε_r = 41.314; ρ = 1000 kg/m^3

Phantom section: Flat Section

Ambient Temperature:22.1℃ Liquid Temperature:21.3℃

DASY5 Configuration:

- Probe: EX3DV4 - SN7510; ConvF(9.97, 9.97, 9.97); Calibrated: 2023.01.19;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454; Calibrated: 2023.03.20
- Phantom: SAM (20deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CC; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Ch68/Area Scan (61x91x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 0.970 W/kg

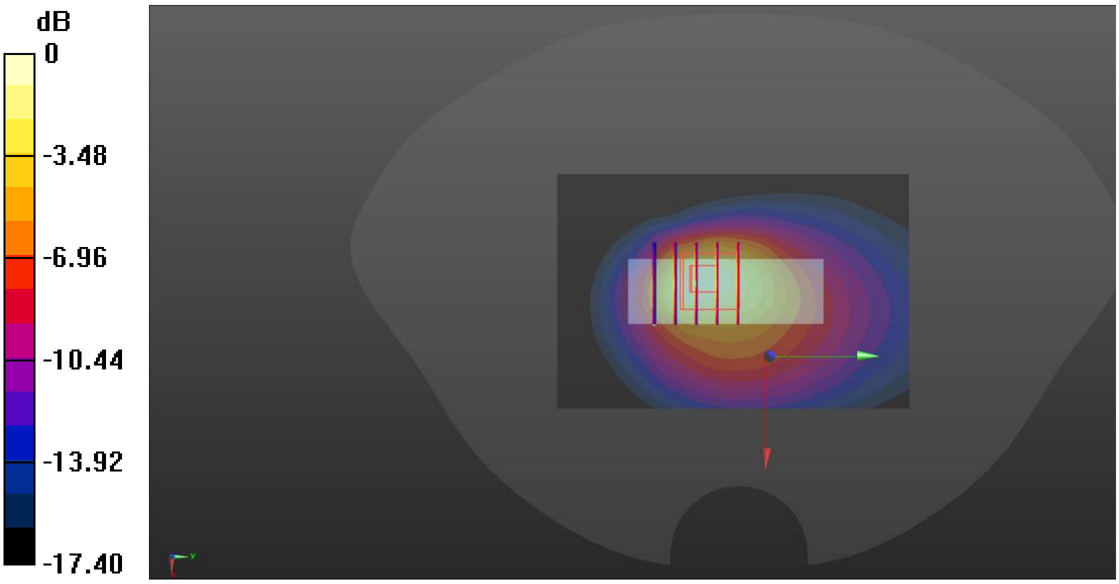
Ch68/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 25.37 V/m; Power Drift = -0.07 dB

Peak SAR (extrapolated) = 1.93 W/kg

SAR(1 g) = 0.935 W/kg; SAR(10 g) = 0.457 W/kg

Maximum value of SAR (measured) = 1.04 W/kg



0 dB = 1.04 W/kg

Meas.2 Body Plane with Left Edge 0mm on 32 Channel in Lora mode

Date: 2023.07.18

Communication System Band: FHSS; Frequency: 908.5 MHz;Duty Cycle: 1:1

Medium parameters used (interpolated): f = 908.5 MHz; σ = 0.958 S/m; ε_r = 41.19; ρ = 1000 kg/m^3

Phantom section: Flat Section

Ambient Temperature:22.1℃ Liquid Temperature:21.3℃

DASY5 Configuration:

- Probe: EX3DV4 - SN7510; ConvF(9.97, 9.97, 9.97); Calibrated: 2023.01.19;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454; Calibrated: 2023.03.20
- Phantom: SAM (20deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CC; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Ch32/Area Scan (61x91x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm

Maximum value of SAR (interpolated) = 1.05 W/kg

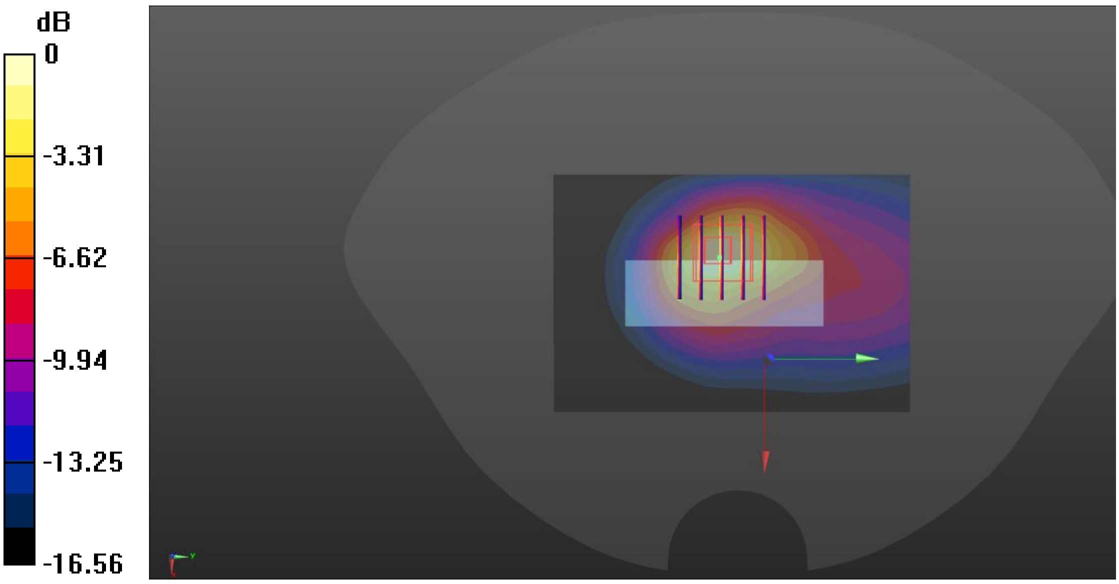
Ch32/Zoom Scan (5x5x7)/Cube 0: Measurement grid: dx=8mm, dy=8mm, dz=5mm

Reference Value = 16.57 V/m; Power Drift = 0.16 dB

Peak SAR (extrapolated) = 1.75 W/kg

SAR(1 g) = 0.824 W/kg; SAR(10 g) = 0.393 W/kg

Maximum value of SAR (measured) = 0.915 W/kg



0 dB = 0.915 W/kg

Meas.3 Body Plane with Right Edge 0mm on 0 Channel in Bluetooth mode

Date: 2023.07.19

Communication System Band: BLE; Frequency: 2402 MHz;Duty Cycle: 1:1

Medium parameters used (interpolated): f = 2402 MHz; σ = 1.768 S/m; ε_r = 40.151; ρ = 1000 kg/m^3

Phantom section: Flat Section

Ambient Temperature:22.8℃ Liquid Temperature:21.7℃

DASY5 Configuration:

- Probe: EX3DV4 - SN7510; ConvF(7.78, 7.78, 7.78); Calibrated: 2023.01.19;
- Sensor-Surface: 4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1454; Calibrated: 2023.03.20
- Phantom: SAM (20deg probe tilt) with CRP v5.0 Right 1857; Type: QD000P40CC; Serial: TP1857
- Measurement SW: DASY52, Version 52.8 (8); SEMCAD X Version 14.6.10 (7331)

Ch0/Area Scan (71x111x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm

Maximum value of SAR (interpolated) = 0.104 W/kg

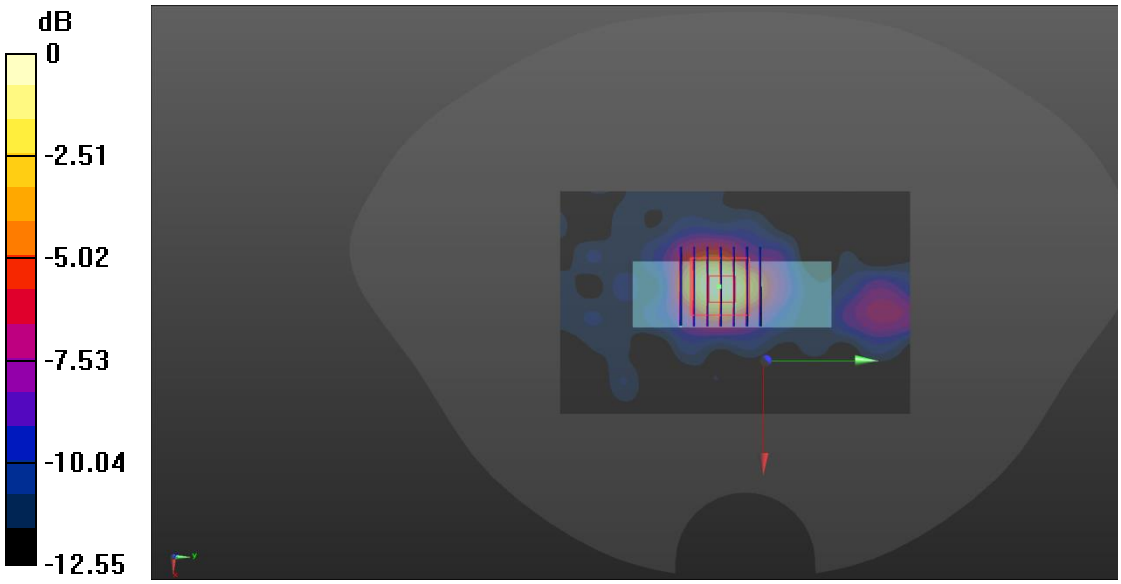
Ch0/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 6.031 V/m; Power Drift = -0.19 dB

Peak SAR (extrapolated) = 0.214 W/kg

SAR(1 g) = 0.091 W/kg; SAR(10 g) = 0.040 W/kg

Maximum value of SAR (measured) = 0.105 W/kg



0 dB = 0.105 W/kg

ANNEX D EUT EXTERNAL PHOTOS

Please refer the document “BL-SZ2351022-AW.pdf”.

ANNEX E SAR TEST SETUP PHOTOS

Please refer the document “BL-SZ2351022-AS.pdf”.

ANNEX F CALIBRATION REPORT

Please refer the document “BL-SZ2351022-AC.pdf”.

ANNEX G TUNE-UP PROCEDURE

Please refer the document “BL-SZ2351022-AT.pdf”.

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