FCC SAR TEST REPORT

Test File No : F690501-RF-SAR000240

Equipment Under Test	Bluetooth Headset
Model Name	SM-R510
Applicant	Samsung Electronics Co., Ltd.
Address of Applicant	129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Republic of Korea
FCC ID	A3LSMR510L
Exposure Category	General Population/Uncontrolled Exposure
Standards	FCC 47 CFR § 2.1093 IEEE 1528, 2013 ANSI/IEEE C95.1, C95.3
Receipt No.	GPRI2205000344SR
Date of Receipt	2022-05-23
Date of Test(s)	2022-06-08 ~ 2022-06-09
Date of Issue	2022-06-10
Test Result	PASS, Refer to the Page 04
Measurement Uncertainty	Refer to the Page 24

In the configuration tested, the EUT complied with the standards specified above.

This test report does not assure KOLAS accreditation.

Remarks:

1) The results of this test report are effective only to the items tested.
2) The SGS Korea is not responsible for the sampling, the results of this test report apply to the sample as received.

Report prepared by /
Seongyeon Yu
Test Engineer

Approved by /
Matthew Park
Technical Manager

Revision history

Revision	Date of issue	Revisions	Revised By
-	June 10, 2022	Initial issue	-

Contents

1. Testing Laboratory

Company Name	SGS Korea Co., Ltd.
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Telephone	+82 +31 - 428 - 5700
FAX	+82 +31 - 427 - 2371

2. Details of Manufacturer

Manufacturer	Samsung Electronics co., Ltd.
Address	129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Rep. of Korea
Email	juntaek79.oh@samsung.com
Phone No.	+82 +31 – 301 - 8362

3. Description of EUT(s)

EUT Type	Bluetooth Headset	
Model Name	SM-R510	
Serial Number	R3AT502F7AD	
Mode of Operation	Bluetooth, Bluetooth Low Energy	
Duty Cycle	76.8 %(Bluetooth)	
Body worn Accessory	None	
Tx Frequency Range	2402.00 ㎒ ~ 2480.00 ㎒ (Bluetooth)	
Antenna Information※	Manufacturer	Ethertronics, Inc.
	Type	Internal antenna
	Antenna Gain (dBi)	Left
		-7.30

4. The Highest Reported SAR Values

Equipment Class	Band	Highest Reported SAR 1g (W/kg)
DSS	Bluetooth(Left)	0.470
Simultaneous SAR per KDB 690783 D01v0r03		N/A

- The data marked ※ in this report was provided by the customer and may affect the validity of the test results.
  We are responsible for all the information of this test report except for the data(※) provided by the customer.

5. Test Methodology

ANSI/IEEE C95.1–2005: IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz. It specifies the maximum exposure limit of 1.6 W/kg as averaged over any 1 gram of tissue for portable devices being used within 20 cm of the user in the uncontrolled environment.

Test tests documented in this report were performed in accordance with IEEE Standard 1528-2013 and the following published KDB procedures.

In additions;

☒	**KDB 865664 D01v01r04**	**SAR Measurement Requirements for 100 MHz to 6 GHz**
☒	**KDB 865664 D02v01r02**	**RF Exposure Compliance Reporting and Documentation Considerations**
☒	**KDB 447498 D01v06**	**Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies**
☐	KDB 447498 D02v02r01	SAR Measurement Procedures for USB Dongle Transmitters
☐	KDB 248227 D01v02r02	SAR Guidance For IEEE 802.11 (Wi-Fi) Transmitters
☐	KDB 615223 D01v01r01	802.16e/WiMax SAR Measurement Guidance
☐	KDB 616217 D04v01r02	SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers
☐	KDB 643646 D01v01r03	SAR Test Reduction Considerations for Occupational PTT Radios
☐	KDB 648474 D03v01r04	Evaluation and Approval Considerations for Handsets with Specific Wireless Charging Battery Covers
☐	KDB 648474 D04v01r03	SAR Evaluation Considerations for Wireless Handsets
☐	KDB 680106 D01v03r01	RF Exposure Considerations for Low Power Consumer Wireless Power Transfer Applications
☐	KDB 941225 D01v03r01	3G SAR Measurement Procedures
☐	KDB 941225 D05v02r05	SAR Evaluation Considerations for LTE Devices
☐	KDB 941225 D06v02r01	SAR Evaluation Procedures for Portable Devices with Wireless Router Capabilities
☐	KDB 941225 D07v01r02	SAR Evaluation Procedures for UMPC Mini-Tablet Devices

6. Testing Environment

Ambient temperature	: 18°C ~ 25°C
Relative humidity	: 30% ~ 70%
Liquid temperature of during the test	: <± 2°C
Ambient noise & Reflection	: < 0.012 W/kg

7 Specific Absorption Rate (SAR)

7.1 Introduction

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

7.2 SAR Definition

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:

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

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

SAR measurement can be either related to the temperature elevation in tissue by

$$SAR = C\left(\frac{\delta T}{\delta t}\right)$$

Where: C is the specific head capacity, δT is the temperature rise and δt is the exposure duration, or related to the electrical field in the tissue by

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

Where: σ is the conductivity of the tissue, ρ is the mass density of the tissue and E is the RMS electrical field strength.

However for evaluating SAR of low power transmitter, electrical field measurement is typically applied.

7.3 Test Standards and Limits

According to FCC 47CFR §2.1093(d) The limits to be used for evaluation are based generally on criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (“SAR”) in Section 4.2 of “IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 ㎑ to 300 ㎓,” ANSI/IEEE C95.3–2003, Copyright 2003 by the Institute of Electrical and Electronics Engineers, Inc., New York, New York 10017. These criteria for SAR evaluation are similar to those recommended by the National Council on Radiation Protection and Measurements (NCRP) in “Biological Effects and Exposure Criteria for Radio frequency Electromagnetic Fields,” NCRP Report No. 86, Section 17.4.5. Copyright NCRP, 1986, Bethesda, Maryland 20814. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards. The criteria to be used are specified in paragraphs (d)(1) and (d)(2) of this section and shall apply for portable devices transmitting in the frequency range from 100 ㎑ to 6 ㎓. Portable devices that transmit at frequencies above 6 ㎓ are to be evaluated in terms of the MPE limits specified in § 1.1310 of this chapter. Measurements and calculations to demonstrate compliance with MPE field strength or power density limits for devices operating above 6 ㎓ should be made at a minimum distance of 5 cm from the radiating source.

(1) Limits for Occupational/Controlled exposure: 0.4 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 8 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 20 W/kg, as averaged over an 10 grams of tissue (defined as a tissue volume in the shape of a cube). Occupational/Controlled limits apply when persons are exposed as a consequence of their employment provided these persons are fully aware of and exercise control over their exposure. Awareness of exposure can be accomplished by use of warning labels or by specific training or education through appropriate means, such as an RF safety program in a work environment.

(2) Limits for General Population/Uncontrolled exposure: 0.08 W/kg as averaged over the whole-body and spatial peak SAR not exceeding 1.6 W/kg as averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube). Exceptions are the hands, wrists, feet and ankles where the spatial peak SAR shall not exceed 4 W/kg, as averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube). General Population/Uncontrolled limits apply when the general public may be exposed, or when persons that are exposed as a consequence of their employment may not be fully aware of the potential for exposure or do not exercise control over their exposure. Warning labels placed on consumer devices such as cellular telephones will not be sufficient reason to allow these devices to be evaluated subject to limits for occupational/controlled exposure in paragraph (d)(1) of this section.

Human Exposure	Uncontrolled Environment General Population	Controlled Environment Occupational
Partial Peak SAR (Partial)	1.60 m W/g	8.00 m W/g
Partial Average SAR (Whole Body)	0.08 m W/g	0.40 m W/g
Partial Peak SAR (Hands/Feet/Ankle/Wrist)	4.00 m W/g	20.00 m W/g

1. The spatial Peak value of the SAR averaged over any 1g gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.
2. The spatial Average value of the SAR averaged over the whole body.
3. The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

8 The SAR Measurement System

A block diagram of the SAR measurement System is given in Fig. 1. This SAR Measurement System uses a Computer-controlled 3-D stepper motor system (SPEAG DASY professional system). The model EX3DV4 field probe is used to determine the internal electric fields. The SAR can be obtained from the equation SAR= $\sigma (|Ei|^2)/ \rho$ where σ and ρ are the conductivity and mass density of the tissue-simulant.

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

- A standard high precision 6-axis robot (Staubli TX family) with controller, teach pendant and software. An arm extension is for accommodating the data acquisition electronics (DAE).
- A dosimeter 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.
- Data acquisition electronics (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.

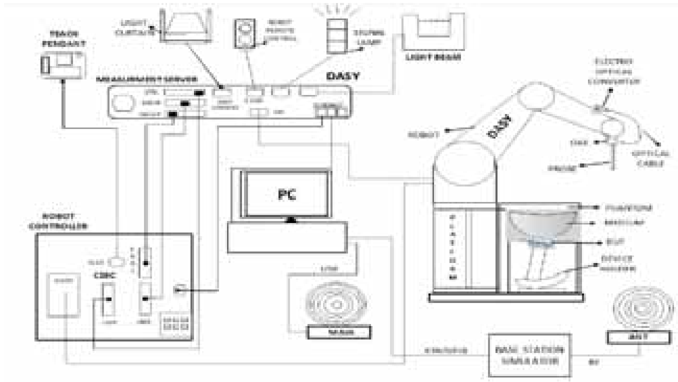


Fig 1. The microwave circuit arrangement used for SAR system verification

- The Electro-optical converter (EOC) performs the conversion between optical and electrical of the signals for the digital communication to the DAE and for the analog signal from the optical surface detection. The EOC is connected to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
- A computer operating Windows.
- DASY software.
- Remote control with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
- The SAM twin phantom enabling testing left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- Verification dipole kits allowing to validate the proper functioning of the system.

9 System Components

9.1 Probe


EX3DV4 E-Field Probe

Construction : Symmetrical design with triangular core.
Built-in shielding against static charges.
PEEK enclosure material (resistant to organic solvents, e.g., DGBE)

Calibration : Basic Broad Band Calibration in air Conversion Factors (CF) for HSL 835 and HSL1900.
Additional CF-Calibration for other liquids and frequencies upon request.

Frequency : 10 ㎒ to 6 ㎓; Linearity: ± 0.2 ㏈ (30 ㎒ to 6 ㎓)

Directivity : ± 0.3 ㏈ in HSL (rotation around probe axis)
± 0.5 ㏈ in tissue material (rotation normal to probe axis)

Dynamic Range : 10µW/g to > 100 m W/g;
Linearity: ± 0.2 ㏈(noise: typically < 1 µW/g)

Dimensions : Overall length: 337 ㎜ (Tip length: 20 ㎜)
Tip diameter: 2.5 ㎜ (Body diameter: 12 ㎜)
Distance from probe tip to dipole centers: 1 ㎜

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 ㎓ with precision of better 30%

NOTE:

1. The Probe parameters have been calibrated by the SPEAG. Please reference “APPENDIX C” for the Calibration Certification Report.

9.2 SAM Phantom

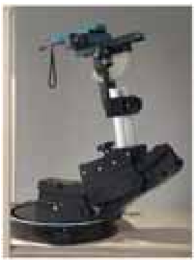

SAM Phantom

Construction : The SAM Phantom is constructed of a fiberglass shell integrated in a wooden table. The shape of the shell is based on data from an anatomical study designed to determine the maximum exposure in at least 90 % of all users. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents the evaporation of the liquid. Reference markings on the Phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points in the robot

Shell Thickness : 2.0 ㎜ ± 0.1 ㎜

Filling Volume : Approx. 25 liters

9.3 Device Holder


Device Holder

Construction: : In combination with the Twin SAM PhantomV4.0/V4.0C or Twin SAM, the Mounting Device (made from POM) enables the rotation of the mounted transmitter in spherical coordinates, whereby the rotation point is the ear opening. The devices can be easily and accurately positioned according to IEC, IEEE, CENELEC, FCC or other specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).

10 SAR Measurement Procedures

10.1 Normal SAR Measurement Procedure

Step 1: Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The Minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 1.4 ㎜. This distance cannot be smaller than the Distance of sensor calibration points to probe tip as defined in the probe properties.

Step 2 and 3: Area Scan & Zoom Scan Procedures

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

1. The extraction of the measured data (grid and values) from the Zoom Scan.
2. The calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters)
3. The generation of a high-resolution mesh within the measured volume
4. The interpolation of all measured values from the measurement grid to the high-resolution grid
5. The extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
6. The calculation of the averaged SAR within masses of 1 g and 10 g.

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 last Power Reference Measurement. 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. SAR drift shall be kept within ± 5 % and if it without ± 5 %, SAR retest according to measurement procedure step 1~4.

< Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v01r04 >

			≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface			5 ± 1 mm	½·δ·ln(2) ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location			30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}			≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}			When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	
Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
Maximum zoom scan spatial resolution, normal to phantom surface	graded grid	$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
Maximum zoom scan spatial resolution, normal to phantom surface	graded grid	$\Delta z_{Zoom}(n>1)$: between subsequent points	$\le 1.5 \cdot \Delta z_{Zoom}(n-1)$	
Minimum zoom scan volume	x, y, z		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm

Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.

* 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 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.

11 SAR System Verification

The microwave circuit arrangement for system verification is sketched in Fig 2. The daily system accuracy verification occurs within the flat section of the SAM phantom. A SAR measurement was performed to see if the measured SAR was within +/- 10% from the target SAR values. These tests were done at 2450 ㎒. The tests were conducted on the same days as the measurement of the DUT. The obtained results from the system accuracy verification are displayed in the table 1. (SAR values are normalized to 1W forward power delivered to the dipole). During the tests, the ambient temperature of the laboratory was in the range (22 ± 2) ° C, the relative humidity was in the range (55 ± 5) % R.H and the liquid depth above the ear reference points was ≥ 15 cm ± 5 mm (frequency ≤ 3 GHz) or ≥ 10 cm ± 5 mm (frequency > 3 G Hz)in all the cases. It is seen that the system is operating within its specification, as the results are within acceptable tolerance of the reference values.

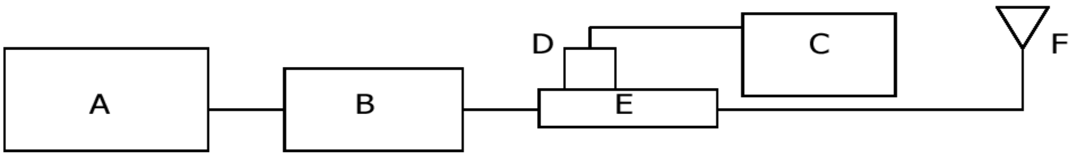


Fig 2. The microwave circuit arrangement used for SAR system verification

A. Signal Generator
B. RF Amplifier
C. Power Meter
D. Power Sensor
E. Dual Directional Coupler
F. Reference dipole Antenna

Photo of the dipole Antenna

Verification Kit	Probe S/N	Tissue	Target SAR 1 g from Calibration Certificate (1 W)	Measured SAR 1 g (0.1 W)	Normalized SAR 1 g (1 W)	Deviation (%)	Date	Liquid Temp. (°C)
D2450V2 SN:892	7413	2450	52.30	5.26	52.60	0.57	2022-06-08	21.8
D2450V2 SN:892	7413	2450	52.30	5.32	53.20	1.72	2022-06-09	21.8

Table1. Results system verification

12 Tissue Simulant Fluid for the Frequency Band

The dielectric properties for this simulant fluid were measured by using the Speag Model DAKS-3.5 Dielectric Probe in conjunction with Speag Model Performance Check for Vector Network Analyzer and Vector Reflectometer by using a procedure.

f (MHz)	Positions	Limits / Measured	Dielectric Parameters		
			Permittivity	Conductivity	Simulated Tissue Temp(℃)
2450.00	Body	Measured, 2022-06-08	39.74	1.77	21.8
		Target Tissue	*39.20*	*1.80*	
		Deviation (%)	**1.38**	**-1.67**	
2441.00		Measured, 2022-06-08	39.76	1.76	
		Deviation (%)	**1.43**	**-2.22**	
2450.00	Body	Measured, 2022-06-09	40.81	1.76	21.8
		Target Tissue	*39.20*	*1.80*	
		Deviation (%)	**4.11**	**-2.22**	
2441.00		Measured, 2022-06-09	40.82	1.75	
		Deviation (%)	**4.13**	**-2.78**	

The brain mixtures consist of a viscous gel using hydroxyethyl cellulose(HEC) gelling agent and saline solution. Preservation with a bactericide is added and visual inspection is made to make sure air bubbles are not trapped during the mixing process. The mixture is calibrated to obtain proper dielectric constant (permittivity) and conductivity of the desired tissue. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation. The dielectric properties of the liquid material required to fill the phantom shell shall be target.

Frequency (㎒)	450	835	900	1800-2000	2450	2600
Tissue Type	**Head & Body**					
Ingredient (% by weight)						
Water	38.91	40.29	40.29	55.24	45.0	45.0
Salt (NaCl)	3.79	1.38	1.38	0.31	0	0
Sugar	56.93	57.90	57.90	0	0	0
HEC	0.25	0.24	0.24	0	0	0
Bactericide	0.12	0.18	0.18	0	0	0
Triton X-100	0	0	0	0	0	0
DGBE	0	0	0	44.45	55.00	55.00
Tissue parameter target by IEEE 1528-2013						
Dielectric Constant	43.50	41.50	41.50	40.00	39.20	39.00
Conductivity (S/m)	0.87	0.90	0.97	1.40	1.80	1.96

Salt: 99^{+}% Pure Sodium Chloride　　Sucrose: 98^{+}% Pure Sucrose
Water: De-ionized, 16 M $^{+}$ resistivity　　HEC: Hydroxyethyl Cellulose
DGBE: 99^{+}% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]

13 Justification for Extended SAR Dipole Calibrations

Usage of SAR dipoles calibrated less than 3 years ago but more than 1 year ago were confirmed in maintaining return loss (< -20 ㏈, within 20 % of prior calibration) and impedance (within 5 ohm from prior calibration) requirements per extended calibrations in KDB publication 865664 D01V01r04:

2450V2_Head (SN : 892)				
2450 GHz				
Measurement Date	Return Loss (㏈)	Δ%	Impedance (Ω)	ΔΩ
2022 / 04 / 12	-25.47	-0.20	53.68	-1.11

14 Instruments List

Test Platform	SPEAG DASY System				
Manufacture	SPEAG				
Description	SAR Test System (Frequency range 300 MHz – 6 GHz)				
Software Reference	DASY52: 52.10.4(1527) SEMCAD X: 14.6.14(7483)				
Equipment	**Type**	**Serial Number**	**Cal Date**	**Cal Interval**	**Cal Due**
Phantom	SAM Phantom	TP-1905	N/A	N/A	N/A
Verification Dipole	D2450V2	892	2021-04-23	Biennial	2023-04-23
Dielectric Assessment Kit	DAKS-3.5	1068	2022-02-28	Annual	2023-02-28
DAE	DAE4	1507	2021-09-27	Annual	2022-09-27
E-Field Probe	EX3DV4	7413	2021-09-29	Annual	2022-09-29
Network Analyzer	DAKS_VNA R140	160115	2022-02-25	Annual	2023-02-25
Power Meter	E4419B	GB43311125	2022-04-20	Annual	2023-04-20
Power Sensor	N8481A	MY56120026	2021-12-01	Annual	2022-12-01
Power Sensor	N8481A	MY56120030	2022-02-25	Annual	2023-02-25
Signal Generator	SMBV100A	262093	2022-05-06	Annual	2023-05-06
Power Amplifier	AMP2027	10008	2022-03-04	Annual	2023-03-04
Dual Directional Coupler	772D	MY52180226	2022-03-04	Annual	2023-03-04
LP Filter	LA-30N	LF03	2022-03-03	Annual	2023-03-03
Attenuator	RFHB1210NC2	3	2022-03-03	Annual	2023-03-03
Attenuator	05AS102-K03	A1	2021-12-06	Annual	2022-12-06
Hygro-Thermometer	TE-201	TE-201-2	2022-06-04	Annual	2023-06-04
Digital Thermometer	SDT25	19081500027	2022-03-04	Annual	2023-03-04
Spectrum Analyzer	FSV7	103082	2022-02-28	Annual	2023-02-28
Bluetooth Tester	TC-3000B	3000B63018	2022-05-13	Annual	2023-05-13

15 FCC Power Measurement Procedures

The SAR measurement Software calculates a reference point at the start and end of the test to check for power drifts. If conducted power deviations of more than 5 % occurred, the tests were repeated.

16 Measured and Reported SAR

Per FCC KDB Publication 447498 D01v06, When SAR is not measured at the maximum power level allowed for production units, the results must be scaled to the maximum tune-up tolerance limit according to the power applied to the individual channels tested to determine compliance. For simultaneous transmission, the measured aggregate SAR must be scaled according to the sum of the differences between the maximum tune-up tolerance and actual power used to test each transmitter. When SAR is measured at or scaled to the maximum tune-up tolerance limit, the results are referred to as reported SAR. Test highest reported SAR results are identified on the grant of equipment authorization according to procedures in KDB 690783 D01v01r03.

17 Maximum Output Power Specifications※

This device operates using the following maximum output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB Publication 447498 D01v06.

Average power for Production (dBm)					
Channel	**Frequency (MHz)**	**GFSK (dBm)**	**π/4 DQPSK (dBm)**	**8DPSK (dBm)**	**Low Energy (dBm)**
Bluetooth	Maximum	**13.50**	**12.00**	**12.00**	**12.50**
	Normal	12.50	11.00	11.00	11.50
Tune-up Tolerance: + 1.0dB					

- The data marked ※ in this report was provided by the customer and may affect the validity of the test results. We are responsible for all the information of this test report except for the data(※) provided by the customer.

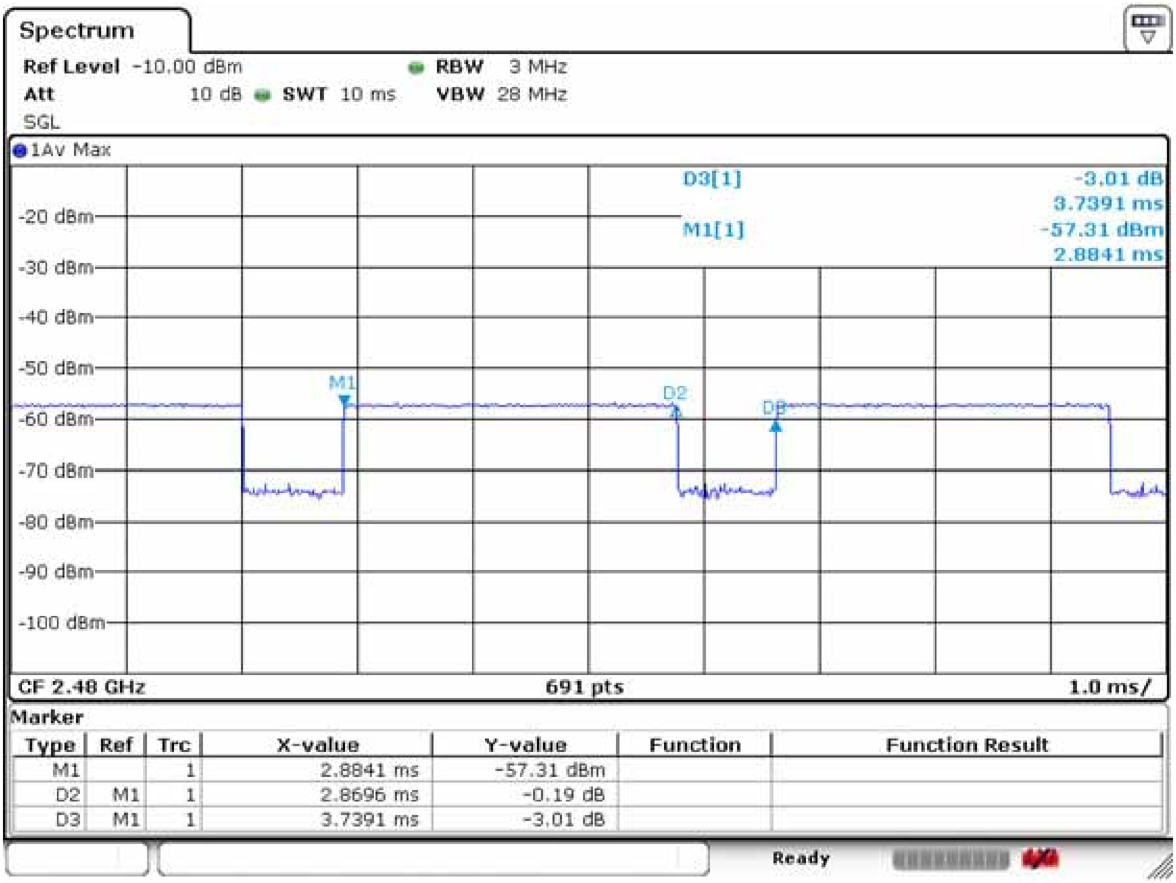
18 RF Conducted Power Measurement

Bluetooth Conducted Power (Left)

Modulation	Channel	Frequency (MHz)	Conducted Power (dBm)	E.I.R.P (dBm)
GFSK	Low	2402.00	11.81	4.51
	Middle	2441.00	13.08	5.78
	High	2480.00	12.51	5.21
π/4 DQPSK	Low	2402.00	10.23	2.93
	Middle	2441.00	11.54	4.24
	High	2480.00	11.41	4.11
8DPSK	Low	2402.00	10.61	3.31
	Middle	2441.00	11.60	4.30
	High	2480.00	11.35	4.05

Packet Size	PHY	Channel	Frequency (MHz)	Conducted Power (dBm)	E.I.R.P (dBm)
Low Energy 1M	37	Low	2402.00	12.36	5.06
		Middle	2440.00	12.35	5.05
		High	2480.00	12.15	4.85
	255	Low	2402.00	12.40	5.10
		Middle	2440.00	12.41	5.11
		High	2480.00	12.17	4.87
Low Energy 2M	37	Low	2402.00	12.42	5.12
		Middle	2440.00	12.25	4.95
		High	2480.00	12.16	4.86
	255	Low	2402.00	12.28	4.98
		Middle	2440.00	12.42	5.12
		High	2480.00	12.10	4.80

19 Bluetooth Duty Cycle used for SAR Testing



Bluetooth Duty cycle measurement

T_{on} = 2.870 ms

T_{on}+ T_{off} = 3.739 ms

Duty Cycle = (T_{on} / T_{on}+ T_{off}) x 100

76.8 % = (2.870 / 3.739) x 100

SAR Crest Factor = 1 / 0.768 = **1.303**

Bluetooth Duty cycle: 76.8%

20 SAR Data Summary

Bluetooth Body SAR (Left)

EUT Position	Mode	Distance (mm)	Traffic Channel		Power(dBm)		Peak SAR of Area Scan (W/kg)	1-g SAR (W/kg))	Scaling Factor (Power)	Scaling Factor (Duty)	1-g Scaled SAR (W/kg)	Plot No
			Frequency (㎒)	Channel	Conducted Power	Tune-Up Limit						
Basic mode												
Edge 1	DH5	0	2441.00	39	13.08	13.50	0.187	0.103	1.102	1.303	0.148	-
Edge 2		0	2441.00	39	13.08	13.50	0.243	0.106	1.102	1.303	0.152	-
Edge 3		0	2441.00	39	13.08	13.50	0.123	0.058	1.102	1.303	0.083	-
Edge 4		0	2441.00	39	13.08	13.50	0.347	0.168	1.102	1.303	0.241	-
Top		0	2441.00	39	13.08	13.50	0.494	0.327	1.102	1.303	**0.470**	A2
Bottom		0	2441.00	39	13.08	13.50	0.092	0.056	1.102	1.303	0.080	-

General Notes:

1. The test data reported are the worst-case SAR values according to test procedures specified in FCC KDB Publication 447498 D01v07.
2. Liquid tissue depth was at least 15 cm for all frequencies.
3. All modes of operation were investigated, and worst-case results are reported.
4. The EUT is tested 2nd hot-spot peak, if it is less than 2 dB below the highest peak.
5. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
6. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB Publication 447498 D01v07.
7. Batteries are fully charged at the beginning of the SAR measurements.

21 SAR Measurement Variability

21.1 Measurement Variability

Per FCC KDB Publication 865664 D01v01r04, SAR measurement variability was assessed for each frequency band, which was determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. When both head and body tissue-equivalent media were required for SAR measurements in a frequency band, the variability measurement procedures were applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium. These additional measurements were repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device was returned to ambient conditions (normal room temperature) with the battery fully charged before it was re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

SAR Measurement Variability was assessed using the following procedures for each frequency band:

1. When the original highest measured SAR is ≥ 0.80 W/kg, the measurement was repeated once.
2. A second repeated measurement was preformed only if the ratio of largest to smallest SAR for the original and first repeated measurements was > 1.20 or when the original or repeated measurement was ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
3. A third repeated measurement was performed only if the original, first or second repeated measurement was ≥ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.
4. Repeated measurements are not required when the original highest measured SAR is < 0.80 W/kg

21.2 Measurement Uncertainty

The measured SAR was < 1.5 W/kg for all frequency bands. Therefore, per KDB Publication 865664 D01v01r04, the extended measurement uncertainty analysis per IEEE 1528-2013 was not required.

Appendixes List

Appendix A	A.1 Verification Test Plots for 2450MHz A.2 SAR Test Plots for Bluetooth (Left)
Appendix B	B.1 Uncertainty Analysis
Appendix C	C.1 Calibration certificate for Probe(S/N: 7413) C.2 Calibration certificate for DAE(S/N: 1507) C.3 Calibration certificate for Dipole(S/N: 892)

Appendix A.1 Verification Test Plots for 2450 MHz

Date: 2022-06-08

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: 2450MHz Verification 2022_06_08.da53:0

Input Power : 100 mW

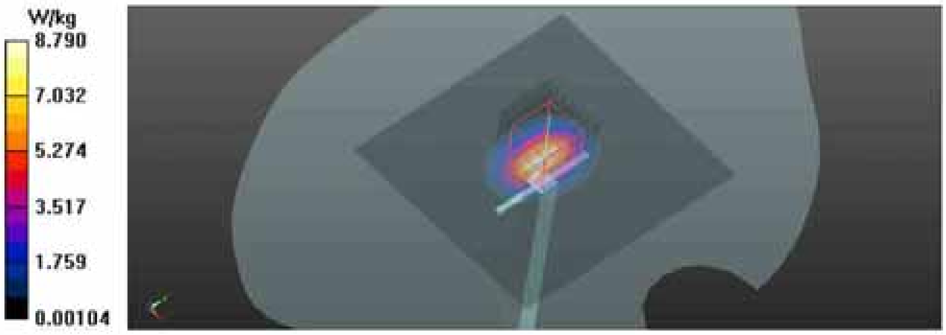
DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2 - SN:892

Communication System: UID 0, CW (0); Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 1.766 S/m; ε_r = 39.739; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY52 Configuration:
- Probe: EX3DV4 - SN7413; ConvF(7.29, 7.29, 7.29) @ 2450 MHz; Calibrated: 2021-09-29
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1507; Calibrated: 2021-09-27
- Phantom: Twin-SAM V.5.0 SN:1905; Type: SN:1905; Serial: SN:1905
- DASY52 52.10.4(1527)SEMCAD X 14.6.14(7483)

Verification/2450MHz Verification/Area Scan (111x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 8.79 W/kg

Verification/2450MHz Verification/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 71.61 V/m; Power Drift = 0.09 dB
Peak SAR (extrapolated) = 10.8 W/kg
SAR(1 g) = 5.26 W/kg; SAR(10 g) = 2.44 W/kg
Smallest distance from peaks to all points 3 dB below = 9 mm
Ratio of SAR at M2 to SAR at M1 = 49.2%
Maximum value of SAR (measured) = 8.80 W/kg



Date: 2022-06-09

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: 2450MHz Verification 2022_06_09.da53:0

Input Power : 100 mW

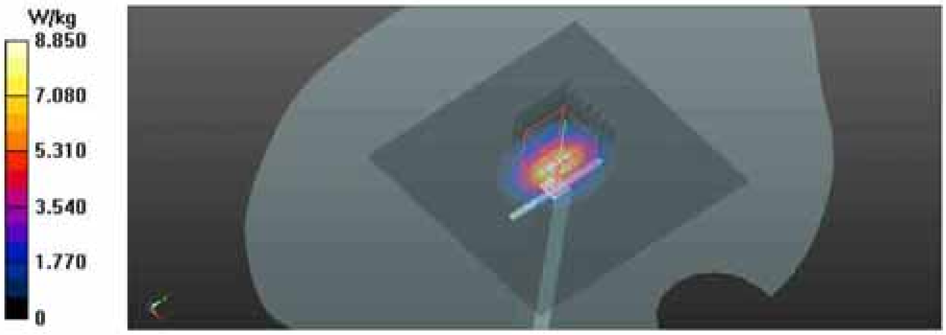
DUT: Dipole 2450 MHz D2450V2; Type: D2450V2; Serial: D2450V2 - SN:892

Communication System: UID 0, CW (0); Frequency: 2450 MHz;Duty Cycle: 1:1
Medium parameters used: f = 2450 MHz; σ = 1.76 S/m; ε_r = 40.806; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY52 Configuration:
- Probe: EX3DV4 - SN7413; ConvF(7.29, 7.29, 7.29) @ 2450 MHz; Calibrated: 2021-09-29
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1507; Calibrated: 2021-09-27
- Phantom: Twin-SAM V.5.0 SN:1905; Type: SN:1905; Serial: SN:1905
- DASY52 52.10.4(1527)SEMCAD X 14.6.14(7483)

Verification/2450MHz Verification/Area Scan (111x121x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 8.85 W/kg

Verification/2450MHz Verification/Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 72.70 V/m; Power Drift = 0.04 dB
Peak SAR (extrapolated) = 11.0 W/kg
SAR(1 g) = 5.32 W/kg; SAR(10 g) = 2.47 W/kg
Smallest distance from peaks to all points 3 dB below = 9 mm
Ratio of SAR at M2 to SAR at M1 = 49.2%
Maximum value of SAR (measured) = 8.89 W/kg



Appendix A.2 SAR Test Plots for Bluetooth (Left)

Date: 2022-06-09

Test Laboratory : SGS Korea (Gunpo Laboratory)
File Name: Bluetooth_GFSK_DH5_Top_CH39_Left.da53:0

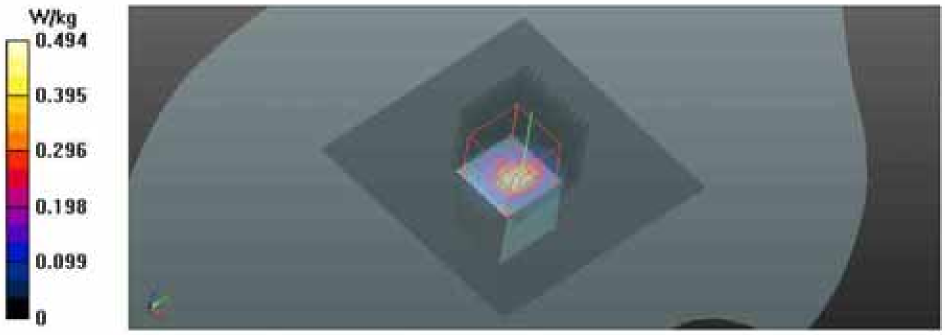
DUT: SM-R510; Type: SAMSUNG Bluetooth Headset; Serial: R3AT502F7AD

Communication System: UID 0, Bluetooth 3.0 (0); Frequency: 2441 MHz;Duty Cycle: 1:1.30317
Medium parameters used: f = 2441 MHz; σ = 1.752 S/m; ε_r = 40.82; ρ = 1000 kg/m^3
Phantom section: Flat Section

DASY52 Configuration:
- Probe: EX3DV4 - SN7413; ConvF(7.29, 7.29, 7.29) @ 2441 MHz; Calibrated: 2021-09-29
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn1507; Calibrated: 2021-09-27
- Phantom: Twin-SAM V.5.0 SN:1905; Type: SN:1905; Serial: SN:1905
- DASY52 52.10.4(1527)SEMCAD X 14.6.14(7483)

Body/Bluetooth_GFSK_DH5_Top_CH39_Left/Area Scan (91x91x1): Interpolated grid: dx=1.000 mm, dy=1.000 mm
Maximum value of SAR (interpolated) = 0.494 W/kg

Body/Bluetooth_GFSK_DH5_Top_CH39_Left/Zoom Scan (11x11x8)/Cube 0: Measurement grid: dx=3mm, dy=3mm, dz=1.4mm
Reference Value = 16.41 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 3.01 W/kg
SAR(1 g) = 0.327 W/kg; SAR(10 g) = 0.089 W/kg
Smallest distance from peaks to all points 3 dB below = 3.6 mm
Ratio of SAR at M2 to SAR at M1 = 51%
Maximum value of SAR (measured) = 1.02 W/kg



Appendix B.1 Uncertainty Analysis

a	c	d	e = f(d,k)	f	g	h = cxg/e	i = cxg/e	k
Uncertainty Component	Tol (%)	Prob . Dist.	Div.	Ci (1g)	Ci (10g)	1g ui (%)	10g ui (%)	Vi (Veff)
Probe calibration	6.55	N	1.00	1.00	1.00	6.55	6.55	∞
Axial Isotropy	4.70	R	1.73	0.71	0.71	1.92	1.92	∞
Hemispherical Isotropy	9.60	R	1.73	0.71	0.71	3.92	3.92	∞
Boundary Effects	2.00	R	1.73	1.00	1.00	1.15	1.15	∞
Linearity	4.70	R	1.73	1.00	1.00	2.71	2.71	∞
System Detection Limits	0.25	R	1.73	1.00	1.00	0.14	0.14	∞
Modulation Response	4.80	R	1.73	1.00	1.00	2.77	2.77	∞
Readout Electronics	0.30	N	1.00	1.00	1.00	0.30	0.30	∞
Response Time	0.80	R	1.73	1.00	1.00	0.46	0.46	∞
Integration Time	2.60	R	1.73	1.00	1.00	1.50	1.50	∞
RF Ambient Noise	3.00	R	1.73	1.00	1.00	1.73	1.73	∞
RF Ambient Reflections	3.00	R	1.73	1.00	1.00	1.73	1.73	∞
Probe Positioner mechanical tolerance	0.40	R	1.73	1.00	1.00	0.23	0.23	∞
Probe Positioning with respect to phantom shell	6.70	R	1.73	1.00	1.00	3.87	3.87	∞
Extrapolation, interpolation, and integration algorithms for max. SAR evaluation	4.00	R	1.73	1.00	1.00	2.31	2.31	∞
Test sample positioning	3.84/3.83	N	1.00	1.00	1.00	3.84	3.83	29
Device holder uncertainty	2.79/2.66	N	1.00	1.00	1.00	2.79	2.66	3
Output power variation - SAR drift measurement	5.00	R	1.73	1.00	1.00	2.89	2.89	∞
Phantom uncertainty	6.60	R	1.73	1.00	1.00	3.81	3.81	∞
Liquid conductivity– Target	5.00	N	1.00	0.78	0.71	3.90	3.55	∞
Liquid conductivity– measurement	3.55	N	1.00	0.78	0.71	2.77	2.52	5
Liquid permittivity– Target	5.00	N	1.00	0.23	0.26	1.15	1.30	∞
Liquid permittivity– measurement	3.40	N	1.00	0.23	0.26	0.78	0.88	7
Liquid conductivity-temperature	2.74	R	1.73	0.78	0.71	1.23	1.12	21
Liquid permittivity – temperature	1.94	R	1.73	0.23	0.26	0.26	0.29	21
Combined standard uncertainty			RSS			13.38	13.22	438
Expanded uncertainty (95% CONFIDENCE INTERVAL)			*k*=2			**26.76**	**26.44**	

-THE END-