SAR EVALUATION REPORT

IEEE Std 1528-2013

For
Wearable Smart Watch

FCC ID: IPH-04413
Model Name: A04413

Report Number: R15191165-S1
Issue Date: 2024-05-01

Prepared for
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ACCREDITED
CERT #0751.06

Revision History

Rev.	Date	Revisions	Revised By
V1	2024-05-01	Initial Issue	--

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1. Attestation of Test Results

Applicant Name	Garmin International Inc.			
FCC ID	IPH-04413			
Model Name	A04413			
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	0.725	0.121	0.167	0.000
Simultaneous Tx	0.725	0.121	0.167	0.725
Date Tested	3/20/2024 to 4/25/2024			
Test Results	Pass			

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.

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.

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.

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.

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
- 447498 D04 Interim General RF Exposure Guidance 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 2015; RF Exposure Procedures (KDB 941225 D05A)
- 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.

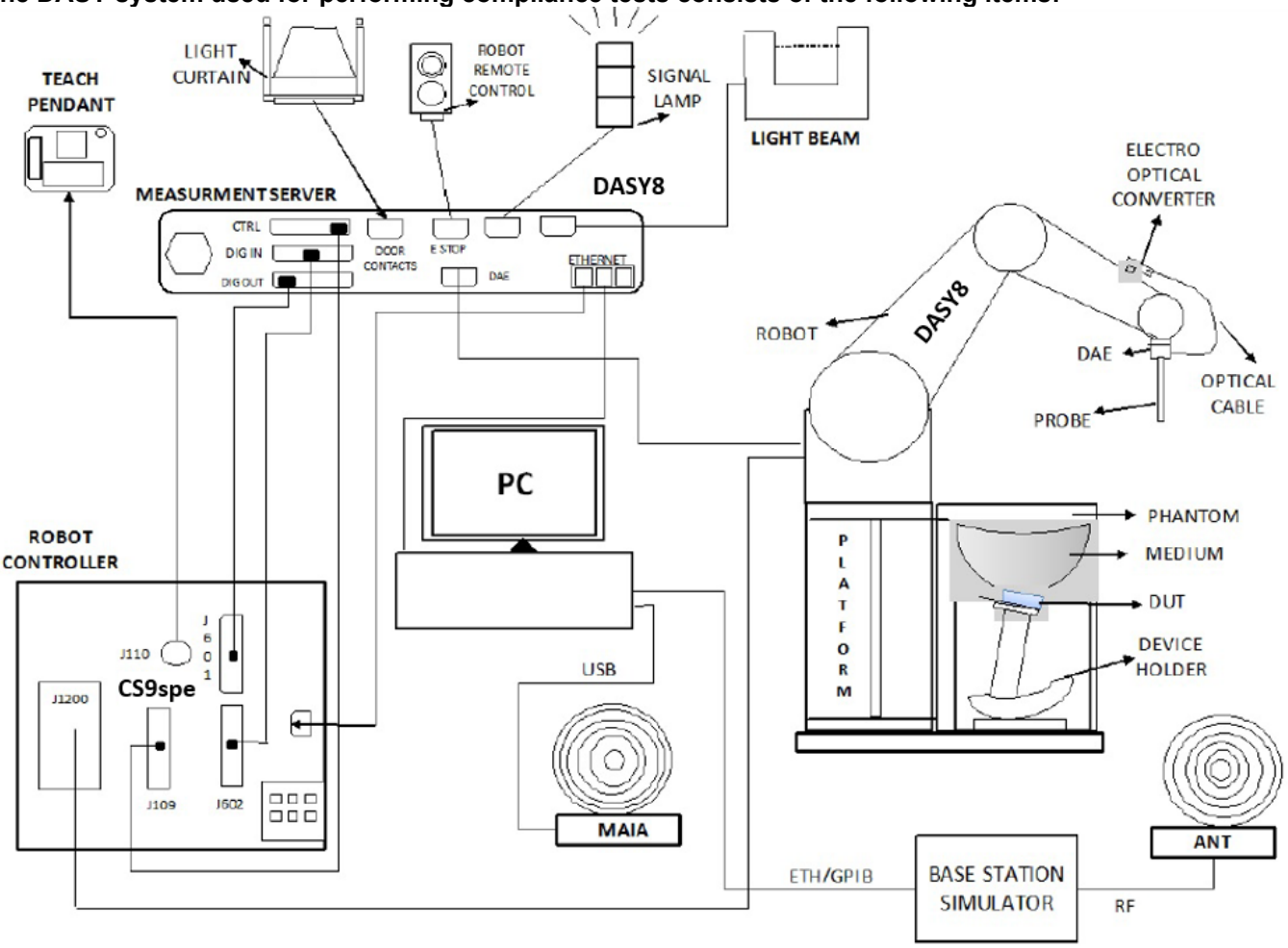
- SAR Lab 1A
- SAR Lab 2A
- SAR Lab 2B

	Address	ISED CABID	ISED Company Number	FCC Registration
☐	Building: 12 Laboratory Dr RTP, NC 27709, U.S.A	US0067	2180C	825374
☒	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 DASY8[1] 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	½·δ·ln(2) ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}	≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
	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 SAR Measurement 100 MHz to 6 GHz

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

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

* When zoom scan is required and the *reported* SAR from the *area scan based 1-g SAR estimation* procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.

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	2023-08-04	2024-08-04
Dielectric Probe	SPEAG	DAKS-3.5	1051	2023-10-25	2024-10-25
Shorting Block	SPEAG	DAK-3.5 Short	SM DAK 200 DA	2023-10-25	2024-10-25
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	2024-03-29	2025-03-30

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Date	Cal. Due Date
Signal Generator	Keysight	N5181A	MY50140788	2023-08-03	2024-08-03
RF Power Meter	Keysight	N1912A	MY55136012	2023-08-04	2024-08-04
RF Power Sensor	Keysight	N1921A	MY55090030	2023-06-26	2024-06-26
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	2023-06-13	2024-06-13

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
Data Acquisition Electronics	SPEAG	DAE4	1714	2023-11-22	2024-11-22
Data Acquisition Electronics	SPEAG	DAE4	1715	2024-02-12	2025-02-12
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
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 Power Meter	Keysight	N1911a	MY55116001	2023-07-31	2024-07-31
RF Power Meter	Keysight	N1911a	MY55116002	2023-08-02	2024-08-02
RF Power Meter	Keysight	N1912a	MY55136012	2023-08-02	2024-08-02
RF Power Sensor	Keysight	N1921a	MY55120011	2023-07-31	2024-07-31
RF Power Sensor	Keysight	N1921a	MY55090025	2023-08-21	2024-08-21
RF Power Sensor	Keysight	N1921a	MY55090030	2023-06-30	2024-06-30
RF Power Sensor	Keysight	E9323A	MY55110008	2023-08-21	2024-08-21
RF Power Sensor	Boonton Electronics	RTP5008	12001	2023-08-01	2024-08-01
RF Power Sensor	Boonton Electronics	RTP5008	12002	2023-08-01	2024-08-01
RF Power Sensor	Boonton Electronics	RTP5008	11835	2023-08-01	2024-08-01
RF Power Sensor	Boonton Electronics	RTP5008	11997	2023-08-01	2024-08-01
RF Power Sensor	Boonton Electronics	RTP5008	11835	2023-08-01	2024-08-01
Base Station Simulator	R & S	CMW 500	170194	2023-06-06	2024-06-06
Base Station Simulator	Anritsu	MT8821C	6262116751	2023-06-05	2024-06-05
Base Station Simulator	Anritsu	MT8000A	6272354129	2023-06-09	2024-06-09

Note(s):

1. Equipment not used for calibrated measurements past calibration due date.
2. Equipment not used for calibrated measurements prior to the calibration.

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

Device Dimension	Overall (Length x Width): 50 mm x 50 mm This is a Small wearable device (When the factor is smaller than 9 cm × 5 cm)
Back Cover	The Back Cover is not removable
Battery Options	The rechargeable battery is not user accessible.
Test sample information	**S/N** — **Notes** 3467745272 — Conducted #1 3467745309 — Conducted #2 3467745401 — Radiated/SAR #1 3460648451 — Radiated/SAR #2
Hardware Version	0.02
Software Version	8.00

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, and LE	100.0% (GFSK) [1]
ANT+	2.4 GHz	GFSK	N/A[2]
NFC	13.56 MHz	Type A	N/A

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)

Refer to “SAR Photos and Ant locations” Appendix for the specific details of the antenna-to-antenna and antenna-to-edge(s) distances.

Wireless technologies	RF Exposure Conditions	DUT-to-User Separation	Test Position	Antenna-to-edge/surface	SAR Required	Note
WLAN, BT, ANT+, and NFC	Extremity (Hand/Wrist)	0	Back	N/A	Yes	

8. Dielectric Property Measurements & System Check

8.1. 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.
The dielectric constant (εr) and conductivity (σ) of typical tissue-equivalent media recipes are expected to be within ± 5% of the required target values; but for SAR measurement systems that have implemented the SAR error compensation algorithms documented in IEC/IEEE 62209-1528, to automatically compensate the measured SAR results for deviations between the measured and required tissue dielectric parameters, the tolerance for εr and σ may be relaxed to ± 10%. This is limited to frequencies ≤ 3 GHz.

Tissue Dielectric Parameters

FCC KDB 865664 D01 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

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
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 Measurements Results:

SAR Lab	Date	Band (MHz)	Tissue Type	Frequency (MHz)	Relative Permittivity (εr)			Conductivity (σ)		
					Measured	Target	Delta (%)	Measured	Target	Delta (%)
1A	2024-04-03	13	Head	13	53.3	55.0	-3.09	0.75	0.75	-0.37
				12	53.3	55.0	-3.09	0.75	0.75	-0.39
				14	53.3	55.0	-3.15	0.75	0.75	-0.37
2A	2024-04-02	2450	Head	2450	40.3	39.2	2.88	1.88	1.80	4.22
				2400	40.4	39.3	2.88	1.84	1.75	4.93
				2480	40.3	39.2	2.85	1.90	1.83	3.80
2A	2024-04-22	2450	Head	2450	39.6	39.2	0.94	1.84	1.80	2.39
				2400	39.7	39.3	0.92	1.81	1.75	3.27
				2480	39.5	39.2	0.94	1.87	1.83	1.89

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 ±10% of the manufacturer calibrated dipole SAR target. Refer to Appendix B for the SAR System Check Plots.

SAR Lab	Date	Tissue Type	Dipole Type_Serial #	Dipole Cal. Due Data	Dipole Power (dBm)	Measured Results for 1g SAR				Measured Results for 10g SAR				Plot No.
						Zoom Scan	Normalize to 1 W	Target (Ref. Value)	Delta ±10 %	Zoom Scan	Normalize to 1 W	Target (Ref. Value)	Delta ±10 %	
1A	2024-04-03	Head	CLA13 SN: 1017	2025-03-07	16.00	0.022	0.55	0.55	0.84	0.014	0.35	0.34	2.83	1
2A	2024-04-02	Head	D2450V2 SN: 963	2024-10-20	17.00	2.570	51.28	53.30	-3.79	1.200	23.94	25.10	-4.61	
2A	2024-04-22	Head	D2450V2 SN: 963	2024-10-20	17.00	2.530	50.48	53.30	-5.29	1.180	23.54	25.10	-6.20	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 DSSS (SISO)	20 MHz	1	2412	19.50
		2	2417	19.50
		3	2422	19.50
		4	2427	19.50
		5	2432	19.50
		6	2437	19.50
		7	2442	20.25
		8	2447	18.50
		9	2452	20.00
		10	2457	16.50
		11	2462	16.50
		12	2467	14.00
		13	2472	12.25
802.11g	20 MHz	1	2412	18.00
		2	2417	18.00
		3	2422	18.00
		4	2427	18.00
		5	2432	18.00
		6	2437	18.75
		7	2442	18.00
		8	2447	16.50
		9	2452	17.00
		10	2457	15.50
		11	2462	14.00
		12	2467	12.50
		13	2472	10.25
802.11n	20 MHz	1	2412	16.50
		2	2417	17.50
		3	2422	17.50
		4	2427	17.50
		5	2432	17.50
		6	2437	18.00
		7	2442	16.75
		8	2447	16.75
		9	2452	16.75
		10	2457	15.00
		11	2462	11.50
		12	2467	11.75
		13	2472	10.00

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	1	2412	18.2	19.50	Yes
		6	2437	18.8	19.50	
		7	2442	19.2	20.25	
		8	2447	17.4	18.50	
		9	2452	19.0	20.00	
		10	2457	15.5	16.50	
		11	2462	15.5	16.50	
OFDM 2.4 GHz	802.11g	1	2412	17.0	18.00	No
		6	2437	17.7	18.75	
		7	2442	17.1	18.00	
		8	2447	16.3	16.50	
		9	2452	15.9	17.00	
		10	2457	14.5	15.50	
		11	2462	12.9	14.00	
	802.11n (HT20)	1	2412	15.3	16.50	No
		2	2417	16.6	17.50	
		6	2437	16.9	18.00	
		7	2442	15.8	16.75	
		8	2447	15.8	16.75	
		9	2452	15.8	16.75	
		10	2457	14.0	15.00	
		11	2462	10.3	11.50	

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

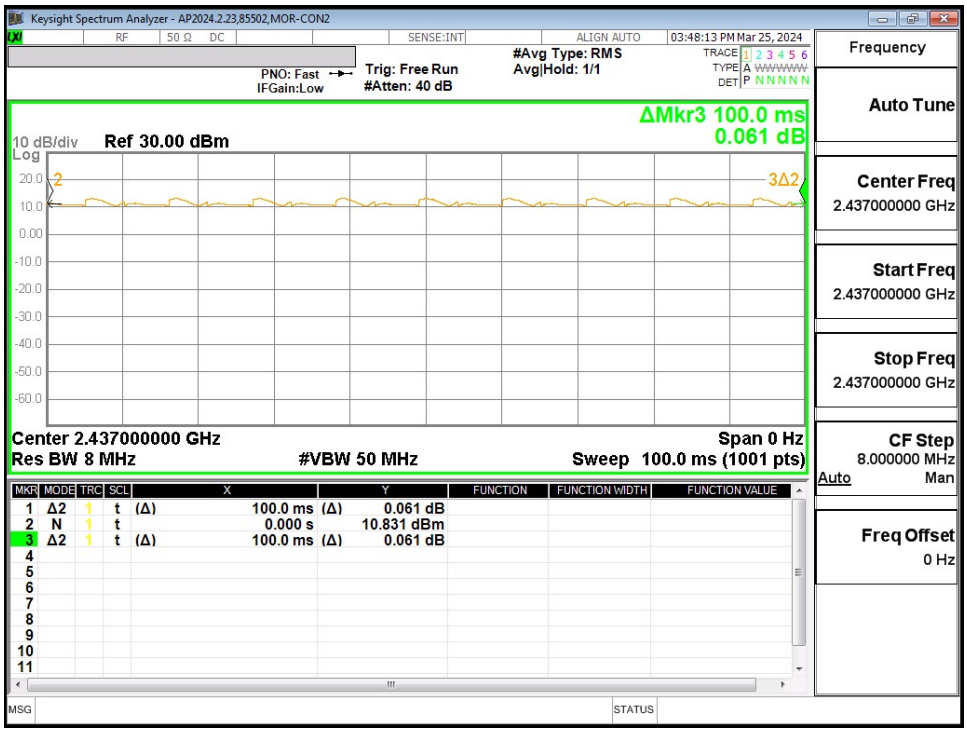
Mode	T on (ms)	Period (ms)	Duty Cycle	Crest Factor (1/duty cycle)
802.11b	100	100	100.00%	1.00

Note(s):

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

Duty Cycle plots

802.11b



9.2. Bluetooth

Maximum Output Power (Tune-up Limit) for Bluetooth

SAR measurement is not required for the EDR and LE. When the secondary mode is ≤ ¼ dB higher than the primary mode.

Band	Mode	Channel	Frequency (MHz)	Tune-up PowerLimit (dBm)
				Main Antenna
Bluetooth 2.4 GHz	BR	0	2402	15.5
		39	2441	15.5
		78	2480	15.5
	EDR	0	2402	15.0
		39	2441	15.0
		78	2480	15.0
	LE	0	2402	5.0
		17	2440	5.0
		39	2480	3.0

Bluetooth Measured Results

Band	Mode	Ch #	Freq. (MHz)	Main Antenna Average Power (dBm)		
				Meas Pwr	Tune-up	SAR Test (Yes/No)
Bluetooth 2.4 GHz	BR GFSK	0	2402	13.9	15.5	Yes
		39	2441	14.2	15.5	
		78	2480	14.5	15.5	
	EDR, π/4 DQPSK	0	2402	13.6	15.0	No
		39	2441	13.6	15.0	
		78	2480	13.9	15.0	
	EDR, 8-DPSK	0	2402	13.4	15.0	No
		39	2441	14.1	15.0	
		78	2480	13.3	15.0	
	LE, GFSK	0	2404	4.7	6.0	No
		17	2440	4.9	6.0	
		38	2478	1.7	3.0	

Duty Factor Measured Results

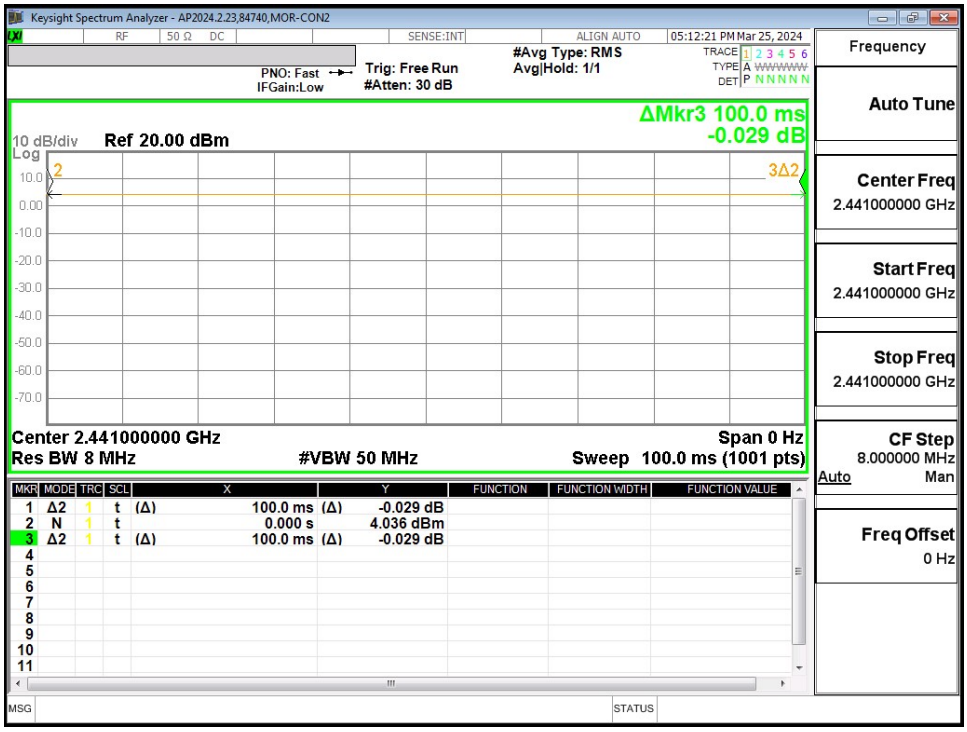
Mode	Type	T on (ms)	Period (ms)	Duty Cycle	Crest Factor (1/duty cycle)
GFSK	DH5	100	100	100.00%	1.00

Note(s):

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

Duty Cycle plots

GFSK



9.3. ANT+

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

Band	Mode	Frequency (MHz)	Tune-up PowerLimit (dBm)
			Main Antenna
ANT+	GFSK	2404	6.0
		2440	6.0
		2478	6.0

Band	Mode	Freq. (MHz)	Main Antenna Average Power (dBm)		
			Meas Pwr	Tune-up	SAR Test (Yes/No)
ANT+	GFSK	2404	4.7	6.0	Yes
		2440	5.0	6.0	
		2478	5.3	6.0	

Duty Factor Measured Results

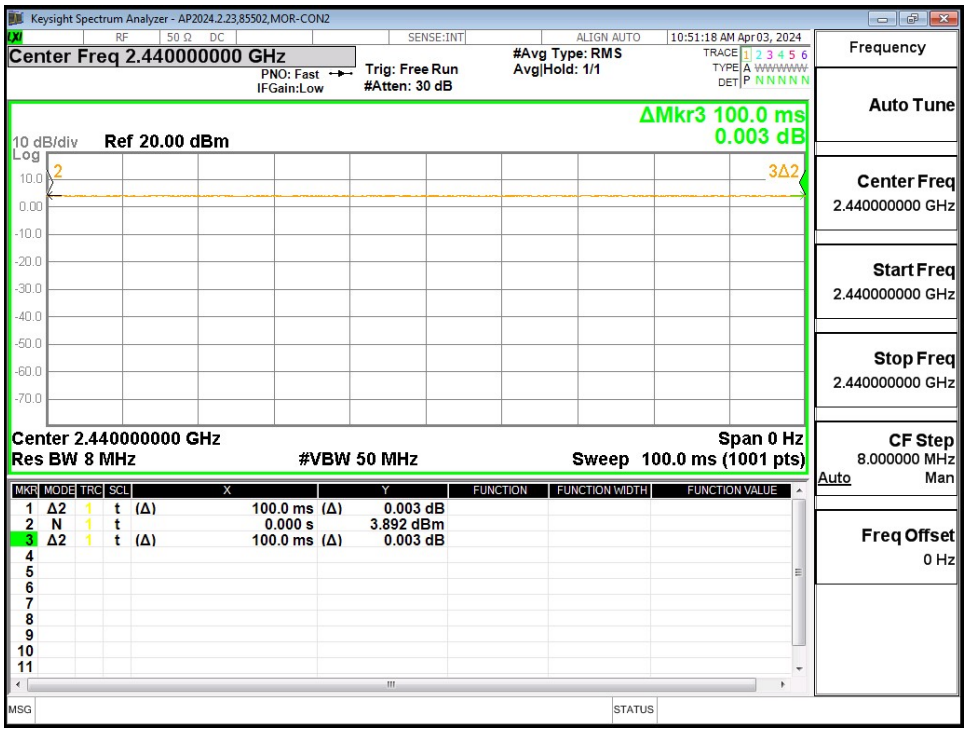
Mode	Type	T on (ms)	Period (ms)	Duty Cycle	Crest Factor (1/duty cycle)
GFSK	DH5	100	100	100.00%	1.00

Note(s):

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

Duty Cycle plots

GFSK



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 closet/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	Antenna	Power State	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Area Scan Max SAR (W/kg)	Duty Cycle	Power (dBm)		10-g SAR (W/kg)		Plot No.
										Tune-up Limit	Meas.	Meas.	Scaled	
Extremity	802.11b	Main Antenna	Default	0	Back	7	2442.0	0.558	100.0%	20.25	19.2	0.569	**0.725**	1

10.2. Bluetooth

RF Exposure Conditions	Mode	Antenna	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	Main Antenna	Default	0	Back	39	2441.0	15.5	14.2	0.090	**0.121**	2

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

10.4. 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:

[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)]·[√f(GHz)] ≤ 3.0, for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- $f_{(GHz)}$ 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.

When the standalone SAR test exclusion is applied to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to following to determine simultaneous transmission SAR test exclusion:

- *(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)]·[√$f_{(GHz)}$/x]* W/kg for test separation distances ≤ 50 mm;
  where x = 7.5 for 1-g SAR, and x = 18.75 for 10-g SAR.
- 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distances is > 50 mm.

RF Air interface	RF Exposure Conditions	Frequency (GHz)	Max. tune-up tolerance Power		Min. test separation distance (mm)	SAR test exclusion Result*	Estimated 1-g SAR (W/kg)
			(dBm)	(mW)			
ANT+	Extremity	2.440	6.0	4	5	1.2	0.167

Conclusion:

*: The computed value is ≤ 3; 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 (~ 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	Capable Transmit Configurations		
Extremity	1	Wi-Fi	+	NFC
	1	BT	+	NFC
	1	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 NFC & Wi-Fi

RF Exposure Conditions	SAR (W/kg)		Σ 10-g SAR (W/kg)
	Wi-Fi	NFC	Wi-Fi + NFC
	Main Antenna ①	NFC Antenna ②	① + ②
Body	0.725	0.000	**0.725**

12.3. Sum of the SAR for NFC & BT

RF Exposure Conditions	SAR (W/kg)		Σ 10-g SAR (W/kg)
	BT	NFC	BT + NFC
	Main Ant ①	NFC Antenna ②	① + ②
Body	0.121	0.000	**0.121**

12.4. Sum of the SAR for NFC & ANT+

RF Exposure Conditions	SAR (W/kg)		Σ 10-g SAR (W/kg)
	ANT+	NFC	ANT+ + NFC
	Main Antenna ①	NFC Antenna ②	① + ②
Body	0.167	0.000	**0.167**

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