SAR EVALUATION REPORT

FCC 47 CFR § 2.1093
IEEE Std. 1528-2013

For
Headphone

FCC ID: SBVRM049

MODEL NUMBER: S49

Report Number: 4791057978-SAR-1

Issue Date: Jan. 6, 2024

Prepared for
Sonos, Inc.
301 COROMAR DR. GOLETA, California 93117 United States

Prepared by
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Revision History

Rev.	Date	Revisions	Revised By
V1.0	Jan. 6, 2024	Initial Issue	\

Note:

1. The Measurement result for the sample received is<Pass> according to < < IEEE Std. 1528> when <Accuracy Method> decision rule is applied.
2. This report is only published to and used by the applicant, and it is not for evidence purpose in China.

Table of Contents

1. Attestation of Test Results

Applicant Name	SONOS, INC.	
Address	301 COROMAR DR. GOLETA, California 93117 United States	
Manufacturer	SONOS, INC.	
Address	301 COROMAR DR. GOLETA, California 93117 United States	
EUT Name	Headphone	
Model	S49	
Sample Status	Normal	
Sample Received Date	Dec. 4, 2023	
Date of Tested	Dec. 29, 2023	
Applicable Standards	FCC 47 CFR § 2.1093 IEEE Std. 1528-2013 KDB publication	
SAR Limits (W/Kg)		
Exposure Category	Peak spatial-average (1g of tissue)	Extremities (hands, wrists, ankles, etc.) (10g of tissue)
General population / Uncontrolled exposure	1.6	4
The Highest Reported SAR (W/kg)		
RF Exposure Conditions	**Equipment Class**	
	DTS	**NII**	**DSS**
Head 1-g (0mm)	0.794	1.146	0.076
Simultaneous Transmission (1-g)	1.222		
Test Results	Pass		
Prepared By: Burt Hu Laboratory Engineer	Reviewed By: Denny Huang Senior Project Engineer	Approved By: Stephen Guo Laboratory Manager	

2. Test Specification, Methods and Procedures

The tests documented in this report were performed in accordance with IEEE Std.1528-2013, the following FCC Published RF exposure KDB procedures:

- 447498 D01 General RF Exposure Guidance
- 690783 D01 SAR Listings on Grants
- 865664 D01 SAR measurement 100 MHz to 6 GHz
- 865664 D02 RF Exposure Reporting

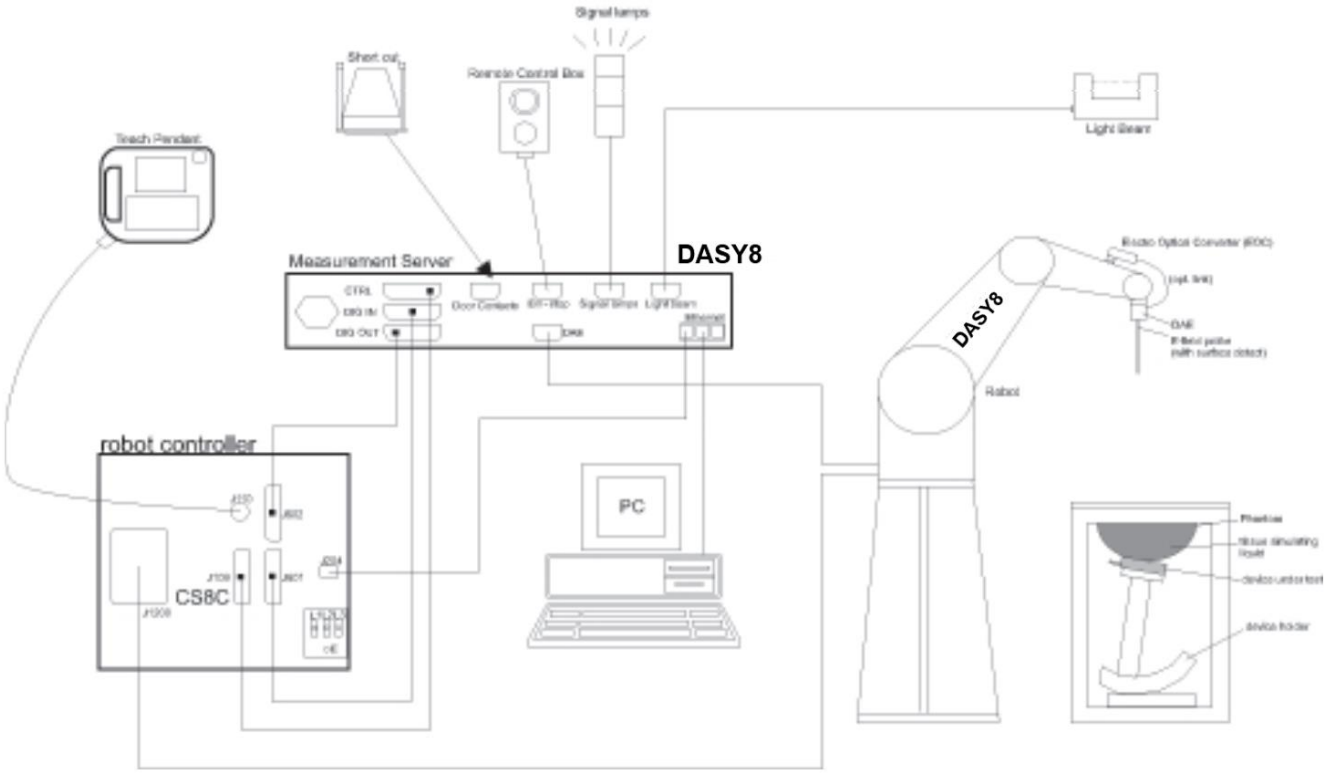
3. Facilities and Accreditation

Test Location	UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch.
Address	Building 10, Innovation Technology Park, Song Shan Lake Hi-tech Development Zone, Dongguan, 523808, China
Accreditation Certificate	**A2LA (Certificate No.: 4102.01)** UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch has been assessed and proved to be in compliance with A2LA. **FCC (FCC Recognized No.: CN1187)** UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch has been recognized to perform compliance testing on equipment subject to the Commission's Declaration of Conformity (DoC) and Certification rules. **ISED (Company No.: 21320)** UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch. has been registered and fully described in a report filed with ISED. The Company Number is 21320 and the test lab Conformity Assessment Body Identifier (CABID) is CN0046. **VCCI (Registration No.: G-20192, C-20153, T-20155 and R-20202)** UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch. has been assessed and proved to be in compliance with VCCI, the Membership No. is 3793. Facility Name: Chamber D, the VCCI registration No. is G-20192 and R-20202 Shielding Room B, the VCCI registration No. is C-20153 and T-20155
Description	All measurement facilities use to collect the measurement data are located at Building 10, Innovation Technology Park, Song Shan Lake Hi tech Development Zone, Dongguan, 523808, China

4. SAR Measurement System & Test Equipment

4.1. SAR Measurement System

The DASY8 system used for performing compliance tests consists of the following items:



- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- A 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.
- 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.
- 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.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running Win10 and the DASY8 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

4.2. SAR Scan Procedures

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 2.1 mm. This distance cannot be smaller than the distance of 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 2 dB range is required in IEEE Standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan). If only one Zoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of Zoom Scans has to be increased accordingly.

Area Scan Parameters extracted from KDB 865664 D01 v01r04 SAR Measurement 100 MHz to 6 GHz

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 mm ± 1 mm	$½ \cdot \delta \cdot \ln(2)$ mm ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}	≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
	When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	

Step 3: Zoom Scan

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. 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 1 g and 10 g and displays these values next to the job's label.

Zoom Scan Parameters extracted from KDB 865664 D01 v01r04 SAR Measurement 100 MHz to 6 GHz

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
	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
		$\Delta z_{Zoom}(n>1)$: between subsequent points	≤ 1.5·$\Delta z_{Zoom}(n-1)$ mm	
Minimum zoom scan volume	x, y, z		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm

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.

Step 5: Z-Scan (FCC only)

The Z Scan measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. In order to get a reasonable extrapolation the extrapolated distance should not be greater than the step size in Z-direction.

4.3. Test Equipment

The measuring equipment used to perform the tests documented in this report has been calibrated in accordance with the manufacturers' recommendations, and is traceable to recognized national standards.

Name of equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
ENA Network Analyzer	Keysight	E5080A	MY55100583	2024.10.11
Dielectric Probe kit	SPEAG	SM DAK 040 SA	1155	2025.02.27
DC power supply	Keysight	E36103A	MY55350020	2024.10.11
Signal Generator	Rohde & Schwarz	SME06	837633\001	2024.08.06
BI-Directional Coupler	KRYTAR	1850	54733	2024.10.11
Peak and Average Power Sensor	Keysight	E9325A	MY62220002	2024.10.11
Peak and Average Power Sensor	Keysight	E9325A	MY62220003	2024.10.11
Dual Channel PK Power Meter	Keysight	N1912A	MY55416024	2024.10.11
Amplifier	CORAD TECHNOLOGY LTD	AMF-4D-00400600-50-30P	1983561	NCR
Dosimetric E-Field Probe	SPEAG	EX3DV4	7383	2024.06.04
Data Acquisition Electronic	SPEAG	DAE3	427	2024.05.16
Dipole Kit 2450 MHz	SPEAG	D2450V2	977	2024.12.16
Dipole Kit 5 GHz	SPEAG	D5GHzV2	1231	2024.12.15
Software	SPEAG	DASY8	N/A	NCR
Twin Phantom	SPEAG	SAM V8.0	2100	NCR
Thermometer	/	GX-138	150709653	2024.10.18
Thermometer	VICTOR	ITHX-SD-5	18470005	2024.10.18

Note:

1) As per KDB865664D01 requirements for dipole calibration, the test laboratory has adopted three-year extended calibration interval. Each measured dipole is expected to evaluate with the following criteria at least on annual interval in Appendix C.
   a) There is no physical damage on the dipole;
   b) System check with specific dipole is within 10% of calibrated value;
   c) The most recent return-loss result, measured at least annually, deviates by no more than 20% from the previous measurement.
   d) The most recent measurement of the real or imaginary parts of the impedance, measured at least annually is within 5Ω from the previous measurement.
2) Dielectric assessment kit is calibrated against air, distilled water and a shorting block performed before measuring liquid parameters.
3) NCR is short for "No Calibration Requirement".

5. Measurement Uncertainty

Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg and the measured 10-g SAR within a frequency band is < 3.75 W/kg. The expanded SAR measurement uncertainty must be ≤ 30%, for a confidence interval of k =2. If these conditions are met, extensive SAR measurement uncertainty analysis described in IEEE Std. 1528-2013 is not required in SAR reports submitted for equipment approval.
Therefore, the measurement uncertainty is not required.

6. Device Under Test (DUT) Information

6.1. DUT Description

The DUT is a Headphone with 2.4/5GHz Wi-Fi and Bluetooth.	
DUT Dimension	Overall (Length x Width x Height): 160.5 mm x 90mm x 190.9mm

6.2. Wireless Technology

Wireless technology	Frequency band
Bluetooth	2.4 GHz
Wi-Fi	2.4 GHz
Wi-Fi	5 GHz

7. Conducted Output Power Measurement and tune-up tolerance

7.1. Power measurement result of 2.4G Wi-Fi

Mode	Date Rate	Ch.#	Freq. (MHz)	Ant 1		Ant 2		Duty Cycle (%)
				Avg. Pwr. (dBm)	Tune-up (dBm)	Avg. Pwr. (dBm)	Tune-up (dBm)	
802.11b	1Mbps	1	2412	17.96	18.0	17.26	18.0	99.59
		6	2437	17.44		16.85		
		11	2462	17.80		17.09		
802.11g	6Mbps	1	2412	Not Required	16.0	Not Required	16.0	/
		6	2437					
		11	2462					
802.11n (20M)	HT0	1	2412		16.0		16.0	/
		6	2437					
		11	2462					

Note:
1) As per KDB 447498 D01 sec.4.1.d at the maximum rated output power and within the tune-up tolerance range specified for the product, but not more than 2 dB lower than the maximum tune-up tolerance limit.

7.2. Power measurement result of 5G Wi-Fi

Band	Mode Data Rate	BW[MHz]	Channel	Freq[MHz]	Ant 1		Ant 2		Duty Cycle (%)
					Avg Pwr(dBm)	Tune-up (dBm)	Avg Pwr(dBm)	Tune-up (dBm)	
5.3GHz	802.11a 6Mbps	20M	36	5180	Not Required	13.0	Not Required	13.0	/
			40	5200					
			44	5220					
			48	5240					
			52	5260	13.06	14.0	12.30	13.5	98.04
			56	5280	13.38		12.80		
			60	5300	13.01		12.65		
			64	5320	13.20		13.20		
	802.11n HT0	20M	36	5180	Not Required	10.5	Not Required	10.5	/
			40	5200					
			44	5220					
			48	5240					
			52	5260					
			56	5280					
			60	5300					
			64	5320					
			46	5230					
			54	5270					
			62	5310					

Note:
1) As per KDB 447498 D01 sec.4.1.d at the maximum rated output power and within the tune-up tolerance range specified for the product, but not more than 2 dB lower than the maximum tune-up tolerance limit.

Band	Mode Data Rate	BW[MHz]	Channel	Freq[MHz]	Ant 1		Ant 2		Duty Cycle (%)
					Avg Pwr(dBm)	Tune-up (dBm)	Avg Pwr(dBm)	Tune-up (dBm)	
5.6GHz	802.11a 6Mbps	20M	100	5500	12.65	13.5	14.35	15.0	98.04
			104	5520	12.24		14.01		
			108	5540	12.36		14.03		
			112	5560	12.52		14.22		
			116	5580	12.75		14.76		
			120	5600	12.44		13.98		
			124	5620	12.18		13.85		
			128	5640	12.37		14.05		
			132	5660	12.47		13.74		
			136	5680	12.05		13.14		
			140	5700	13.38		13.64		
			144	5720	11.98		13.03		
	802.11n HT0	20M	100	5500	Not Required	9.5	Not Required	11.5	/
			104	5520					
			108	5540					
			112	5560					
			116	5580					
			120	5600					
			124	5620					
			128	5640					
			132	5660					
			136	5680					
			140	5700					
			144	5720					

Note:
1) As per KDB 447498 D01 sec.4.1.d at the maximum rated output power and within the tune-up tolerance range specified for the product, but not more than 2 dB lower than the maximum tune-up tolerance limit.

Band	Mode Data Rate	BW[MHz]	CH	Freq[MHz]	Ant 1		Ant 2		Duty Cycle (%)
					Avg Pwr(dBm)	Tune-up (dBm)	Avg Pwr(dBm)	Tune-up (dBm)	
5.8G	802.11a 6Mbps	20M	149	5745	13.05	13.5	13.58	14.0	98.04
			153	5765	12.87		13.05		
			157	5785	12.92		13.69		
			161	5805	12.86		13.06		
			165	5825	12.55		12.93		
	802.11n20 HT0	20M	149	5745	Not Required	11.0	Not Required	12.5	/
			153	5765					
			157	5785					
			161	5805					
			165	5825					
			159	5795					

Note:
1) As per KDB 447498 D01 sec.4.1.d at the maximum rated output power and within the tune-up tolerance range specified for the product, but not more than 2 dB lower than the maximum tune-up tolerance limit.

7.3. Power measurement result of Bluetooth

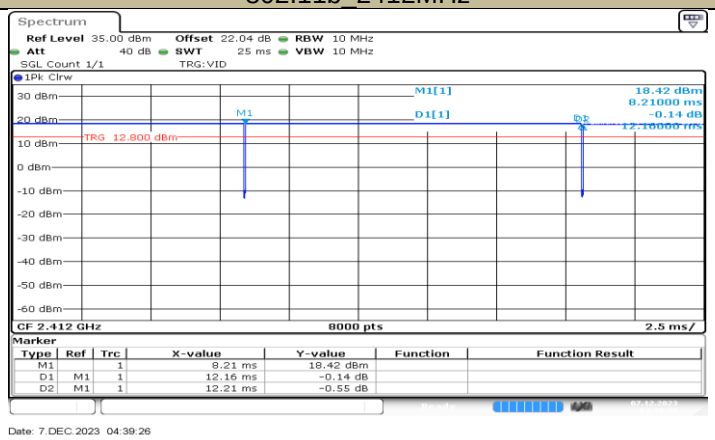
Mode	Test Mode	Ch.#	Freq. (MHz)	Ant 1		Duty Cycle (%)
				Avg. Pwr. (dBm)	Tune-up (dBm)	
BT	DH5	0	2402	11.78	13.0	77.01
		39	2441	12.34		
		78	2480	11.89		
	3DH5	0	2402	Not Required	11.5	/
		39	2441			
		78	2480			
BLE	1M	0	2402		5.0	/
		19	2440			
		39	2480			
	2M	1	2404		5.0	/
		19	2440			
		38	2478			
QHS	P2	1	2404		11.5	/
		19	2440			
		38	2478			
	P6	1	2404		11.5	/
		19	2440			
		38	2478			

Note:
1) As per KDB 447498 D01 sec.4.1.d at the maximum rated output power and within the tune-up tolerance range specified for the product, but not more than 2 dB lower than the maximum tune-up tolerance limit.
2) The maximum output power mode BT DH5 was selected as the primary mode to test SAR for Bluetooth mode. SAR measurement is not required for the other modes, when the secondary mode is ≤0.25 dB higher than the primary mode.

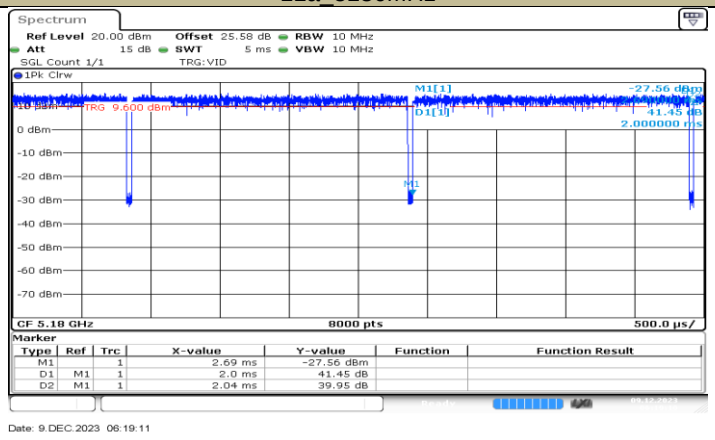
7.4. Duty Cycle

Test Mode	On Time (msec)	Period (msec)	Duty Cycle x (Linear)	Duty Cycle (%)
11B	12.16	12.21	0.9959	99.59
11A	2	2.04	0.9804	98.04
BT DH5	2.89	3.75	0.7707	77.07

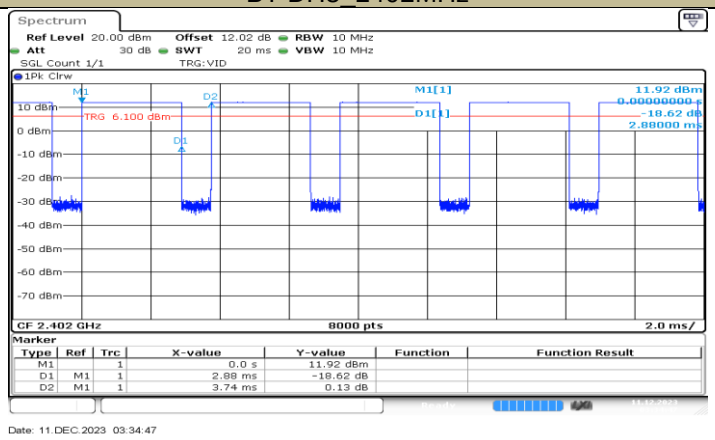
802.11b_2412MHz



11a_5180MHz



BT DH5_2402MHz



8. Test Configuration

8.1. 2.4GHz BT/BLE SAR Test Requirements

2.4GHz BT operating modes are tested independently according to the service requirements in each frequency band for each antenna. DH5 / 3DH5 / 1M/2M SISO modes are tested on the maximum average output power mode.

8.2. Wi-Fi Test Configuration

For Wi-Fi SAR testing, a communication link is set up with the testing software for Wi-Fi mode test. During the test, at the each test frequency channel, the EUT is operated at the RF continuous emission mode. The test procedures in KDB 248227D01 are applied.

8.2.1. Initial Test Position Procedure

For exposure condition with multiple test position, such as handsets operating next to the ear, devices with hotspot mode or UMPC mini-tablet, procedures for initial test position can be applied. Using the transmission mode determined by the DSSS procedure or initial test configuration, area scans are measured for all position in an exposure condition. The test position with the highest extrapolated (peak) SAR is used as the initial test position. When reported SAR for the initial test position is ≤ 0.4W/kg, no additional testing for the remaining test position is required. Otherwise, SAR is evaluated at the subsequent highest peak SAR position until the reported SAR result is ≤ 0.8W/kg or all test position are measured. For all positions/configurations tested using the initial test position and subsequent test positions, when the reported SAR is > 0.8 W/kg, SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel(s) until the reported SAR is ≤ 1.2 W/kg or all required channels are tested.

8.2.2. Initial Test Configuration Procedure

An initial test configuration is determined for OFDM transmission modes according to the channel bandwidth, modulation and data rate combination(s) with the highest maximum output power specified for production units in each standalone and aggregated frequency band. SAR is measured using the highest measured maximum output power channel. For configurations with the same specified or measured maximum output power, additional transmission mode and test channel selection procedures are required (see section 5.3.2 of KDB 248227D01). SAR test reduction of subsequent highest output test channels is based on the reported SAR of the initial test configuration.

For next to the ear, hotspot mode and UMC mini-tablet exposure configurations where multiple test positions are required, the initial test position procedure is applied to minimize the number of test positions required for SAR measurement using the initial test configuration transmission mode. For fixed exposure conditions that do not have multiple SAR test positions, SAR is measured in the transmission mode determined by the initial test configuration.

When the reported SAR of the initial test configuration is > 0.8 W/kg, SAR measurement is required for the subsequent next highest measured output power channel(s) in the initial test configuration until the reported SAR is ≤ 1.2 W/kg or all required channels are tested.

8.2.3. Sub Test Configuration Procedure

SAR measurement requirements for the remaining 802.11 transmission mode configurations that have not been tested in the initial test configuration are determined separately for each standalone and aggregated frequency band, in each exposure condition, according to the maximum output power specified for production units.

When the highest reported SAR for the initial test configuration, according to the initial test position or fixed exposure position requirements, is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for that subsequent test configuration.

8.2.4. 2.4GHz Wi-Fi SAR Test Procedures

Separate SAR procedures are applied to DSSS and OFDM configurations in the 2.4 GHz band to simplify DSSS test requirements. For 802.11b DSSS SAR measurements, DSSS SAR procedure applies to fixed exposure test position and initial test position procedure applies to multiple exposure test positions.

A) 802.11b DSSS SAR Test Requirements

SAR is measured for 2.4 GHz 802.11b DSSS using either a fixed test position or, when applicable, the initial test position procedure. SAR test reduction is determined according to the following:

1) When the reported SAR of the highest measured maximum output power channel (section 3.1 of KDB 248227D01) for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.
2) When the reported SAR is > 0.8 W/kg, SAR is required for that exposure configuration using the next highest measured output power channel. When any reported SAR is > 1.2 W/kg, SAR is required for the third channel; i.e., all channels require testing.

B) 2.4GHz 802.11g/n OFDM SAR Test Exclusion Requirements

When SAR measurement is required for 2.4 GHz 802.11g/n OFDM configurations, the measurement and test reduction procedures for OFDM are applied (section 5.3 of KDB 248227D01). SAR is not required for the following 2.4 GHz OFDM conditions.

1) When KDB Publication 447498 SAR test exclusion applies to the OFDM configuration.
2) When the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.

C) SAR Test Requirements for OFDM configurations

When SAR measurement is required for 802.11 g/n OFDM configurations, each standalone and frequency aggregated band is considered separately for SAR test reduction. In applying the initial test configuration and subsequent test configuration procedures, the 802.11 transmission configuration with the highest specified maximum output power and the channel within a test configuration with the highest measured maximum output power should be clearly distinguished to apply the procedures.

9. RF Exposure Conditions

9.1. Antenna location map

Pls refer to the internal photo.

Note:
1) The EUT is a headphone, so only the side that close to the ear is taken into consideration for SAR evaluation.
2) Wi-Fi ANT1/2 is transmitted in SISO mode, the two antennas can’t transmit simultaneously.

10. SAR Test Configuration

The EUT is a Headphone that will be used very close to the human's head, so Head SAR (0mm) is considered.

11. Dielectric Property Measurements & System Check

11.1. Dielectric Property Measurements

The temperature of the tissue-equivalent medium used during measurement must also be within 18°C to 25°C and within ± 2°C of the temperature when the tissue parameters are characterized.
The dielectric parameters must be measured before the tissue-equivalent medium is used in a series of SAR measurements. The parameters should be re-measured after each 3 – 4 days of use; or earlier if the dielectric parameters can become out of tolerance; for example, when the parameters are marginal at the beginning of the measurement series.
Tissue dielectric parameters were measured at the low, middle and high frequency of each operating frequency range of the test device.

Tissue Dielectric Parameters

FCC KDB 865664 D01 v01r04 SAR Measurement 100 MHz to 6 GHz

Target Frequency (MHz)	Head		Body	
	ε_r	σ (S/m)	ε_r	σ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800 – 2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5000	36.2	4.45	49.3	5.07
5100	36.1	4.55	49.1	5.18
5200	36.0	4.66	49.0	5.30
5300	35.9	4.76	48.9	5.42
5400	35.8	4.86	48.7	5.53
5500	35.6	4.96	48.6	5.65
5600	35.5	5.07	48.5	5.77
5700	35.4	5.17	48.3	5.88
5800	35.3	5.27	48.2	6.00

IEEE Std 1528-2013
Refer to Table 3 within the IEEE Std 1528-2013

Dielectric Property Measurements Results:

Liquid	Freq.	Liquid Parameters				Deviation(%)		Limit (%)	Temp. (℃)	Test Date
		Measured		Target						
		ϵ_r	σ	ϵ_r	σ	ϵ_r	σ			
Head 2450	2360	39.40	1.72	39.36	1.72	0.10	0.00	±5	21.4	2023.12.29
	2450	39.20	1.84	39.20	1.80	0.00	2.22			
	2540	39.10	1.97	39.09	1.90	0.03	3.68			
Head 5250	5160	35.80	4.44	36.03	4.61	-0.64	-3.69	±5	21.4	2023.12.29
	5250	35.70	4.54	35.93	4.71	-0.64	-3.61			
	5340	35.60	4.64	35.83	4.80	-0.64	-3.33			
Head 5600	5500	35.10	4.78	35.64	4.96	-1.52	-3.63	±5	21.4	2023.12.29
	5600	34.90	4.91	35.53	5.07	-1.77	-3.16			
	5700	34.80	5.01	35.41	5.17	-1.72	-3.09			
Head 5750	5660	34.80	4.95	35.46	5.13	-1.86	-3.51	±5	21.4	2023.12.29
	5750	34.70	5.08	35.36	5.22	-1.87	-2.68			
	5840	34.40	5.20	35.27	5.30	-2.47	-1.89			

11.2. System Check

SAR system verification 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 re-measured or sooner when marginal liquid parameters are used at the beginning of a series of measurements.

System Performance Check Measurement Conditions:

- The measurements were performed in the flat section of the TWIN SAM or ELI phantom, shell thickness: 2.0 ±0.2 mm (bottom plate) filled with Body or Head simulating liquid of the following parameters.
- The depth of tissue-equivalent liquid in a phantom must be ≥ 15.0 cm for SAR measurements ≤ 3 GHz and ≥ 10.0 cm for measurements > 3 GHz.
- The DASY system with an E-Field Probe was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm (above 1GHZ) and 15mm (below 1GHz) from dipole center to the simulating liquid surface.
- For area scan, standard grid spacing for head measurements is 15 mm in x- and y- dimension(≤2GHz), 12 mm in x- and y-dimension (2-4 GHz) and 10mm in x- and y- dimension(4-6GHz).
- For zoom scan, Δ x_{zoom}, Δ y_{zoom}≤ 2GHz - ≤8mm, 2-4GHz - ≤5 mm and 4-6 GHz-≤4 mm; Δ z_{zoom} ≤3GHz - ≤5 mm, 3-4 GHz- ≤4 mm and 4-6 GHz-≤2 mm.
- Distance between probe sensors and phantom surface was set to 3 mm except for 5 GHz band. For 5GHz band, Distance between probe sensors and phantom surface was set to 2.5 mm
- The dipole input power (forward power) was set to 100 mW or 250 mW depend on the certificate of the dipoles.
- The results are normalized to 1 W input power.

System Check Results

The 1-g and 10-g SAR measured with a reference dipole, using the required tissue-equivalent medium at the test frequency, must be within 10% of the manufacturer calibrated dipole SAR target.

T.S. Liquid		Messured Results		Target (Ref. value)	Delta (%)	Limit (%)	Temp. (℃)	Test Date
		Zoom Scan (W/Kg)	Normalize to 1W (W/Kg)					
Head 2450	1-g	13.100	52.40	53.20	-1.50	±10	21.4	2023.12.29
	10-g	6.160	24.64	24.20	1.82			
Head 5250	1-g	7.520	75.20	77.90	-3.47	±10	21.4	2023.12.29
	10-g	2.160	21.60	22.60	-4.42			
Head 5600	1-g	8.050	80.50	80.90	-0.49	±10	21.4	2023.12.29
	10-g	2.210	22.10	23.30	-5.15			
Head 5750	1-g	7.810	78.10	78.30	-0.26	±10	21.4	2023.12.29
	10-g	2.340	23.40	22.40	4.46			

12. Measured and Reported (Scaled) SAR Results

As per KDB 447498 D01 v06 sec.4.1.e), When SAR or MPE is measured at or scaled to the maximum tune-up tolerance limit, the results are referred to as reported.

Scaled SAR calculation formula:

Scaled SAR = Tune-up in mW / Conducted power in mW * Duty cycle (if available) * SAR value

SAR Test Reduction criteria are as follows:

KDB 447498 D01 v06 General RF Exposure Guidance:

A）Per KDB447498 D01 v06, all SAR measurement results are scaled to the maximum tune-up tolerance limit to demonstrate SAR compliance.

B）Testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:

- ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz.
- ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz.
- ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz.

Per KDB865664 D01 v01r04:

For each frequency band, repeated SAR measurement is required only when the measured SAR is ≥0.8W/Kg; if the deviation among the repeated measurement is ≤ 20%, and the measured SAR <1.45W/Kg, only one repeated measurement is required.

When the highest reported SAR for the initial test configuration, according to the initial test position or fixed exposure position requirements, is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for that subsequent test configuration.

Wi-Fi Notes:

As per KDB248227 D01:

1) When reported SAR for the initial test position is ≤ 0.4W/kg, no additional testing for the remaining test position is required. Otherwise, SAR is evaluated at the subsequent highest peak SAR position until the reported SAR result is ≤ 0.8W/kg or all test position are measured. For all positions/configurations tested using the initial test position and subsequent test positions, when the *reported* SAR is > 0.8 W/kg, SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel(s) until the *reported* SAR is ≤ 1.2 W/kg or all required channels are tested.
2) The highest SAR measured for the initial test position or initial test configuration should be used to determine SAR test exclusion according to the sum of 1-g SAR and SAR peak to location ratio provisions in KDB 447498. In addition, a test lab may also choose to perform standalone SAR measurements for test positions and 802.11 configurations that are not required by the initial test position or initial test configuration procedures and apply the results to determine simultaneous transmission SAR test exclusion, according to sum of 1-g and SAR peak to location ratio requirements to reduce the number of simultaneous transmission SAR measurements.
3) When the specified maximum output power is the same for both UNII 1 and UNII 2A, begin SAR measurements in UNII 2A with the channel with the highest measured output power. If the reported SAR for UNII 2A is ≤ 1.2 W/kg, SAR is not required for UNII 1; otherwise treat the remaining bands separately and test them independently for SAR.

13. Measured SAR Results

13.1. SAR Test Results of 2.4GHz Wi-Fi

Test Position (Head 0mm)	Test Mode	Channel/ Frequency	Power (dBm)		SAR Value	Power Drift	Duty Factor (%)	Scaled (W/Kg)
			Tune-up	Meas.	1-g (W/Kg)			
ANT 1								
Back Side	11b	1/2412	18.0	17.96	0.587	0.00	99.59	0.595
Back Side	11b	6/2437	18.0	17.44	0.367	-0.12	99.59	0.419
Back Side	11b	11/2462	18.0	17.80	0.437	-0.18	99.59	0.459
ANT 2								
Back Side	11b	1/2412	18.0	17.26	0.388	-0.01	99.59	0.462
Back Side	11b	6/2437	18.0	16.89	0.612	0.01	99.59	0.794
Back Side	11b	11/2462	18.0	17.09	0.461	-0.02	99.59	0.571

Note:
The SAR testing was set to transmit at maximum power for all tests.

OFDM mode SAR evaluation exclusion analysis ANT 1

Mode	Tune-up (dBm)	Tune-up (mW)	Highest Reported SAR (W/Kg)	Adjusted SAR (W/Kg)	SAR Test
802.11b	18	63.10	0.595	\	\
802.11g	16	39.81	\	0.375	Excluded
802.11n (20M)	16	39.81	\	0.375	Excluded

Note:
1) The highest reported SAR for OFDM adjusted by the ratio of OFDM 802.11n to OFDM specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, so SAR evaluation for 802.11n is not required.

OFDM mode SAR evaluation exclusion analysis ANT 2

Mode	Tune-up (dBm)	Tune-up (mW)	Highest Reported SAR (W/Kg)	Adjusted SAR (W/Kg)	SAR Test
802.11b	18	63.10	0.794	\	\
802.11g	16	39.81	\	0.501	Excluded
802.11n (20M)	16	39.81	\	0.501	Excluded

Note:
1) The highest reported SAR for OFDM adjusted by the ratio of OFDM 802.11n to OFDM specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, so SAR evaluation for 802.11n is not required.

13.2. SAR Test Results of 5GHz Wi-Fi

Test Position (Head 0mm)	Test Mode	Channel/ Frequency	Power (dBm)		Measured SAR Value	Power Drift	Duty Factor (%)	Scaled (W/Kg)
			Tune-up	Meas.	1-g (W/Kg)			
ANT 1								
5.3G								
Back Side	11a	56/5280	14.0	13.38	0.709	-0.01	98.04	0.834
Back Side	11a	52/5260	14.0	13.38	0.715	0.00	98.04	0.841
Back Side	11a	64/5320	14.0	13.38	0.974	-0.09	98.04	1.146
Worst mode retest								
Back Side	11a	64/5320	14.0	13.38	0.944	-0.05	98.04	1.111
5.6G								
Back Side	11a	100/5500	13.5	12.65	0.676	-0.02	98.04	0.839
Back Side	11a	116/5580	13.5	12.75	0.825	0.08	98.04	1.000
Back Side	11a	144/5720	13.5	11.98	0.546	-0.02	98.04	0.790
Worst mode retest								
Back Side	11a	116/5580	13.5	12.75	0.813	0.02	98.04	0.986
5.8G								
Back Side	11a	149/5745	13.5	13.05	0.594	-0.12	98.04	0.672
Back Side	11a	157/5785	13.5	12.92	0.695	0.10	98.04	0.810
Back Side	11a	165/5825	13.5	12.55	0.594	-0.07	98.04	0.754
ANT 2								
5.3G								
Back Side	11a	56/5280	13.5	12.80	0.430	-0.05	98.04	0.515
Back Side	11a	52/5260	13.5	12.30	0.436	0.00	98.04	0.586
Back Side	11a	64/5320	13.5	13.20	0.656	0.00	98.04	0.717
5.6G								
Back Side	11a	100/5500	15.0	14.35	0.513	0.04	98.04	0.608
Back Side	11a	116/5580	15.0	14.76	0.335	-0.05	98.04	0.361
Back Side	11a	144/5720	15.0	13.03	0.188	-0.05	98.04	0.302
5.8G								
Back Side	11a	149/5745	14.0	13.58	0.191	-0.05	98.04	0.215
Back Side	11a	157/5785	14.0	13.69	0.334	-0.02	98.04	0.366
Back Side	11a	165/5825	14.0	12.93	0.197	0.03	98.04	0.257

Note:

1) When the reported SAR of the initial test configuration is ＞0.8W/kg, SAR measurement is required for subsequent nest highest measured output power channel(s) in the initial test configuration until reported SAR is ≤1.2 W/kg or all required channels are tested.
2) The SAR testing was set to transmit at maximum power for all tests.

Subsequent test configuration SAR evaluation exclusion analysis for U-NII-2A band ANT 1

Mode	Tune-up (dBm)	Tune-up (mW)	Highest Reported SAR (W/Kg)	Adjusted SAR (W/Kg)	SAR Test
802.11a	14	25.12	1.146	\	\
802.11n 20M	9.5	8.91	\	0.407	Excluded

Note:

1) The 802.11a mode is selected as Initial Test Configuration for SAR test according to the specified maximum output power. As the highest reported SAR for the initial test configuration is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR test for the other 802.11 modes is not required.

Subsequent test configuration SAR evaluation exclusion analysis for U-NII-2A band ANT 2

Mode	Tune-up (dBm)	Tune-up (mW)	Highest Reported SAR (W/Kg)	Adjusted SAR (W/Kg)	SAR Test
802.11a	13.5	22.39	0.171	\	\
802.11n 20M	10.5	11.22	\	0.086	Excluded

Note:

1) The 802.11a mode is selected as Initial Test Configuration for SAR test according to the specified maximum output power. As the highest reported SAR for the initial test configuration is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR test for the other 802.11 modes is not required.

Subsequent test configuration SAR evaluation exclusion analysis for U-NII-2C band ANT 1

Mode	Tune-up (dBm)	Tune-up (mW)	Highest Reported SAR (W/Kg)	Adjusted SAR (W/Kg)	SAR Test
802.11a	13.5	22.39	1.000	\	\
802.11n 20M	9.5	8.91	\	0.398	Excluded

Note:

1) The 802.11a mode is selected as Initial Test Configuration for SAR test according to the specified maximum output power. As the highest reported SAR for the initial test configuration is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR test for the other 802.11 modes is not required.

Subsequent test configuration SAR evaluation exclusion analysis for U-NII-2C band ANT 2

Mode	Tune-up (dBm)	Tune-up (mW)	Highest Reported SAR (W/Kg)	Adjusted SAR (W/Kg)	SAR Test
802.11a	15	31.62	0.608	\	\
802.11n 20M	11.5	14.13	\	0.272	Excluded

Note:

1) The 802.11a mode is selected as Initial Test Configuration for SAR test according to the specified maximum output power. As the highest reported SAR for the initial test configuration is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR test for the other 802.11 modes is not required.

Subsequent test configuration SAR evaluation exclusion analysis for U-NII-3 band ANT 1

Mode	Tune-up (dBm)	Tune-up (mW)	Highest Reported SAR (W/Kg)	Adjusted SAR (W/Kg)	SAR Test
802.11a	13.5	22.39	0.810	\	\
802.11n 20M	11	12.59	\	0.455	Excluded

Note:

1) The 802.11a mode is selected as Initial Test Configuration for SAR test according to the specified maximum output power. As the highest reported SAR for the initial test configuration is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR test for the other 802.11 modes is not required.

Subsequent test configuration SAR evaluation exclusion analysis for U-NII-3 band ANT 2

Mode	Tune-up (dBm)	Tune-up (mW)	Highest Reported SAR (W/Kg)	Adjusted SAR (W/Kg)	SAR Test
802.11a	14	25.12	0.366	\	\
802.11n 20M	12.5	17.78	\	0.259	Excluded

Note:

1) The 802.11a mode is selected as Initial Test Configuration for SAR test according to the specified maximum output power. As the highest reported SAR for the initial test configuration is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR test for the other 802.11 modes is not required.

13.3. SAR Test Results of Bluetooth

Test Position (Head 0mm))	Test Mode	Channel/ Frequency	Power (dBm)		SAR Value	Power Drift	Duty Factor (%)	Scaled (W/Kg)
			Tune-up	Meas.	1-g (W/Kg)			
Back Side	BT DH5	39/2441	13.0	12.34	0.050	-0.09	77.01	0.076
Back Side	BT DH5	0/2402	13.0	11.78	0.041	0.00	77.01	0.071
Back Side	BT DH5	78/2480	13.0	11.89	0.037	-0.01	77.01	0.062

Note:

1) The SAR testing was set to transmit at maximum power for all tests.

14. Simultaneous Transmission SAR Analysis

According to FCC OET KDB447498 D01, when the sum of 1g SAR for all simultaneously transmitting antennas in an operating mode and exposure condition combination is within the SAR limit, SAR test exclusion applies to that simultaneous transmission configuration.

14.1. Simultaneous Transmission calculation

NO.	Combination	Scenario
		Head
1	2.4GHz Wi-Fi ANT1+BT	√
2	5GHz Wi-Fi ANT1+BT	√
3	2.4GHz Wi-Fi ANT2+BT	√
4	5GHz Wi-Fi ANT2+BT	√

Note:
1) "√" indicates exist, "×" indicates inexistence.

Position	Simultaneous Tx Antenna Combination		∑SAR 1g (W/kg)	Limit (W/kg)
	BT_{MAX}	2.4G Wi-Fi $ANT1_{MAX}$		
Back Side	0.076	0.595	0.671	1.6

Position	Simultaneous Tx Antenna Combination		∑SAR 1g (W/kg)	Limit (W/kg)
	BT_{MAX}	5G Wi-Fi $ANT1_{MAX}$		
Back Side	0.076	1.146	1.222	1.6

Position	Simultaneous Tx Antenna Combination		∑SAR 1g (W/kg)	Limit (W/kg)
	BT_{MAX}	2.4G Wi-Fi $ANT2_{MAX}$		
Back Side	0.076	0.794	0.870	1.6

Position	Simultaneous Tx Antenna Combination		∑SAR 1g (W/kg)	Limit (W/kg)
	BT_{MAX}	5G Wi-Fi $ANT2_{MAX}$		
Back Side	0.076	0.717	0.793	1.6

Appendixes

Refer to separated files for the following appendixes.

4791057978-SAR-1_App A Photo

4791057978-SAR-1_App B System Check Plots

4791057978-SAR-1_App C Highest Test Plots

4791057978-SAR-1_App D Cal. Certificates

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