

SAR EVALUATION REPORT

IEEE Std 1528-2013 IEC/IEEE 62209-1528:2020

For Sensor Device and Charger

FCC ID: 2AJ2X-WS50 2AJ2X-WB50 2AJ2X-WD50

Model Name: WS50 WB50 WD50

Report Number: R14956064-S1 Issue Date: 2025-03-05

Prepared for WHOOP Inc. 1 KENMORE SQUARE, SUITE 601 BOSTON, MA 02215-3900, USA

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Rev.	Date	Revisions	Revised By
V1	2024-09-11	Initial Issue	
V2	2024-11-08	Added reference to IEC/IEEE 62209-1528:2020 to Cover Page, §1, and §2 to address 13.56 MHz testing	Sarah Kuhaneck
V3	2024-11-27	Added Accessory WD50 (FCC ID: 2AJ2X-WD50) to report.	Sarah Kuhaneck
		§1 – Simultaneous Tx updated to include WD50. Results summary table reformatted for clarity. Changed NFC to DXX. Added notes that WD50 is accessory only and clarifying simultaneous transmissions.	
		§4.1 – Updated DASY version footnote to version 16.4.0.5005.	
		§4.3 – Added equipment used for WD50 measurements. Added secondary calibration dates for equipment that was recalibrated during test window.	
		§6.1 – Added WD50 as an accessory. Added WD50 sample serial number and software version.	
		§6.2 – Added WD50 wireless technologies.	
		S7 – Removed reference to Appendix A for antenna diagram as diagram was not provided. Added Device Configuration column. Added configurations "WS50 Tx with WD50 Mounted" and "WD50 Tx Mounted on WS50". Reformatted for clarity.	
		§8 – Added Dielectric Property Measurements and System Checks for measurements with WD50. Unified formatting with updated template.	
		§10 – Added WS50 BLE measurements with WD50 mounted and WD50 WPT measurements mounted on WS50. Added Device Configuration column for clarity.	
		§12 – Added WS50 with WD50 simultaneous transmission condition and Sum of SAR. Added notes explaining simultaneous transmission scenarios.	
		Appendix A – Added setup photos with WD50.	
		Appendix B – Updated System Check Plots to reflect inclusion of WD50.	
		Appendix C – Added Highest Test Plots for "WS50 Tx with WD50 Mounted" and "WD50 Tx Mounted on WS50" device configurations.	
		Appendix E – Added Calibration Certificate for EX3DV4 SN 7711.	
		Appendix F – Added Calibration Certificate for D2450V2 SN 963.	
V4	2025-01-08	Corrected model name in §1.	Lindsay Ryan
V5	2025-02-03	Updated wording of note in §6.2.	Lindsay Ryan
V6	2025-02-19	Added FCC IDs 2AJ2X-WB50 and 2AJ2X-WD50 and Model Names WB50 and WD50 to cover page and §1	Sarah Kuhaneck
V7	2025-03-05	Corrected BLE equipment class to DTS. Corrected BLE tune- up to match Operational Description. Updated BLE tune-up and scaled values in §9, 10, and 11.	Lindsay Ryan

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1. Attestation of Test Results

Applicant Name		WHOOP Inc.			
FCC ID		2AJ2X-WS50, 2AJ2X-WB50, and 2AJ2X-WD50			
Model Name		WS50, WB50, and WD50			
Applicable Standards		Published RF exposure KDB procedures IEEE Std 1528-2013 IEC/IEEE 62209-1528:2020			
			SAR Limits (W/Kg)		
Exposure Catego	bry		Extremities (hands, wrists, ankles, e (10g of tissue)	tc.)	
General populati Uncontrolled exp	on / ousure		4.0		
	aditions	Equi	oment Class - Highest Reported SAF	R (W/kg)	
		DTS	DXX (WPT)	DXX (NFC)	
Extremity		0.029	0.000	0.000	
Extromity	WS50	0.013	N/A	0.000	
Extremity	WB50	0.029	0.000	N/A	
Simultaneous Tx	(0.015	<mark>0.015</mark>	0.012	
	WS50 Standalone	0.012	N/A	0.012	
Simultaneous Tx	WS50 + WB50 ¹	0.015	0.015	N/A	
WS50 + WD50 ²		<mark>0.013</mark>	<mark>0.013</mark>	N/A	
Date Tested		2024-06-17 to 2024-11-15			
Test Results		Pass			
Note: This report in Model WD50 requi 1. For a mo with WB 2. For a mo with WD	ncludes Simultaneou res no standalone S ore accurate simultan 50 Mounted" and "W ore accurate simultan 50 Mounted" and "W	us Transmission analysis with t FAR assessment. neous transmission scenario of /B50 Tx Mounted on WS50" ar neous transmission scenario of /D50 Tx Mounted on WS50" ar	he WPT charger accessory model WDS the WS50 + WB50 system, only the De e considered. the WS50 + WD50 system, only the De e considered	50 (FCC ID: 2AJ2X-WD50). evice Configurations "WS50 Tx evice Configurations "WS50 Tx	
with WD	50 Mounted" and "W	VD50 Tx Mounted on WS50" ar	e considered.	he test regults show that the	
equipment tested is	s capable of demons	strating compliance with the rec	quirements as documented in this repor	t.	
This report contain results after the int	s data provided by t egration of the data	he customer which can impact provided by the customer.	the validity of results. UL LLC is only re	sponsible for the validity of	
The results docum the manufacturer's mechanical compo Uncertainties are p	ented in this report a responsibility to ass ments. All samples to published for informa	apply only to the tested sample sure that additional production to ested were in good operating o tional purposes only and were	, under the conditions and modes of op units of this model are manufactured wi ondition throughout the entire test prog not taken into account unless noted oth	eration as described herein. It is th identical electrical and ram. Measurement nerwise.	
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Richard Jankov	/ics		Lindsay Ryan		
Staff Engineer			Engineer		
ULLLC			UL LLC		

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2. Test Specification, Methods and Procedures

The tests documented in this report were performed in accordance with FCC 47 CFR § 2.1093, IEEE Std 1528-2013, IEC/IEEE 62209-1528:2020, and the following FCC Published RF exposure <u>KDB</u> procedures:

- o 447498 D01 General RF Exposure Guidance v06
- o 447498 D03 Supplement C Cross-Reference v01
- \circ $\,$ 680106 D01 RF Exposure Wireless Charging Apps v04 $\,$
- \circ $\,$ 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04 $\,$
- 865664 D02 RF Exposure Reporting v01r02

In addition to the above, the following information was used:

- <u>TCB Workshop</u> October 2016; RF Exposure Procedures (Bluetooth Duty Factor)
- <u>TCB Workshop</u> October 2016; RF Exposure Procedures (DUT Holder Perturbations)
- o <u>TCB Workshop</u> April 2019; RF Exposure Procedures (Tissue Simulating Liquids (TSL))

3. Facilities and Accreditation

UL LLC is accredited by A2LA, cert. # 0751.06 for all testing performed within the scope of this report. Testing was performed at the locations noted below.

The test sites and measurement facilities used to collect data are located at 2800 Perimeter Park Dr, Morrisville, NC, USA.

- SAR Lab 1A
- SAR Lab 2A

	Address	ISED CABID	ISED Company Number	FCC Registration
	Building: 12 Laboratory Dr RTP, NC 27709, U.S.A	US0067	2180C	825374
X	Building: 2800 Perimeter Park Dr. Suite B Morrisville, NC 27560, U.S.A	US0067	27265	825374

4. SAR Measurement System & Test Equipment

4.1. SAR Measurement System

The DASY 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, ADconversion, 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 DASY8¹ 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.

¹ DASY8 software used: DASY16.4.0.5005 and older generations.

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 IEC/IEEE 62209-1528, 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 SAR Measurement 100 MHz to 6 GHz

	\leq 3 GHz	> 3 GHz	
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	$5 \pm 1 \text{ mm}$	$\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5 \text{ mm}$	
Maximum probe angle from probe axis to phantom surface normal at the measurement location	$30^{\circ}\pm1^{\circ}$	$20^\circ\pm1^\circ$	
	\leq 2 GHz: \leq 15 mm 2 - 3 GHz: \leq 12 mm	$3 - 4 \text{ GHz} \le 12 \text{ mm}$ $4 - 6 \text{ GHz} \le 10 \text{ mm}$	
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 \leq the corresponding x or y dimension of the test device with at least one measurement point on the test device.		

Step 3: Zoom Scan

Zoom 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 SAR Measurement 100 MHz to 6 GHz

				> 3 GHz	
Maximum zoom scan spatial resolution: Δx_{Zoom} , Δy_{Zoom}					
	uniform grid: $\Delta z_{Zoom}(n)$				
Maximum zoom scan spatial resolution, normal to phantom surface	graded grid	$\Delta z_{Zoom}(1)$: between 1 st two points closest to phantom surface	\leq 4 mm	$3 - 4 \text{ GHz:} \le 3 \text{ mm}$ $4 - 5 \text{ GHz:} \le 2.5 \text{ mm}$ $5 - 6 \text{ GHz:} \le 2 \text{ mm}$	
		∆z _{Zoom} (n>1): between subsequent points	≤1.5·∆z	_{Zoom} (n-1)	
Minimum zoom scan volume x, y, z		$ \ge 30 \text{ mm} \qquad \begin{array}{c} 3 - 4 \text{ GHz:} \ge 28 \text{ mm} \\ 4 - 5 \text{ GHz:} \ge 25 \text{ mm} \\ 5 - 6 \text{ GHz:} \ge 22 \text{ mm} \end{array} $			
Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium: see draft standard IEEE					

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

* When zoom scan is required and the <u>reported</u> SAR from the 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.

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.

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.

Dielectric Property Measurements

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Date	Cal. Due Date
		55000	N. 5 4 40000 4	2023-08-04	2024-08-04
Network Analyzer	Keysight	EDUGJA	IVIT 54 10066 I	2024-07-31	2025-07-31
Dielectric Probe ¹	SPEAG	DAKS-3.5	1051	2023-10-25	2024-10-25
Shorting Block ¹	SPEAG	DAK-3.5 Short	SM DAK 200 DA	2023-10-25	2024-10-25
Dielectric Probe	SPEAG	DAKS-3.5	1147	2024-03-11	2025-03-11
Shorting Block	SPEAG	DAK-3.5 Short	SM DAK 200 DB	2024-03-11	2025-03-11
Dielectric Probe	SPEAG	DAKS-12	1037	2024-03-11	2025-03-11
Shorting Block	SPEAG	DAK-12 Short	2044	2024-03-11	2025-03-11
Thermometer	Fisher Scientific	15-078-181	1817705017	2024-03-30	2025-03-30

Notes:

1. Equipment not used for calibrated measurements past calibration due date.

2. Equipment was recalibrated during the test period. Both calibrations are listed.

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Date	Cal. Due Date
Signal Concrator ²	Keysight	NE191A	10/50440700	2023-08-03	2024-08-03
		INDIGIA	WIT 50 1407 88	2024-08-01	2025-08-01
2 Path Diado Pow or Sonoor ^{1,2}	Pobdo & Sobwarz		112226	2023-06-03	2024-06-30
	Ronde & Schwarz	NICE 03	112230	2024-07-12	2025-07-12
2 Path Diado Pow or Sonoor ^{1,2}	Pobdo & Sobwarz		110007	2023-06-03	2024-06-30
S-Fail Didde Fow er Sensor	Ronue & Schwarz	INITE OS	112237	2024-07-12	2025-07-12
PE Pour or Motor ²	Keysight	N1912A	MY55136012	2023-08-04	2024-08-04
				2024-08-02	2025-08-02
PF Power Sensor ²	Kovoint	N1021A	N/FE00002E	2023-08-21	2024-08-21
RF Pow er Serisor	Reysigni	NI921A	WIT 55090025	2024-08-16	2025-08-16
PE Power Sensor ^{1,2}	Kayaight	N1021A	MY 55090030	2023-06-26	2024-06-26
RF Pow er Sensor	Keysight	NI9ZIA		2024-07-09	2025-07-09
Amplifier	Mini-Circuits	ZVA-183WA-S+	S C484802241	N/A	N/A
Directional Coupler	Mini-Circuits	ZUDC10-183+	2214	NA	NA
Dual Directional Coupler	Werlatone	C5100-10	92249	N/A	N/A
DC Pow er Supply	Miteq	PS 15V1	1990186	N/A	N/A

Notes

1. Equipment not used for calibrated measurements between calibration expiration and next calibration.

2. Equipment was recalibrated during the test period. Both calibrations are listed.

Lab Equipment

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Date	Cal. Due Date
E-Field Probe	SPEAG	EX3DV4	7709	2023-11-30	2024-11-30
E-Field Probe	SPEAG	EX3DV4	7710	2024-01-16	2025-01-16
E-Field Probe	SPEAG	EX3DV4	7711	2024-03-15	2025-03-15
Data Acquisition Electronics	SPEAG	DA E4	1714	2023-11-22	2024-11-22
Data Acquisition Electronics	SPEAG	DAE4	1715	2024-02-12	2025-02-12
Data Acquisition Electronics	SPEAG	DA E4	1716	2024-03-13	2025-03-13
System Validation Dipole	SPEAG	CLA13	1017	2024-03-07	2025-03-07
System Validation Dinala	SPEAG	D2450V2	963	2023-10-20	2024-10-20
System validation Dipole				2024-10-11	2025-10-11
Environmental Indicator	Fisher Scientific	Traceable	240072452	2024-01-24	2026-01-24
Environmental Indicator	Fisher Scientific	Traceable	240072459	2024-01-24	2026-01-24

Other

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Date	Cal. Due Date
RF Pow er Sensor ¹	Boonton Electronics	RTP5000	211057	2023-08-01	2024-08-01
Notes:					

1. Equipment not used for calibrated measurements past calibration due date.

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 \leq 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

Device Dimension WS50	Overall (Length x Width x Depth): 40 mm x 25 mm x 14 mm					
	This is a Small wearable devic	This is a Small wearable device (When the factor is smaller than 9 cm \times 5 cm)				
Device Diversity M/D50	Overall (Length x Width x Dep	oth): 43 mm x 34 mm x 14 mm				
Device Dimension WB50	This is a Small wearable devic	ce (When the factor is smaller than 9 cm $ imes$ 5 cm)				
Back Cover	The Back Cover is not remova	able				
Battery Options	The rechargeable battery is no	ot user accessible.				
Accessory	Charger WD50					
Test sample information	S/N	Notes				
	5AMD001305	WS50 Radiated				
	5AMD002598	WS50 Conducted				
	B5APD001559	WB50 Radiated				
	B5APD002872	WB50 Conducted				
	D5ZPE200050	WD50 WPT				
Hardware Version	A					
Software Version	WS50 BLE: 50.13.1.110000943					
	WS50 NFC: 50.19.0.130000256					
	WB50: 3.13.1.0					
	WD50: 23.19.1.0					

6.2. Wireless Technologies

<u>WS50 - EUT</u>

	Wireless technologies	Frequency bands	Operating mode	Duty Cycle used for SAR testing	
	Bluetooth	2.4 GHz	LE	100.0% _(GFSK) ¹	
	NFC	13.56 MHz	Туре А	N/A	
N	otes:	•			

1. Duty cycle for Bluetooth is referenced from §9.

<u>WB50 - EUT</u>

	Wireless technologies	Frequency bands	Operating mode	Duty Cycle used for SAR testing
	Bluetooth	2.4 GHz	LE	100.0% _(GFSK) ¹
	WPT	13.56 MHz	N/A	100%
A	ataa			

Notes:

1. Duty cycle for Bluetooth is referenced from §9.

WD50

Wireless technologies	Frequency bands	Operating mode	Duty Cycle used for SAR testing
WPT	13.56 MHz	N/A	100%

7. RF Exposure Conditions (Test Configurations)

Wireless technologies	RF Exposure Conditions	DUT-to-User Separation	Device Configuration	Test Position	Antenna To Surface Separation	SAR Required
		0	WS50 Standalone	Back	N/A	Yes
			WB50 Standalone	Back	N/A	Yes
BLE	Extremity (Wrist)		WS50 Tx with WB50 Mounted	Back	N/A	Yes
			WB50 Tx Mounted on WS50	Back	N/A	Yes
			WS50 Tx with WD50 Mounted	Back	N/A	Yes
W/DT	Extremity	0	WB50 Tx Mounted on WS50	Back	N/A	Yes
VVFI	(Wrist)		WD50 Tx Mounted on WS50	Back	N/A	Yes
NFC (Tag On and Tag Off)	Extremity (Wrist)	0	WS50 Standalone	Back	N/A	Yes

8. Dielectric Property Measurements & System Check

8.1. Dielectric Property Measurements

IEC/IEEE 62209-1528

fable 2 – Dielectric prop	perties of the tiss	ue-equivalent medium
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Frequency	Real part of the complex relative permittivity, <i>c</i> r	Conductivity, σ	Penetration depth (E-field), δ	
MHz		S/m	mm	
4	55,0	0,75	293,0	
13	55,0	0,75	165,5	
30	55,0	0,75	112,8	
150	52,3	0,76	62,0	
300	45,3	0,87	46,1	
450	43,5	0,87	43,0	
750	41,9	0,89	39,8	
835	41,5	0,90	39,0	
900	41,5	0,97	36,2	
1 450	40,5	1,20	28,6	
1 800	40,0	1,40	24,3	
1 900	40,0	1,40	24,3	
1 950	40,0	1,40	24,3	
2 000	40,0	1,40	24,3	
2 100	39,8	1,49	22,8	
2 450	39,2	1,80	18,7	
2 600	39,0	1,96	17,2	
3 000	38,5	2,40	14,0	
3 500	37,9	2,91	11,4	
4 000	37,4	3,43	10,0	
4 500	36,8	3,94	9,7	
Frequency	Real part of the complex relative permittivity. c/	Conductivity, σ	Penetration depth (E-field), δ	
MHz		S/m	mm	
5 000	36,2	4,45	1,5	
5 200	36,0	4,66	8,4	
5 400	35,8	4,86	8,1	
5 600	35,5	5,07	7,5	
5 800	35,3	5,27	7,3	
6 000	35,1	5,48	7,0	
6 500	34,5	6,07	6,7	
7 000	33,9	6,65	6,4	
7 500	33,3	7,24	6,1	
8 000	32,7	7,84	5,9	
8 500	32,1	8,46	5,3	
9 000	31,6	9,08	4,8	
9 500	31,0	9,71	4,4	
10 000	30,4	10,40	4,0	
OTE For convenie hat are not a part of alicized values are	ence, permittivity and condu- the original data from Dros linearly interpolated (below	uctivity values are linearly i sos et al. [2]. They are sho v 5800 MHz) or extrapolate	interpolated for frequencie wn in italics in Table 2. Th ed (above 5800 MHz) fro	

Dielectric Property Measurements Results:

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SAR	Data	Tissue	Band	Freq.	Relat	Relative Permittivity (cr)			Conductivity (σ)		
Lab	Date	Туре	(MHz)	(MHz)	Measured	Target	Delta	Measured	Target	Delta	
				13	53.7	55.0	-2.33%	0.73	0.75	-2.29%	
SAR 1A	2024-06-17	Head	13	12	53.7	55.0	-2.29%	0.73	0.75	-2.29%	
				14	53.7	55.0	-2.40%	0.73	0.75	-2.28%	
				13	53.4	55.0	-2.85%	0.73	0.75	-2.85%	
SAR 1A	2024-11-12	Head	13	12	53.4	55.0	-2.93%	0.73	0.75	-2.87%	
				14	53.4	55.0	-2.87%	0.73	0.75	-2.84%	
		Head	Head 2450	2450	37.4	39.2	-4.64%	1.78	1.80	-1.06%	
SAR 2A	2024-06-17			2400	37.5	39.3	-4.55%	1.74	1.75	-0.55%	
				2480	37.3	39.2	-4.68%	1.80	1.83	-1.66%	
				2450	37.4	39.2	-4.25%	1.78	1.80	-0.94%	
SAR 2A	2024-06-28	Head	2450	2400	37.5	39.3	-4.55%	1.74	1.75	-0.49%	
				2480	37.4	39.2	-4.50%	1.78	1.83	-2.70%	
		5 Head	2450	2450	40.2	39.2	0.02%	1.76	1.80	-0.02%	
SAR 2A	2024-11-15			2400	40.3	39.3	0.02%	1.72	1.75	-0.02%	
				2500	40.1	39.1	0.02%	1.80	1.85	-0.03%	

8.2. 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 10 mm (above 1 GHz) and 15 mm (below 1 GHz) from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 15 mm was aligned with the dipole. For 5 GHz band - The coarse grid with a grid spacing of 10 mm was aligned with the dipole.
- Special 7x7x7 (below 3 GHz) and/or 8x8x7 (above 3 GHz) fine cube was chosen for the cube.
- Distance between probe sensors and phantom surface was set to 3 mm.
 For 5 GHz band Distance between probe sensors and phantom surface was set to 2.5 mm
- The dipole input power (forward power) was recorded and 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 $\pm 10\%$ of the manufacturer calibrated dipole SAR target. Refer to Appendix B for the SAR System Check Plots.

SAR		Dipole Type	Dipole Type Dipole Ir	Input Power	N	Aeasured resu	ults for 1-g SA	R	Measured results for 10-g SAR				Plot
Lab	Date Seri	& Cal. Due Date	Cal. Due Date (dBm)	Meas. Zoom Scan	Normalize to 1 W	Target (Ref. Value)	Delta ±10%	Meas. Zoom Scan	Normalize to 1 W	Target (Ref. Value)	Delta ±10%	No.	
SAR 1A	2024-06-17	CLA13 SN: 1017	2024-05-01	16.0	0.021	0.527	0.548	-3.74%	0.013	0.327	0.342	-4.52%	-
SAR 1A	2024-11-12	CLA13 SN: 1017	2025-03-07	16.0	0.021	0.527	0.551	-4.27%	0.013	0.327	0.344	-5.07%	1
SAR 2A	2024-06-17	D2450V2 SN: 963	2024-10-20	17.0	2.650	52.874	53.300	-0.80%	1.230	24.542	25.100	-2.22%	-
SAR 2A	2024-06-28	D2450V2 SN: 963	2024-10-20	17.0	2.580	51.478	53.300	-3.42%	1.200	23.943	25.100	-4.61%	-
SAR 2A	2024-11-15	D2450V2 SN: 963	2025-10-11	17.0	2.470	49.283	52.600	-6.31%	1.160	23.145	24.400	-5.14%	2

9. Conducted Output Power Measurements

Tune-Up Power Limits provided by the manufacturer are used to scale measured SAR values.

9.1. Bluetooth

		Dat Rate		Frequency	Tune-up PowerLimit (dBm)
Band	Mode		Channel	(MHz)	BLE Main Antenna
Bluetooth	LE	1 Mbps / 2Mbps	37	2402	4.11
2.4 GHz			17	2440	4.11
WS50			39	2480	4.11
Bluetooth		4.14	37	2402	8.04
2.4 GHz	LE	1 Mbps / 2Mbps	17	2440	8.04
WB50		2101003	39	2480	8.04

WS50 Bluetooth Measured Results

			Freq	BLE Antenna Average Power (dBm)			
Band	Mode	Ch#	(MHz)	Meas Pwr	Tune-up	SAR Test (Yes/No)	
	LE, GESK	37	2402	3.9	4.11		
2 4 GHz		17	2440	3.7	4.11	Yes	
2.4 0112	Gron	39	2480	3.5	4.11		

WB50 Bluetooth Measured Results

			Freq	BLE Antenna Average Power (dBm)			
Band	Mode	Ch#	(MHz)	Meas Pwr	Tune-up	SAR Test (Yes/No)	
		37	2402	7.8	8.04		
2 4 GHz	LE, GESK	17	2440	7.8	8.04	Yes	
2.4 0112	GF3K	39	2480	7.8	8.04		

Duty Factor Measured Results

Mode	Туре	T on (ms)	Period (ms)	Duty Cycle	Crest Factor (1/duty cycle)
GFSK	DH5	100	100	100.00%	1.00

Note(s):

Duty Cycle = (T on / period) * 100%

Duty Cycle plots

LE, GFSK, 1 Mbps (WS50)

🏬 К	eysight	Spect	rum /	Analyzer	- AP202	24.2.23,	85502,	MOR-	CON2																		ē 🗙
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<u>10 c</u>	dB/div	,	Rei	f 20.0	00 di	Зm	IF(NO: F Gain:	ast • Low		#Atte	n: 30 d	IB			,,,,,,			Δ	Mk	ء r3 1 0	00. 00.	0 n 04 d	ns IB		Auto	o Tune
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Duty Cycle plots

LE, GFSK, 1 Mbps (WB50)

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-30.0																								2.440000000 GHz
-40.0																							F	
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9.2. WPT

Conducted output power cannot be measured for WPT, therefore a 2 dB scaling factor shall be used to account for potential variations between samples.

9.3. NFC

Conducted output power cannot be measured for NFC, therefore a 2 dB scaling factor shall be used to account for potential variations between samples.

10. Measured and Reported (Scaled) SAR Results

SAR Test Reduction criteria are as follows:

• Reported SAR(W/kg) for Bluetooth = Measured SAR * Tune-up scaling factor

KDB 447498 D01 General RF Exposure Guidance:

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:

- \leq 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is \leq 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
- \leq 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is \geq 200 MHz

10.1. Bluetooth

WS50 Standalone

RF Exposure		Device	Dist					Power	(dBm)	10-g SA	R (W/kg)	Plot
Conditions	Mode	Configuration	(mm)	Test Position	Ch#.	Freq. (MHz)	Duty Cycle	Tune-up Limit	Meas.	Meas.	Scaled	No.
Extremity	LE GFSK 1 Mbps	WS50 Standalone	0	Back	17	2440	100%	4.11	3.7	0.011	0.012	1

WB50 Standalone

RF Exposure		Device	Dist					Power	(dBm)	10-g SA	R (W/kg)	Plot
Conditions	Mode	Configuration	(mm)	Test Position	Ch#.	Freq. (MHz)	Duty Cycle	Tune-up Limit	Meas.	Meas.	Scaled	No.
Extremity	LE GFSK 1 Mbps	WB50 Standalone	0	Back	17	2440	100%	8.04	7.8	0.027	0.029	2

WS50 with WB50

RE Exposure		Device	Dist					Power	(dBm)	10-g SA	R (W/kg)	Plot
Conditions	Mode	Configuration	(mm)	Test Position	Ch#.	Freq. (MHz)	Duty Cycle	Tune-up Limit	Meas.	Meas.	Scaled	No.
Extremity	LE GFSK 1 Mbps	WS50 Tx with WB50 Mounted	0	Back	17	2440	100%	4.11	3.7	0.010	0.011	3
Extremity	LE GFSK 1 Mbps	WB50 Tx Mounted on WS50	0	Back	17	2440	100%	8.04	7.8	0.004	0.004	4

WS50 with WD50

RF Exposure		Device	Dist					Power	(dBm)	10-g SA	R (W/kg)	Plot
Conditions	Mode	Configuration	(mm)	Test Position	Ch#.	Freq. (MHz)	Duty Cycle	Tune-up Limit	Meas.	Meas.	Scaled	No.
Extremity	LE GFSK 1 Mbps	WS50 Tx with WD50 Mounted	0	Back	17	2440	100%	4.11	3.7	0.012	0.013	5

10.2. WPT

WS50 with WB50

		Devies	Dist		F ree r		Tolerance	10-g SA	R (W/kg)	Det
Conditions	Mode	Configuration	Dist. (mm)	Test Position	Freq. (MHz)	Duty Cycle	Scaling Factor (dBm)	Meas.	Scaled	Plot No.
Extremity	WPT	WB50 Tx Mounted on WS50	0	Back	13.56	100%	2.0	0.000	0.000	6

Note:

Conducted output power cannot be measured for WPT, therefore a 2 dB scaling factor shall be used to account for potential variations between samples.

WS50 with WD50

		Devier	Diet		En en		Tolerance	10-g SA	R (W/kg)	Det
Conditions	Mode	Configuration	(mm)	Test Position	Freq. (MHz)	Duty Cycle	Scaling Factor (dBm)	Meas.	Scaled	Mo.
Extremity	WPT	WD50 Tx Mounted on WS50	0	Back	13.56	100%	2.0	0.000	0.000	7

Note:

Conducted output power cannot be measured for WPT, therefore a 2 dB scaling factor shall be used to account for potential variations between samples. WPT is only supported on model WD50 (FCC ID: 2AJ2X-WD50). It is included here for Simultaneous Transmission analysis only.

10.3. NFC

WS50 Standalone

		Devies	Diet		F		Tolerance	10-g SA	R (W/kg)	
Conditions	Mode	Configuration	Dist. (mm)	Test Position	Freq. (MHz)	Duty Cycle	Scaling Factor (dBm)	Meas.	Scaled	Plot No.
Extromity	NEC	WS50	0	Back (Tag)	13.56	100%	2.0	0.000	0.000	8
Extremity	NIC	Standalone	0	Back (No Tag)	13.56	100%	2.0	0.000	0.000	

Note:

Conducted output power cannot be measured for NFC, therefore a 2 dB scaling factor shall be used to account for potential variations between samples.

11. SAR Measurement Variability

In accordance with published RF Exposure KDB 865664 D01 SAR measurement 100 MHz to 6 GHz. 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.

- 1) Repeated measurement is not required when the original highest measured SAR is < 0.8 or 2 W/kg (1-g or 10-g respectively); steps 2) through 4) do not apply.
- When the original highest measured SAR is ≥ 0.8 or 2 W/kg (1-g or 10-g respectively), repeat that measurement once.
- 3) Perform a second repeated measurement only 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 or 3.6 W/kg (~ 10% from the 1-g or 10-g respective SAR limit).
- 4) Perform a third repeated measurement only if the original, first, or second repeated measurement is ≥ 1.5 or 3.75 W/kg (1-g or 10-g respectively) and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

Note(s):

Repeated measurement is not required since the original highest measured SAR is <0.8 W/kg (1-g) or 2 W/kg (10-g).

12. Simultaneous Transmission Conditions

RF Exposure Condition	Item		Cap	able Transmit Configurat	ions	
	1	DTS (WS50)	+	DXX (WS50)		
Extremity	2	DTS (WS50)	+	DTS(WB50)	+	DXX (WB50)
	3	DTS (WS50)	+	DXX (WD50)		

Notes:

* For a more accurate simultaneous transmission scenario of the WS50 Standalone use-case, only the Device Configuration "WS50 Standalone" is considered.

** For a more accurate simultaneous transmission scenario of the WS50 + WB50 system, only the Device Configurations "WS50 Tx with WB50 Mounted" and "WB50 Tx Mounted on WS50" are considered.

*** For a more accurate simultaneous transmission scenario of the WS50 + WD50 system, only the Device Configurations "WS50 Tx with WD50 Mounted" and "WD50 Tx Mounted on WS50" are considered.

12.1. Sum of the SAR for BLE & NFC (WS50 Standalone)

	Test	Standalone	SAR (W/kg)	∑ 10-g SAR (W/kg)
conditions	Position	1	2	
		BLE WS50	NFC WS50	1+2
Extremity	Back	0.012	0.000	0.012

12.2. Sum of the SAR for BLE & WPT (WS50 with WB50)

		Sta	ndalone SAR (W	/kg)	∑ 10-g SAR (W/kg)
Conditions	l est Position	1	2	3	
Containente	1 conton	BLE WS50	BLE WB50	WPT WB50	1+2+3
Extremity	Back	0.011	0.004	0.000	0.015

12.3. Sum of the SAR for BLE & WPT (WS50 with WD50)

RF Exposure conditions	Test Position	Standalone SAR (W/kg)		∑ 10-g SAR (W/kg)
		1	2	1+2
		BLE	WPT	
		WS50	WD50	
Extremity	Back	0.013	0.000	0.013

Appendixes

Refer to separated files for the following appendixes.

- Appendix A: SAR Setup Photos
- Appendix B: SAR System Check Plots
- **Appendix C: SAR Highest Test Plots**
- Appendix D: SAR Tissue Ingredients
- Appendix E: SAR Probe Certificates
- Appendix F: SAR Dipole Certificates

END OF REPORT