

SAR EVALUATION REPORT

IEEE Std 1528-2013

For
Wearable Wireless Device

FCC ID: IPH-04999
Model Name: A04999

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Revision History

Rev.	Date	Revisions	Revised By
V1	2024-11-26	Initial Issue	--
V2	2024-11-27	Removed dimensions from §6.1 and Appendix A	Sarah Kuhaneck

Table of Contents

1.	Attestation of Test Results	5
2.	Test Specification, Methods and Procedures.....	6
3.	Facilities and Accreditation	7
4.	SAR Measurement System & Test Equipment	8
4.1.	<i>SAR Measurement System.....</i>	8
4.2.	<i>SAR Scan Procedures</i>	9
4.3.	<i>Test Equipment.....</i>	11
5.	Measurement Uncertainty.....	12
6.	Device Under Test (DUT) Information	13
6.1.	<i>DUT Description</i>	13
6.2.	<i>Wireless Technologies.....</i>	14
7.	RF Exposure Conditions (Test Configurations).....	15
8.	Dielectric Property Measurements & System Check	16
8.1.	<i>Dielectric Property Measurements</i>	16
8.2.	<i>System Check.....</i>	18
9.	Conducted Output Power Measurements.....	20
9.1.	<i>Wi-Fi 2.4GHz (DTS Band).....</i>	20
9.2.	<i>Bluetooth</i>	23
9.3.	<i>ANT/ANT+</i>	25
9.4.	<i>NFC.....</i>	25
10.	Measured and Reported (Scaled) SAR Results.....	26
10.1.	<i>Wi-Fi (DTS Band).....</i>	27
10.2.	<i>Bluetooth.....</i>	27
10.1.	<i>NFC.....</i>	27
10.2.	<i>Standalone SAR Test Exclusion Considerations & Estimated SAR</i>	27
11.	SAR Measurement Variability.....	28
12.	Simultaneous Transmission Conditions	29
12.1.	<i>Simultaneous transmission SAR test exclusion considerations</i>	29
12.2.	<i>Sum of the SAR for Bluetooth & NFC.....</i>	29
Appendixes		30
	<i>Appendix A: SAR Setup Photos</i>	30
	<i>Appendix B: SAR System Check Plots.....</i>	30



Appendix C: SAR Highest Test Plots..... 30

Appendix D: SAR Tissue Ingredients..... 30

Appendix E: SAR Probe Certificates..... 30

Appendix F: SAR Dipole Certificates 30

1. Attestation of Test Results

Applicant Name	Garmin International Inc.			
FCC ID	IPH-04999			
Model Name	A04999			
Applicable Standards	Published RF exposure KDB procedures IEEE Std 1528-2013			
Exposure Category	SAR Limits (W/Kg)			
	Extremities (hands, wrists, ankles, etc.) (10g of tissue)			
General population / Uncontrolled exposure	4.0			
RF Exposure Conditions	Equipment Class - Highest Reported SAR (W/kg)			
	DTS	DSS	DXX	NFC
Extremity	0.341	0.042	0.037	0.000
Simultaneous Transmission	N/A	0.042	0.037	0.042
Date Tested	2024-08-19 to 2024-08-22			
Test Results	Pass			
<p>UL LLC tested the above equipment in accordance with the requirements set forth in the above standards. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.</p> <p>This report contains data provided by the customer which can impact the validity of results. UL LLC is only responsible for the validity of results after the integration of the data provided by the customer.</p> <p>The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. It is the manufacturer's responsibility to assure that additional production units of this model are manufactured with identical electrical and mechanical components. All samples tested were in good operating condition throughout the entire test program. Measurement Uncertainties are published for informational purposes only and were not taken into account unless noted otherwise.</p> <p>This document may not be altered or revised in any way unless done so by UL LLC and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL LLC will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by A2LA, NIST, or any agency of the U.S. Government.</p>				
Approved & Released By:		Prepared By:		
				
Richard Jankovics Staff Engineer UL LLC		Lindsay Ryan Engineer UL LLC		

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 the following FCC Published RF exposure [KDB](#) procedures:

- 248227 D01 802.11 Wi-Fi SAR v02r02
- 447498 D01 General RF Exposure Guidance v06
- 447498 D03 Supplement C Cross-Reference v01
- 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:

- TCB Workshop October 2016; RF Exposure Procedures (Bluetooth Duty Factor)
- TCB Workshop October 2016; RF Exposure Procedures (DUT Holder Perturbations)
- TCB Workshop 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.

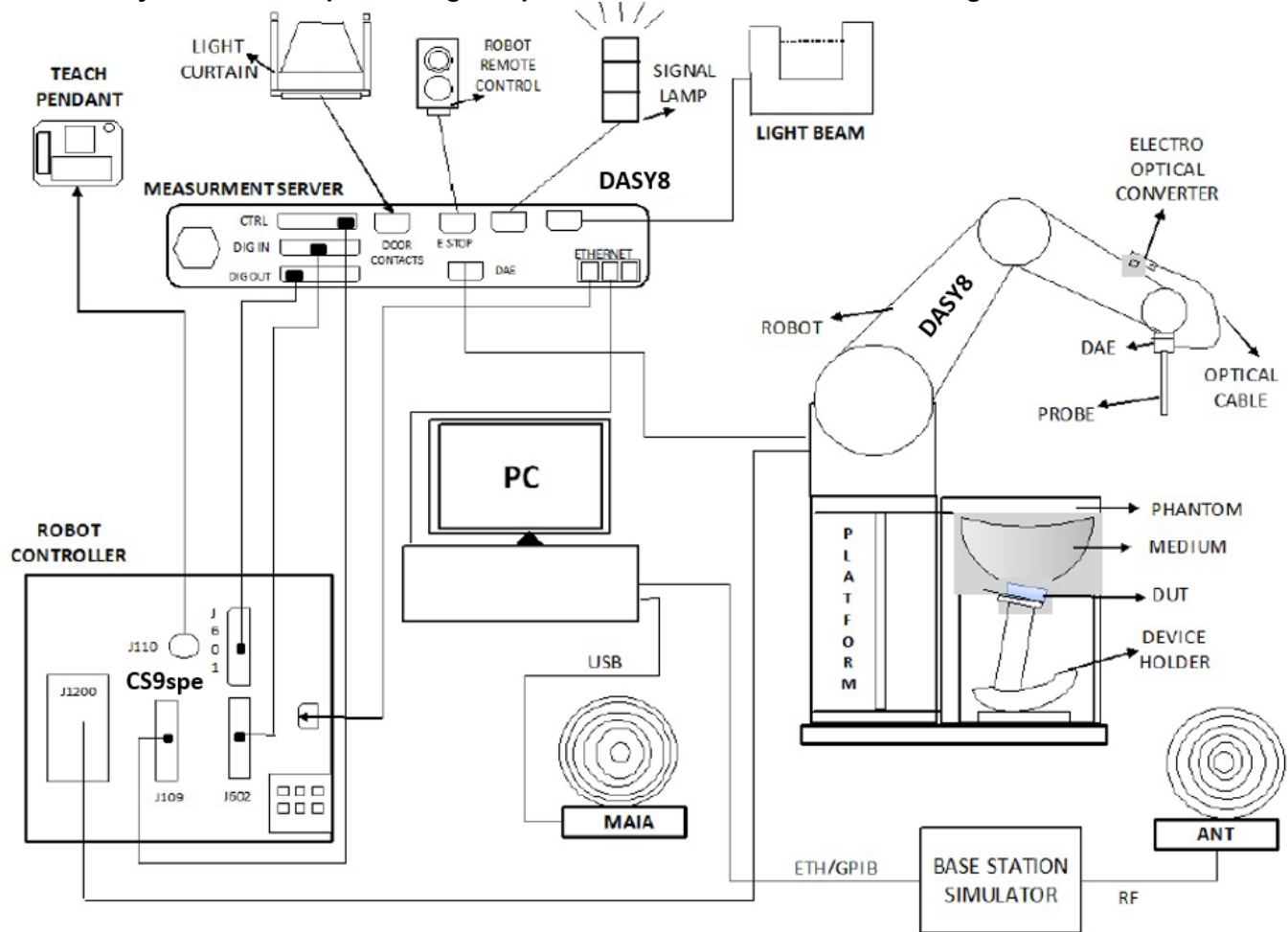
- SAR Lab 2A

	Address	ISED CABID	ISED Company Number	FCC Registration
<input type="checkbox"/>	Building: 12 Laboratory Dr RTP, NC 27709, U.S.A	US0067	2180C	825374
<input checked="" type="checkbox"/>	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, 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 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: DASY16.2.4.2524 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

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 1 mm	$\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5$ mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	$30^\circ \pm 1^\circ$	$20^\circ \pm 1^\circ$
Maximum area scan spatial resolution: $\Delta x_{\text{Area}}, \Delta y_{\text{Area}}$	≤ 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 \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	> 3 GHz
Maximum zoom scan spatial resolution: $\Delta x_{\text{Zoom}}, \Delta y_{\text{Zoom}}$			≤ 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: $\Delta z_{\text{Zoom}}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{\text{Zoom}}(1)$: between 1 st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{\text{Zoom}}(n>1)$: between subsequent points	$\leq 1.5 \cdot \Delta z_{\text{Zoom}}(n-1)$	
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 <u>reported</u> SAR from the <i>area scan based 1-g SAR estimation</i> 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
Network Analyzer	Keysight	E5063A	MY54100681	2024-07-31	2025-07-31
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	2023-03-30	2025-03-30

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Date	Cal. Due Date
Signal Generator	Keysight	N5181A	MY50140788	2024-08-01	2025-08-01
3-Path Diode Power Sensor	Rohde & Schwarz	NRP8S	112236	2024-07-12	2025-07-12
3-Path Diode Power Sensor	Rohde & Schwarz	NRP8S	112237	2024-07-12	2025-07-12
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 Power Supply	Miteq	PS 15V1	1990186	N/A	N/A
RF Power Source	Speag	PowerSource1	4278	2024-06-17	2025-06-17

Lab Equipment

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Date	Cal. Due Date
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	DAE4	1715	2024-02-12	2025-02-12
Data Acquisition Electronics	SPEAG	DAE4	1716	2024-03-13	2025-03-13
System Validation Dipole	SPEAG	CLA13	1017	2024-03-07	2025-03-07
System Validation Dipole	SPEAG	D2450V2	963	2023-10-20	2024-10-20
Environmental Indicator	Fisher Scientific	Traceable	240072452	2024-01-24	2026-01-24

Other

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Date	Cal. Due Date
RF Power Meter	R&S	NRP8S	112236	2024-07-12	2025-07-12
RF Power Meter	R&S	NRP8S	112237	2024-07-12	2025-07-12

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 Form Factor	This is an extremity wrist-worn wearable device.	
Back Cover	The Back Cover is not removable	
Battery Options	The rechargeable battery is not user accessible.	
Test sample information	S/N 3483183437 3483183274	Notes Radiated Sample Conducted Sample
Hardware Version	Rev V3 M0 D3	
Software Version	Ver 1.06	

6.2. Wireless Technologies

Wireless technologies	Frequency bands	Operating mode	Duty Cycle used for SAR testing
Wi-Fi	2.4 GHz	802.11b 802.11g 802.11n (HT20)	100.0% (802.11b) ¹
Bluetooth	2.4 GHz	BR, EDR, LE	100.0% (GFSK) ¹
ANT/ANT+	2.4 GHz	GFSK	N/A ²
NFC	13.56 MHz	Type A, B	100% (Type A) ¹

Notes:

1. Duty cycle for Wi-Fi is referenced from §9.
2. Measured Duty Cycle is not required due to SAR test exemption

7. RF Exposure Conditions (Test Configurations)

Wireless technologies	RF Exposure Conditions	DUT-to-User Separation	Test Position	Antenna-to-edge/surface	SAR Required
WLAN	Extremity (Hand/Wrist)	0	Back	N/A	Yes
BT	Extremity (Hand/Wrist)	0	Back	N/A	Yes
ANT/ANT+	Extremity (Hand/Wrist)	0	Back	N/A	No ¹
NFC	Extremity (Hand/Wrist)	0	Back	N/A	Yes

Note(s):

1. Exempt from SAR testing

SAR Test Exclusion Calculations for WLAN

Antennas < 50mm to adjacent edges

Tx Interface	Frequency (MHz)	Output Power		Separation Distances (mm)	Calculated Threshold Value
		dBm	mW	Back	Back
ANT/ANT+	2457	3.50	2.24	0	0.7 -EXEMPT-

Note(s):

According to KDB 447498, if the calculated threshold value is >7.5 then SAR testing is required.

8. Dielectric Property Measurements & System Check

8.1. Dielectric Property Measurements

IEC/IEEE 62209-1528

Table 2 – Dielectric properties of the tissue-equivalent medium

Frequency MHz	Real part of the complex relative permittivity, ϵ'_r	Conductivity, σ S/m	Penetration depth (E-field), δ 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 MHz	Real part of the complex relative permittivity, ϵ'_r	Conductivity, σ S/m	Penetration depth (E-field), δ 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

NOTE For convenience, permittivity and conductivity values are linearly interpolated for frequencies that are not a part of the original data from Drossos et al. [2]. They are shown in italics in Table 2. The italicized values are linearly interpolated (below 5800 MHz) or extrapolated (above 5800 MHz) from the non-italicized values that are immediately above and below these values.

Dielectric Property Results:

Liquid Check										
SAR Lab	Date	Tissue Type	Band (MHz)	Freq. (MHz)	Relative Permittivity (ϵ_r)			Conductivity (σ)		
					Measured	Target	Delta	Measured	Target	Delta
SAR 1A	2024-08-22	Head	13	13	52.6	55.0	-4.31%	0.72	0.75	-4.45%
				12	52.7	55.0	-4.27%	0.72	0.75	-4.47%
				14	52.6	55.0	-4.35%	0.72	0.75	-4.44%
SAR 2A	2024-08-19	Head	2450	2450	38.0	39.2	-3.04%	1.77	1.80	-1.89%
				2400	38.1	39.3	-3.05%	1.73	1.75	-1.41%
				2500	38.0	39.1	-3.01%	1.81	1.85	-2.54%

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 \pm 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 \geq 15.0 cm for SAR measurements \leq 3 GHz and \geq 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.

System Check													
SAR Lab	Date	Dipole Type & Serial Number	Dipole Cal. Due Date	Input Power (dBm)	Measured results for 1-g SAR				Measured results for 10-g SAR				Plot No.
					Meas. Zoom Scan	Normalize to 1 W	Target (Ref. Value)	Delta $\pm 10\%$	Meas. Zoom Scan	Normalize to 1 W	Target (Ref. Value)	Delta $\pm 10\%$	
SAR 1A	2024-08-22	CLA13 SN: 1017	2025-03-07	16.0	0.020	0.502	0.548	-8.33%	0.013	0.327	0.342	-4.52%	1
SAR 2A	2024-08-19	D2450V2 SN: 963	2024-10-20	17.0	2.520	50.281	53.300	-5.66%	1.170	23.345	25.100	-6.99%	2

9. Conducted Output Power Measurements

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

9.1. Wi-Fi 2.4GHz (DTS Band)

Maximum Output Power (Tune-up Limit) for Wi-Fi 2.4 GHz

The maximum output power specified for production units are determined for all applicable 802.11 transmission modes in each standalone and aggregated frequency band. Maximum output power is measured for the highest maximum output power configuration(s) in each frequency band according to the default power measurement procedures.

For “Not required”, SAR Test reduction was applied from KDB 248227 guidance, Sec. 2.1, b), 1) when the same maximum power is specified for multiple transmission modes in a frequency band, the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order 802.11b/g/n mode is used for SAR measurement, on the highest measured output power channel in the initial test configuration, for each frequency band. Additional output power measurements were not deemed necessary.

SAR testing is not required for OFDM mode(s) 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.

Mode	Bandwidth	Channel	Frequency (MHz)	Tune-up PowerLimit (dBm)
				Main Antenna
802.11b	20 MHz	1	2412	15.50
		2	2417	19.50
		3	2422	19.50
		4	2427	19.50
		5	2432	19.50
		6	2437	19.50
		7	2442	19.50
		8	2447	19.50
		9	2452	19.50
		10	2457	19.50
		11	2462	18.50
		12	2467	14.00
		13	2472	14.00
802.11g	20 MHz	1	2412	11.50
		6	2437	18.50
		7	2442	18.50
		8	2447	18.50
		9	2452	18.50
		10	2457	18.50
		11	2462	15.00
		12	2467	10.50
802.11n	20 MHz	13	2472	10.50
		1	2412	11.50
		2	2417	18.50
		6	2437	18.50
		7	2442	18.50
		8	2447	18.50
		9	2452	18.50
		10	2457	18.50
		11	2462	15.00
		12	2467	10.50
		13	2472	10.50

Wi-Fi 2.4GHz Measured Results

Band	Mode	Ch #	Freq. (MHz)	Main Antenna Average Power (dBm)		
				Meas Pwr	Tune-up	SAR Test (Yes/No)
DSSS 2.4 GHz	802.11b	2	2417	18.0	19.5	Yes
		3	2422	18.0	19.5	
		4	2427	17.8	19.5	
		5	2432	17.9	19.5	
		6	2437	17.7	19.5	
		7	2442	17.7	19.5	
		8	2447	17.6	19.5	
		9	2452	17.6	19.5	
		10	2457	17.5	19.5	

Note(s):

SAR is not required for channel 12 and 13 because the tune-up limit and the measured output power for these two channels are not greater than those for the default test channels. Refer to KDB 248227 D01 section 3.1

Duty Factor Measured Results

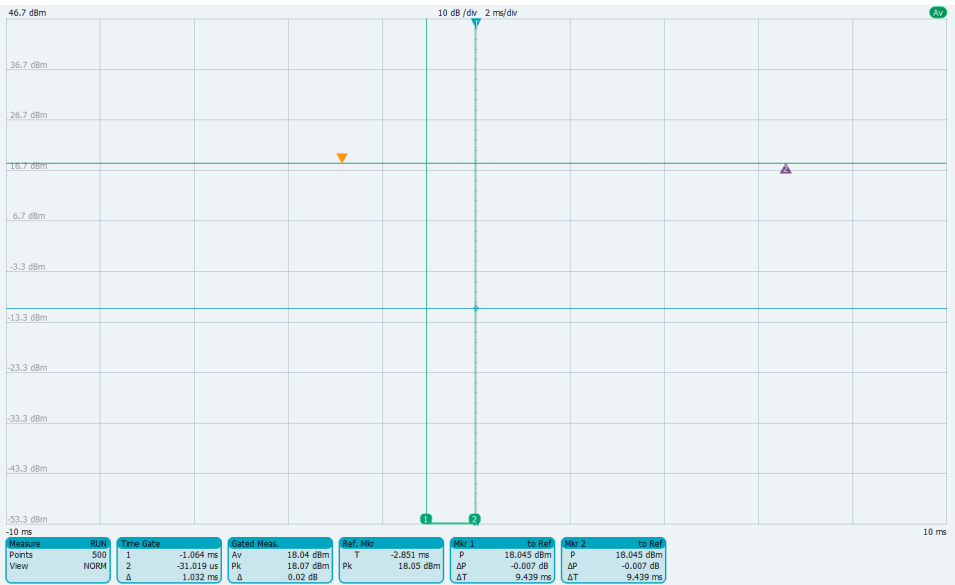
Mode	T on (ms)	Period (ms)	Duty Cycle	Crest Factor (1/duty cycle)
802.11b	9.439	9.439	100.0%	1.00

Note(s):

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

Duty Cycle plots

802.11b



9.2. Bluetooth

Maximum Output Power (Tune-up Limit) for Bluetooth

Band	Mode	Channel	Frequency (MHz)	Tune-up PowerLimit (dBm)
				Main Antenna
Bluetooth 2.4 GHz	BR	0	2402	9.5
		39	2441	9.5
		78	2480	9.5
	EDR	0	2402	8.5
		39	2441	9.0
		78	2480	9.5
	LE	0	2404	1.0
		17	2440	1.0
		36	2478	1.0

Bluetooth Measured Results

Band	Mode	Ch #	Freq. (MHz)	Main Antenna Average Power (dBm)		
				Meas Pwr	Tune-up	SAR Test (Yes/No)
Bluetooth	BR GFSK	0	2402	8.6	9.5	Yes
		39	2441	8.6	9.5	
		78	2480	9.2	9.5	

Duty Factor Measured Results

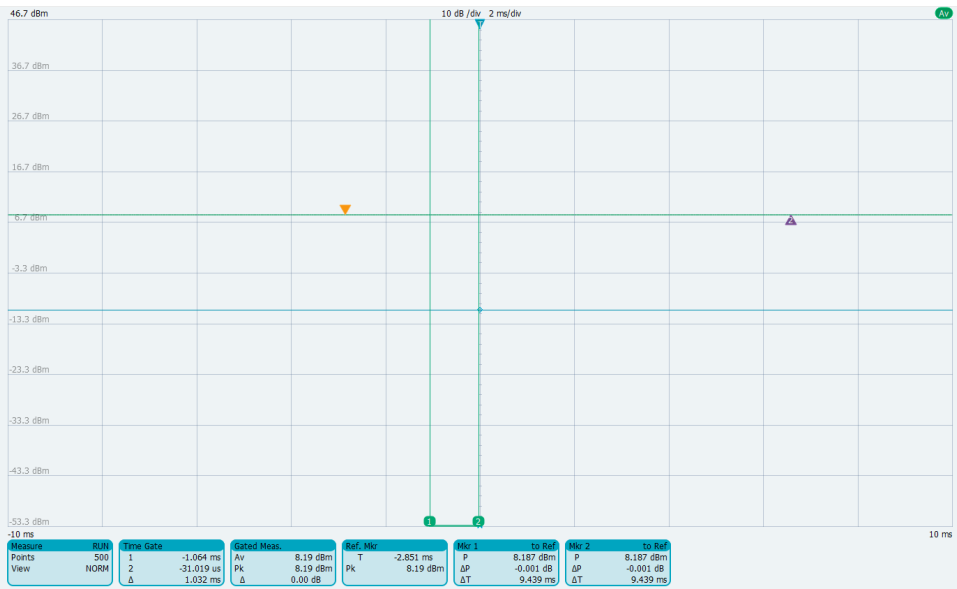
Mode	T on (ms)	Period (ms)	Duty Cycle	Crest Factor (1/duty cycle)
802.11b	9.439	9.439	100.0%	1.00

Note(s):

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

Duty Cycle plots

GFSK



9.3. ANT/ANT+

Maximum Output Power (Tune-up Limit) for ANT/ANT+

Band	Mode	Frequency (MHz)	Tune-up PowerLimit (dBm)
			Main Antenna
ANT/ANT+	GFSK	2404	3.5
		2440	3.5
		2478	3.5

9.4. 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.

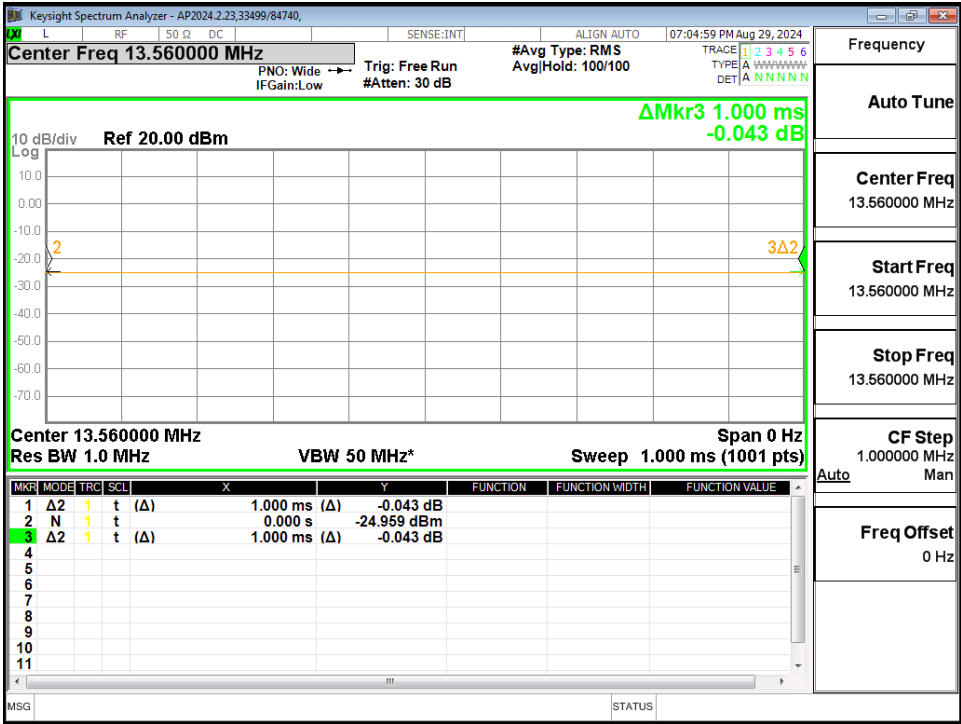
Duty Factor Measured Results

Mode	T on (ms)	Period (ms)	Duty Cycle	Crest Factor (1/duty cycle)
Type A	1.000	1.000	100.0%	1.00

Note(s):

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

Duty Cycle plots
Type A



10. Measured and Reported (Scaled) SAR Results

SAR Test Reduction criteria are as follows:

- Reported SAR(W/kg) for Wi-Fi and Bluetooth = Measured SAR * Tune-up scaling factor * Duty Cycle scaling factor
- Duty Cycle scaling factor = 1 / Duty cycle (%)

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:

- ≤ 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

KDB 248227 D01 SAR meas for 802.11:

SAR test reduction for 802.11 Wi-Fi transmission mode configurations are considered separately for DSSS and OFDM. An initial test position is determined to reduce the number of tests required for certain exposure configurations with multiple test positions. An initial test configuration is determined for each frequency band and aggregated band according to maximum output power, channel bandwidth, wireless mode configurations and other operating parameters to streamline the measurement requirements. For 2.4 GHz DSSS, either the initial test position or DSSS procedure is applied to reduce the number of SAR tests; these are mutually exclusive. For OFDM, an initial test position is only applicable to next to the ear, UMPC mini-tablet and hotspot mode configurations, which is tested using the initial test configuration to facilitate test reduction. For other exposure conditions with a fixed test position, SAR test reduction is determined using only the initial test configuration.

The multiple test positions require SAR measurements in head, hotspot mode or UMPC mini-tablet configurations may be reduced according to the highest reported SAR determined using the initial test position(s) by applying the DSSS or OFDM SAR measurement procedures in the required wireless mode test configuration(s). The initial test position(s) is measured using the highest measured maximum output power channel in the required wireless mode test configuration(s). When the reported SAR for the initial test position is:

- ≤ 0.4 W/kg, further SAR measurement is not required for the other test positions in that exposure configuration and wireless mode combination within the frequency band or aggregated band. DSSS and OFDM configurations are considered separately according to the required SAR procedures.
- > 0.4 W/kg, SAR is repeated using the same wireless mode test configuration tested in the initial test position to measure the subsequent next closest/smallest test separation distance and maximum coupling test position, on the highest maximum output power channel, until the reported SAR is ≤ 0.8 W/kg or all required test positions are tested.
 - For subsequent test positions with equivalent test separation distance or when exposure is dominated by coupling conditions, the position for maximum coupling condition should be tested.
 - When it is unclear, all equivalent conditions must be tested.
- For all positions/configurations tested using the initial test position and subsequent test positions, when the reported SAR is > 0.8 W/kg, measure the SAR for these positions/configurations on the subsequent next highest measured output power channel(s) until the reported SAR is ≤ 1.2 W/kg or all required test channels are considered.
 - The additional power measurements required for this step should be limited to those necessary for identifying subsequent highest output power channels to apply the test reduction.
- 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.
- When the specified maximum output power is different between UNII 1 and UNII 2A, begin SAR with the band that has the higher specified maximum output. If the highest reported SAR for the band with the highest specified power is ≤ 1.2 W/kg, testing for the band with the lower specified output power is not required; otherwise test the remaining bands independently for SAR.

To determine the initial test position, Area Scans were performed to determine the position with the *Maximum Value of SAR (measured)*. The position that produced the highest *Maximum Value of SAR* is considered the worst case position; thus used as the initial test position.

10.1. Wi-Fi (DTS Band)

When the 802.11b reported SAR of the highest measured maximum output power channel is ≤ 0.8 W/kg, no further SAR testing is required. If SAR is > 0.8 W/kg and ≤ 1.2 W/kg, SAR is required for the next highest measured output power channel. Finally, if SAR is > 1.2 W/kg, SAR is required for the third channel.

SAR testing is not required for OFDM mode(s) 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.

RF Exposure Conditions	Mode	Power State	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Area Scan Max. SAR (10g W/kg)	Duty Cycle	Power (dBm)		10-g SAR (W/kg)		Plot No.
									Tune-up Limit	Meas.	Meas.	Scaled	
Extremity	802.11b	Default	0	Back	6	2437	0.212	100.0%	19.5	17.7	0.225	0.341	1

10.2. Bluetooth

RF Exposure Conditions	Mode	Power State	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Power (dBm)		10-g SAR (W/kg)		Plot No.
							Tune-up Limit	Meas.	Meas.	Scaled	
Extremity	GFSK	Default	0	Back	78	2480	9.5	9.2	0.039	0.042	2

10.1. NFC

RF Exposure Conditions	Mode	Dist. (mm)	Freq. (MHz)	Tolerance Scaling ¹ (dB)	Test Position	10-g SAR (W/kg)		Plot No.
						Meas.	Scaled	
Extremity	Type A	0	13.56	2	Back	0.000	0.000	3

Note:

Conducted output power measurements for NFC are not practical, therefore a 2 dB scaling factor shall be used to account for potential variations between samples.

10.2. Standalone SAR Test Exclusion Considerations & Estimated SAR

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$, for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- $f_{(\text{GHz})}$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

RF Air interface	RF Exposure Conditions	Frequency (GHz)	Max. tune-up tolerance Power		Min. test separation distance (mm)	SAR test exclusion Result*	Estimated 10-g SAR (W/kg)
			(dBm)	(mW)			
ANT/ANT+	Extremity	2.440	3.50	2.24	5	0.6	0.037

Conclusion:

*: The computed value is ≤ 7.5 ; therefore, this qualifies for Standalone SAR test exclusion.

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.
- 2) 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 ($\sim 10\%$ 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 $< 0.8 \text{ W/kg}$ (1-g) or 2 W/kg (10-g) .

12. Simultaneous Transmission Conditions

RF Exposure Condition	Item	Capable Transmit Configurations		
Extremity	1	BT/BLE	+	NFC
	2	ANT/ANT+	+	NFC

12.1. Simultaneous transmission SAR test exclusion considerations

KDB 447498 D01 General RF Exposure Guidance provides two procedures for determining simultaneous transmission SAR test exclusion: Sum of SAR and SAR to Peak Location Ratio (SPLSR).

Sum of SAR

To qualify for simultaneous transmission SAR test exclusion based upon Sum of SAR the sum of the reported standalone SARs for all simultaneously transmitting antennas shall be below the applicable standalone SAR limit. If the sum of the SARs is above the applicable limit then simultaneous transmission SAR test exclusion may still apply if the requirements of the SAR to Peak Location Ratio (SPLSR) evaluation are met.

12.2. Sum of the SAR for Bluetooth & NFC

RF Exposure conditions	Test Position	10g SAR (W/kg)			Σ 10-g SAR (W/kg)	
		1	2	3	1+3	2+3
		BT	ANT/ANT+	NFC		
Extremity	Back	0.042	0.037	0.000	0.042	0.037

Conclusion:

Simultaneous transmission SAR measurement (Volume Scan) is not required because either the sum of the 10-g SAR is < 4 W/kg.

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