



ELEMENT MATERIALS TECHNOLOGY

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RF EXPOSURE REPORT

Applicant Name:

Apple Inc.
One Apple Park Way
Cupertino, CA 95014 USA

Date of Testing:

11/14/2025 – 12/05/2025

Test Report Issue Date:

01/05/2026

Test Site/Location:

Element, Morgan Hill, CA, USA

Document Serial No.:

1C2504170045-04.BCG-R2

FCC ID:

BCGA2937

APPLICANT:

APPLE, INC.

DUT Type:

Location Tracking Tag

Application Type:

Certification

FCC Rule Part(s):

CFR §2.1093

Model:

A2937

Equipment Class	Band & Mode	Tx Frequency	SAR	
			1g Body (W/kg)	10g Extremity (W/kg)
DTS	2.4 GHz Bluetooth	2402 - 2480 MHz	0.42	0.19
NII	802.15.4ab-NB	5728.75 - 5846.25 MHz	0.36	0.09
Simultaneous SAR per KDB 690783 D01v01r03:			0.78	0.28
UWB	UWB	7987.2 MHz	N/A	N/A

Note: This revised Test Report supersedes and replaces the previously issued test report on the same subject device for the same type of testing as indicated. Please discard or destroy the previously issued test report(s) and dispose of it accordingly

This wireless portable device has been shown to be capable of compliance for localized specific absorption rate (SAR) for uncontrolled environment/general population exposure limits specified in ANSI/IEEE C95.1-1992 and has been tested in accordance with the measurement procedures specified in Section 1.6 of this report; for North American frequency bands only.

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them. Test results reported herein relate only to the item(s) tested.

RJ Ortanez

Executive Vice President



The SAR Tick is an initiative of the Mobile & Wireless Forum (MWF). While a product may be considered eligible, use of the SAR Tick logo requires an agreement with the MWF. Further details can be obtained by emailing: sartick@mwfai.info.

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Revision Summary

Revision	Description	Issue Date	Revised By:
-	Initial Release	12/11/2025	WKR019070
R1	Addressed Applicant's Comments	01/05/2026	WKR019070
R2	TCB Comments on scaled and simultaneous SAR	01/05/2026	WKR019070

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1 DEVICE UNDER TEST

1.1 Device Overview

Band & Mode	Operating Modes	Tx Frequency
2.4 GHz Bluetooth	Data	2402 - 2480 MHz
802.15.4ab-NB	Data	5731 - 5846.3 MHz
UWB	UWB	7987.2 MHz

1.2 Power Reduction for SAR

There is no power reduction used for any band/mode implemented in this device for SAR purposes.

1.3 Nominal and Maximum Output Power Specifications

This device operates using the following maximum and nominal output power specifications. SAR values were scaled to the maximum allowed power to determine compliance per KDB Publication 447498 D04v01.

1.3.1 Maximum Output Power

Mode / Band		Modulated Average - Single Tx Chain (dBm)
Bluetooth BLE	Maximum	8.00
	Nominal	6.50
802.15.4ab-NB	Maximum	17.00
	Nominal	15.00

1.4 DUT Antenna Locations

Based on the expected use conditions and conservative SAR test conditions, Body-worn SAR and Extremity SAR were evaluated. The antennas are located inside BCGA2937 – which is a location tracking tag. A diagram showing the location of the device antenna can be found in DUT Antenna Diagram and SAR Test Setup Photographs Appendix. More information about the configurations evaluated for SAR can be found in Section 4.2 and Section 4.3.

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1.5 Simultaneous Transmission Capabilities

According to FCC KDB Publication 447498 D04v01, transmitters are considered to be operating simultaneously when there is overlapping transmission, with the exception of transmissions during network hand-offs with maximum hand-off duration less than 30 seconds.

This device contains multiple transmitters that may operate simultaneously and therefore requires a simultaneous transmission analysis according to FCC KDB Publication 447498 D04v01 4.3.2 procedures.

Table 1-1
Simultaneous Transmission Scenarios

No.	Capable Transmit Configuration	Body-Worn	Extremity
1	2.4 GHz Bluetooth + UWB	Yes*	Yes*
2	2.4 GHz Bluetooth + 802.15.4 ab-NB	Yes*	Yes*

1. *Per October 2022 TCB Workshop, the 1 mW test exemption is allowed for 6-8.5 GHz UWB in multitransmitter end products. Since the maximum output power for UWB for this device is 0.05 mW which is less than 1 mW. No further evaluation for UWB is required.

1.6 Guidance Applied

- FCC KDB Publication 447498 D04v01 (General SAR Guidance)
- FCC KDB Publication 865664 D01v01r04, D02v01r02 (SAR Measurements up to 6 GHz)

1.7 Device Serial Numbers

Several samples with identical hardware were used to support SAR testing. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical, and thermal characteristics and are within operational tolerances expected for production units. The serial numbers used for each test are indicated alongside the results in Section 9.

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2 INTRODUCTION

The FCC and Innovation, Science, and Economic Development Canada have adopted the guidelines for evaluating the environmental effects of radio frequency (RF) radiation in ET Docket 93-62 on Aug. 6, 1996, and Health Canada Safety Code 6 to protect the public and workers from the potential hazards of RF emissions due to FCC-regulated portable devices. [1]

The safety limits used for the environmental evaluation measurements are based on the criteria published by the American National Standards Institute (ANSI) for localized specific absorption rate (SAR) in IEEE/ANSI C95.1-1992 Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz [3] and Health Canada RF Exposure Guidelines Safety Code 6 [22]. The measurement procedure described in IEEE/ANSI C95.3-2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave [4] is used for guidance in measuring the Specific Absorption Rate (SAR) due to the RF radiation exposure from the Equipment Under Test (EUT). These criteria for SAR evaluation are similar to those recommended by the International Committee for Non-Ionizing Radiation Protection (ICNIRP) in Biological Effects and Exposure Criteria for Radiofrequency Electromagnetic Fields,” Report No. Vol 74. SAR is a measure of the rate of energy absorption due to exposure to an RF transmitting source. SAR values have been related to threshold levels for potential biological hazards.

2.1 SAR Definition

Specific Absorption Rate is defined as the time derivative (rate) of the incremental energy (dU) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dV) of a given density (ρ). It is also defined as the rate of RF energy absorption per unit mass at a point in an absorbing body (see Equation 2-1).

Equation 2-1
SAR Mathematical Equation

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

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

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

where:

- σ = conductivity of the tissue-simulating material (S/m)
- ρ = mass density of the tissue-simulating material (kg/m³)
- E = Total RMS electric field strength (V/m)

NOTE: The primary factors that control rate of energy absorption were found to be the wavelength of the incident field in relation to the dimensions and geometry of the irradiated organism, the orientation of the organism in relation to the polarity of field vectors, the presence of reflecting surfaces, and whether conductive contact is made by the organism with a ground plane.[6]

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3 DOSIMETRIC ASSESSMENT

3.1 Measurement Procedure

The evaluation was performed using the following procedure compliant to FCC KDB Publication 865664 D01v01r04 and IEEE 1528-2013:

1. The SAR distribution at the exposed side of the head or body was measured at a distance no greater than 5.0 mm from the inner surface of the shell. The area covered the entire dimension of the device-head and body interface, and the horizontal grid resolution was determined per FCC KDB Publication 865664 D01v01r04 (See Table 3-1) and IEEE 1528-2013.
2. The point SAR measurement was taken at the maximum SAR region determined from Step 1 to enable the monitoring of SAR fluctuations/drifts during the 1g/10g cube evaluation. SAR at this fixed point was measured and used as a reference value.
3. Based on the area scan data, the peak of the region with maximum SAR was determined by spline interpolation. Around this point, a volume was assessed according to the measurement resolution and volume size requirements of FCC KDB Publication 865664 D01v01r04 (See Table 3-1) and IEEE 1528-2013. On the basis of this data set, the spatial peak SAR value was evaluated with the following procedure (see references or the cDASY6 manual online for more details):
 - a. SAR values at the inner surface of the phantom are extrapolated from the measured values along the line away from the surface with spacing no greater than that in Table 3-1. The extrapolation was based on a least-squares algorithm. A polynomial of the fourth order was calculated through the points in the z-axis (normal to the phantom shell).
 - b. After the maximum interpolated values were calculated between the points in the cube, the SAR was averaged over the spatial volume (1g or 10g) using a 3D-Spline interpolation algorithm. The 3D-spline is composed of three one-dimensional splines with the “Not a knot” condition (in x, y, and z directions). The volume was then integrated with the trapezoidal algorithm. One thousand points (10 x 10 x 10) were obtained through interpolation, in order to calculate the averaged SAR.
 - c. All neighboring volumes were evaluated until no neighboring volume with a higher average value was found.
4. The SAR reference value, at the same location as step 2, was re-measured after the zoom scan was complete to calculate the SAR drift. If the drift deviated by more than 5%, the SAR test and drift measurements were repeated.

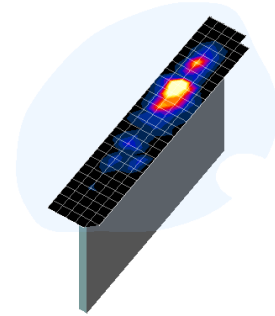


Figure 3-1
Sample SAR Area
Scan

Table 3-1
Area and Zoom Scan Resolutions per FCC KDB Publication 865664 D01v01r04*

Frequency	Maximum Area Scan Resolution (mm) ($\Delta x_{\text{area}}, \Delta y_{\text{area}}$)	Maximum Zoom Scan Resolution (mm) ($\Delta x_{\text{zoomTV}}, \Delta y_{\text{zoom}}$)	Maximum Zoom Scan Spatial Resolution (mm)			Minimum Zoom Scan Volume (mm) (x,y,z)
			Uniform Grid	Graded Grid		
				$\Delta z_{\text{zoom}}(n)$	$\Delta z_{\text{zoom}}(1)^*$	
≤ 2 GHz	≤ 15	≤ 8	≤ 5	≤ 4	≤ 1.5* $\Delta z_{\text{zoom}}(n-1)$	≥ 30
2-3 GHz	≤ 12	≤ 5	≤ 5	≤ 4	≤ 1.5* $\Delta z_{\text{zoom}}(n-1)$	≥ 30
3-4 GHz	≤ 12	≤ 5	≤ 4	≤ 3	≤ 1.5* $\Delta z_{\text{zoom}}(n-1)$	≥ 28
4-5 GHz	≤ 10	≤ 4	≤ 3	≤ 2.5	≤ 1.5* $\Delta z_{\text{zoom}}(n-1)$	≥ 25
5-6 GHz	≤ 10	≤ 4	≤ 2	≤ 2	≤ 1.5* $\Delta z_{\text{zoom}}(n-1)$	≥ 22

*Also compliant to IEEE 1528-2013 Table 6

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4 TEST CONFIGURATION POSITIONS

4.1 Device Holder

The device holder is made out of low-loss POM material having the following dielectric parameters: relative permittivity $\epsilon = 3$ and loss tangent $\delta = 0.02$.

4.2 Body-Worn Exposure Conditions

Devices containing one or more wireless transmitters or transceivers with intended use that includes transmitting with any portion of the device being held directly against a user's body. The DUT was evaluated with a separation distance of 0 mm between the back and front sides of the device and the flat phantom. The phantom is filled with head tissue equivalent medium.

4.3 Extremity Exposure Conditions

Devices that designed or intended for use on extremities or mainly operated in extremity only exposure conditions: i.e., hands, wrists, feet and ankles, may require extremity SAR evaluation. Based on the expected use conditions, extremity SAR was evaluated with the back and front sides of the device touching the flat phantom. The phantom is filled with head tissue-equivalent medium.

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5 RF EXPOSURE LIMITS

5.1 Uncontrolled Environment

UNCONTROLLED ENVIRONMENTS are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

5.2 Controlled Environment

CONTROLLED ENVIRONMENTS are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e., as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

Table 5-1
SAR Human Exposure Specified in ANSI/IEEE C95.1-1992 and Health Canada Safety Code 6

HUMAN EXPOSURE LIMITS		
	UNCONTROLLED ENVIRONMENT <i>General Population</i> (W/kg) or (mW/g)	CONTROLLED ENVIRONMENT <i>Occupational</i> (W/kg) or (mW/g)
Peak Spatial Average SAR Head	1.6	8.0
Whole Body SAR	0.08	0.4
Peak Spatial Average SAR Hands, Feet, Ankle, Wrists, etc.	4.0	20

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

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6 FCC MEASUREMENT PROCEDURES

6.1 Measured and Reported SAR

Per FCC KDB Publication 447498 D04v01, when SAR is not measured at the maximum power level allowed for production units, the results must be scaled to the maximum tune-up tolerance limit according to the power applied to the individual channels tested to determine compliance. For simultaneous transmission, the measured aggregate SAR must be scaled according to the sum of the differences between the maximum tune-up tolerance and actual power used to test each transmitter. When SAR is measured at or scaled to the maximum tune-up tolerance limit, the results are referred to as *reported* SAR. The highest *reported* SAR results are identified on the grant of equipment authorization according to procedures in KDB 690783 D01v01r03.

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7 RF CONDUCTED POWERS

7.1 Bluetooth/802.15.4ab-NB Conducted Powers

Table 7-1
2.4 GHz Bluetooth Average RF Power

Frequency [MHz]	Modulation	Data Rate [Mbps]	Channel No.	Avg Conducted Power	
				[dBm]	[mW]
2402	GFSK	1.0	0	7.12	5.152
2440	GFSK	1.0	19	7.29	5.358
2480	GFSK	1.0	39	7.37	5.458

Table 7-2
802.15.4ab-NB Average RF Power

Type	Band	Frequency	Channel	Average
802.15.4ab-NB	U-NII 3	5728.75	Low	15.97
		5786.25	Mid	15.92
		5846.25	High	15.81

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7.2 Bluetooth/802.15.4ab-NB Duty Cycle Plots

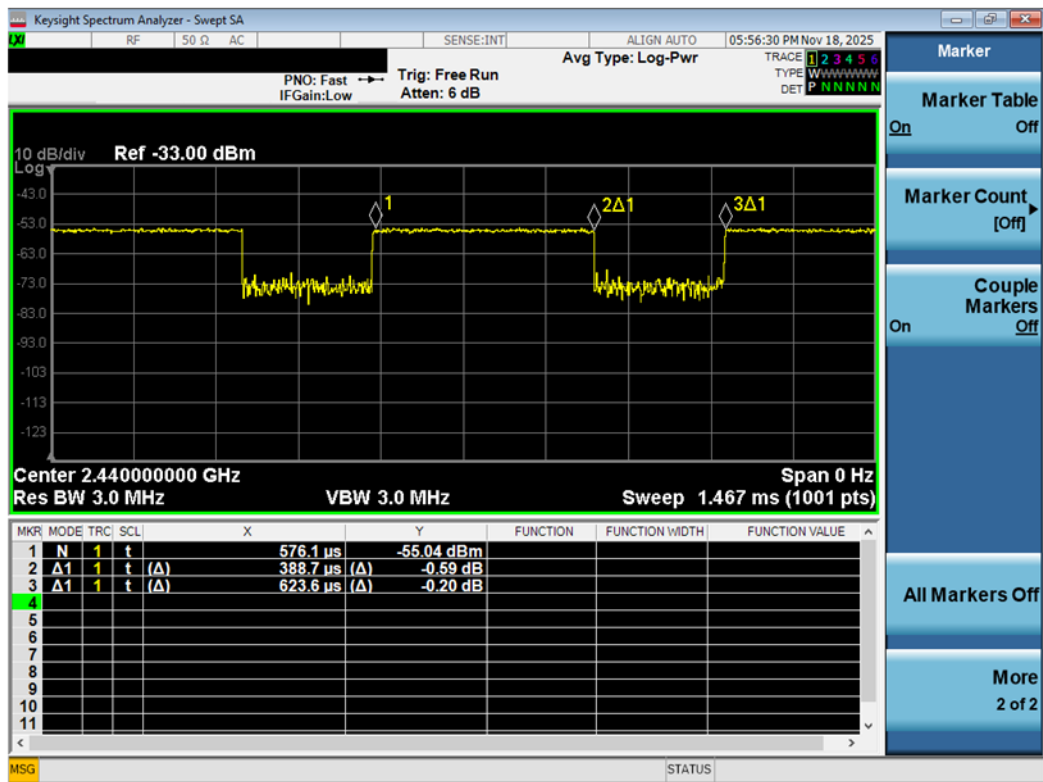


Figure 7-1
2.4 GHz Bluetooth Transmission Plot

Equation 7-1
2.4 GHz Bluetooth Duty Cycle Calculation

$$Duty\ Cycle = \frac{Pulse\ Width}{Period} * 100\% = \frac{0.3887\ ms}{0.6236\ ms} * 100\% = 62.33\%$$

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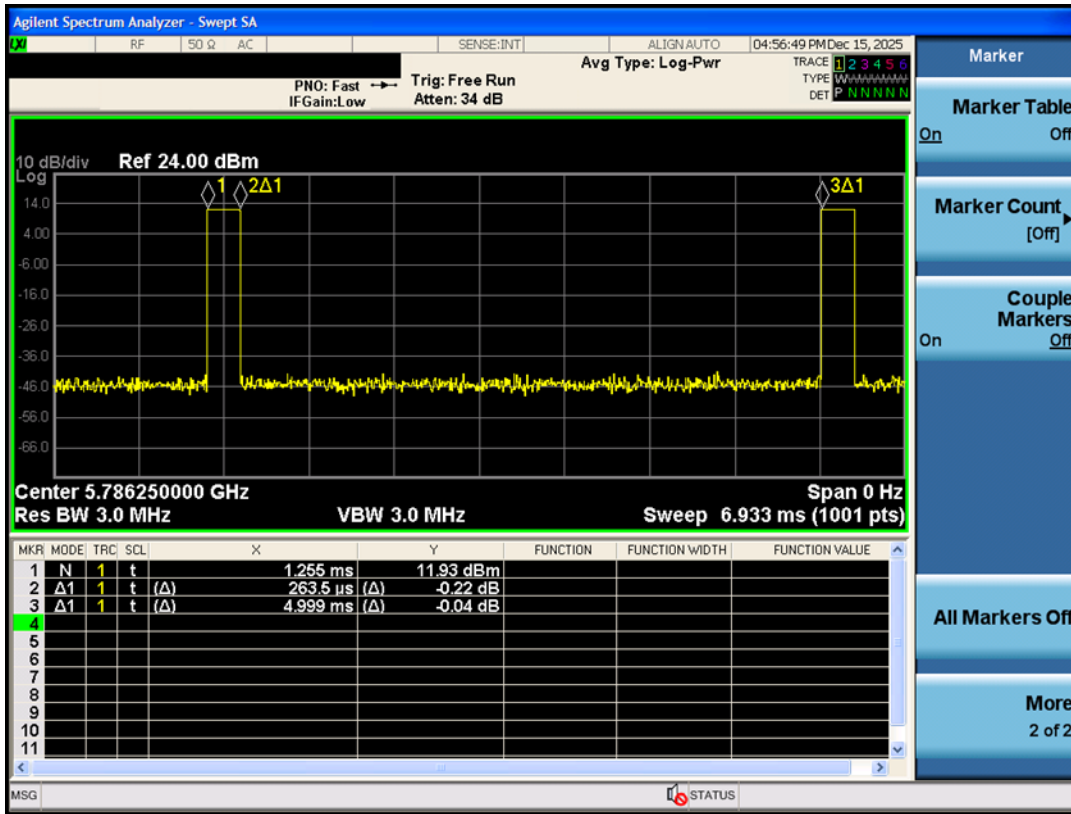


Figure 7-2
802.15.4ab-NB Transmission Plot

Equation 7-2
802.15.4ab-NB Duty Cycle Calculation

$$\text{Duty Cycle} = \frac{\text{Pulse Width}}{\text{Period}} * 100\% = \frac{0.2635 \text{ ms}}{4.999 \text{ ms}} * 100\% = 5.27\%$$

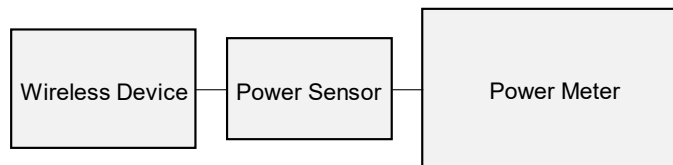


Figure 7-3
Power Measurement Setup

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8 SYSTEM VERIFICATION

8.1 Tissue Verification

Table 8-1
Measured Head Tissue Properties

Calibrated for Tests Performed on:	Tissue Type	Tissue Temp During Calibration (°C)	Measured Frequency (MHz)	Measured Conductivity, σ (S/m)	Measured Dielectric Constant, ϵ	TARGET Conductivity, σ (S/m)	TARGET Dielectric Constant, ϵ	% dev σ	% dev ϵ
11/14/2025	2450 Head	20.5	2300	1.670	39.164	1.670	39.500	0.00%	-0.85%
			2310	1.678	39.156	1.679	39.480	-0.06%	-0.82%
			2320	1.685	39.143	1.687	39.460	-0.12%	-0.80%
			2400	1.745	38.990	1.756	39.289	-0.63%	-0.76%
			2450	1.778	38.916	1.800	39.200	-1.22%	-0.72%
			2480	1.801	38.834	1.833	39.162	-1.75%	-0.84%
			2500	1.819	38.805	1.855	39.136	-1.94%	-0.85%
			2510	1.828	38.800	1.866	39.123	-2.04%	-0.83%
			2535	1.846	38.785	1.893	39.092	-2.48%	-0.79%
			2550	1.855	38.760	1.909	39.073	-2.83%	-0.80%
			2560	1.861	38.737	1.920	39.060	-3.07%	-0.83%
			2600	1.894	38.634	1.964	39.009	-3.56%	-0.96%
			2650	1.933	38.604	2.018	38.945	-4.21%	-0.88%
			2680	1.952	38.536	2.051	38.907	-4.83%	-0.95%
			2700	1.970	38.482	2.073	38.882	-4.97%	-1.03%

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Calibrated for Tests Performed on:	Tissue Type	Tissue Temp During Calibration (°C)	Measured Frequency (MHz)	Measured Conductivity, σ (S/m)	Measured Dielectric Constant, ϵ	TARGET Conductivity, σ (S/m)	TARGET Dielectric Constant, ϵ	% dev σ	% dev ϵ
12/5/2025	5200-5800 Head	19.5	5150	4.497	36.235	4.608	36.050	-2.41%	0.51%
			5160	4.508	36.220	4.618	36.040	-2.38%	0.50%
			5170	4.518	36.200	4.629	36.030	-2.40%	0.47%
			5180	4.528	36.175	4.635	36.009	-2.31%	0.46%
			5190	4.540	36.153	4.645	35.998	-2.26%	0.43%
			5200	4.551	36.133	4.655	35.986	-2.23%	0.41%
			5210	4.560	36.116	4.666	35.975	-2.27%	0.39%
			5220	4.570	36.101	4.676	35.963	-2.27%	0.38%
			5240	4.593	36.063	4.696	35.940	-2.19%	0.34%
			5250	4.603	36.054	4.706	35.929	-2.19%	0.35%
			5260	4.611	36.045	4.717	35.917	-2.25%	0.36%
			5270	4.622	36.022	4.727	35.906	-2.22%	0.32%
			5280	4.634	35.988	4.737	35.894	-2.17%	0.26%
			5290	4.647	35.961	4.748	35.883	-2.13%	0.22%
			5300	4.659	35.952	4.758	35.871	-2.08%	0.23%
			5310	4.669	35.940	4.768	35.860	-2.08%	0.22%
			5320	4.677	35.923	4.778	35.849	-2.11%	0.21%
			5500	4.862	35.605	4.963	35.643	-2.04%	-0.11%
			5510	4.872	35.592	4.973	35.632	-2.03%	-0.11%
			5520	4.882	35.570	4.983	35.620	-2.03%	-0.14%
			5530	4.892	35.541	4.994	35.609	-2.04%	-0.19%
			5540	4.904	35.519	5.004	35.597	-2.00%	-0.22%
			5550	4.914	35.512	5.014	35.586	-1.99%	-0.21%
			5560	4.925	35.504	5.024	35.574	-1.97%	-0.20%
			5580	4.950	35.466	5.045	35.551	-1.88%	-0.24%
			5600	4.977	35.430	5.065	35.529	-1.74%	-0.28%
			5610	4.988	35.416	5.076	35.518	-1.73%	-0.29%
			5620	4.999	35.394	5.086	35.506	-1.71%	-0.32%
			5640	5.022	35.349	5.106	35.483	-1.65%	-0.38%
			5660	5.046	35.326	5.127	35.460	-1.58%	-0.38%
			5670	5.057	35.314	5.137	35.449	-1.56%	-0.38%
			5680	5.070	35.299	5.147	35.437	-1.50%	-0.39%
			5690	5.084	35.283	5.158	35.426	-1.43%	-0.40%
			5700	5.098	35.264	5.168	35.414	-1.35%	-0.42%
			5710	5.111	35.246	5.178	35.403	-1.29%	-0.44%
			5720	5.124	35.225	5.188	35.391	-1.23%	-0.47%
			5745	5.147	35.181	5.214	35.363	-1.29%	-0.51%
			5750	5.151	35.166	5.219	35.357	-1.30%	-0.54%
			5755	5.157	35.154	5.224	35.351	-1.28%	-0.56%
			5765	5.169	35.136	5.234	35.340	-1.24%	-0.58%
			5775	5.185	35.126	5.245	35.329	-1.14%	-0.57%
			5785	5.199	35.124	5.255	35.317	-1.07%	-0.55%
			5795	5.214	35.107	5.265	35.305	-0.97%	-0.56%
			5800	5.221	35.101	5.270	35.300	-0.93%	-0.56%
			5805	5.229	35.091	5.275	35.294	-0.87%	-0.58%
			5825	5.253	35.055	5.296	35.271	-0.81%	-0.61%
			5835	5.263	35.038	5.305	35.230	-0.79%	-0.54%
			5845	5.274	35.015	5.315	35.210	-0.77%	-0.55%
			5850	5.281	35.002	5.320	35.200	-0.73%	-0.56%
			5855	5.286	34.996	5.325	35.197	-0.73%	-0.57%
			5865	5.300	34.979	5.336	35.190	-0.67%	-0.60%
			5875	5.311	34.969	5.347	35.183	-0.67%	-0.61%
			5885	5.322	34.958	5.357	35.177	-0.65%	-0.62%
			5905	5.348	34.923	5.379	35.163	-0.58%	-0.68%

Note: Per April 2019 TCB Workshop Notes, single head-tissue simulating liquid specified in IEC 62209-1 is permitted to use for all SAR tests.

The above measured tissue parameters were used in the cDASY6 software. The cDASY6 software was used to perform interpolation to determine the dielectric parameters at the SAR test device frequencies (per KDB Publication 865664 D01v01r04 and IEEE 1528-2013 6.6.1.2). The tissue parameters listed in the SAR test plots may slightly differ from the table above due to significant digit rounding in the software.

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8.2 Test System Verification

Prior to SAR assessment, the system is verified to $\pm 10\%$ of the SAR measurement on the reference dipole at the time of calibration by the calibration facility. Full system validation status and result summary can be found in the SAR System Validation Appendix.

Table 8-2
System Verification Results

System Verification TARGET & MEASURED																	
SAR System	Tissue Frequency (MHz)	Tissue Type	Date	Amb. Temp. (°C)	Liquid Temp. (°C)	Input Power (W)	Source SN	Probe SN	DAE	Measured SAR 1g (W/kg)	1W Target SAR 1g (W/kg)	1W Normalized SAR 1g (W/kg)	Deviation 1g (%)	Measured SAR 10g (W/kg)	1W Target SAR 10g (W/kg)	1W Normalized SAR 10g (W/kg)	Deviation 10g (%)
AM7	2450	HEAD	11/14/2025	22.1	20.4	0.10	750	7490	1644	5.040	53.300	50.400	-5.44%	2.37	25.10	23.70	-5.58%
AM9	5250	HEAD	12/05/2025	22.1	20.2	0.05	1123	7668	1681	3.860	80.200	77.200	-3.74%	1.11	22.90	22.20	-3.06%
AM9	5600	HEAD	12/05/2025	22.1	20.2	0.05	1123	7668	1681	4.190	82.100	83.800	2.07%	1.19	23.50	23.80	1.28%
AM9	5750	HEAD	12/05/2025	22.1	20.2	0.05	1123	7668	1681	3.900	78.500	78.000	-0.64%	1.12	22.30	22.40	0.45%
AM9	5850	HEAD	12/05/2025	22.1	20.2	0.05	1123	7668	1681	4.050	82.300	81.000	-1.58%	1.15	23.40	23.00	-1.71%

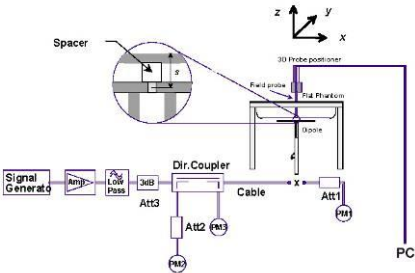


Figure 8-1
System Verification Setup Diagram



Figure 8-2
System Verification Setup Photo

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9

SAR DATA SUMMARY

9.1 2.4 GHz Bluetooth Standalone Body-Worn SAR

Table 9-1

Exposure	Band / Mode	Service / Modulation	Serial Number	Duty Cycle [%]	Power Drift [dB]	Frequency [MHz]	Channel #	Data Rate [Mbps]	Max Allowed Power [dBm]	Conducted Power [dBm]	Test Position	Spacing [mm]	Measured 1g SAR [W/kg]	Power Scaling Factor	Duty Cycle Scaling Factor	Reported 1g SAR [W/kg]	Exposure Ratio (1g SAR)	Plot #
Body-Worn	2.4 GHz Bluetooth LE	GFSK	CKT7JL69W	62.33	-0.01	2480	39	1	8.00	7.37	Back	0	0.090	1.156	1.604	0.167	0.104	
Body-Worn	2.4 GHz Bluetooth LE	GFSK	CKT7JL69W	62.33	0.00	2402	0	1	8.00	7.12	Front	0	0.208	1.225	1.604	0.409	0.256	
Body-Worn	2.4 GHz Bluetooth LE	GFSK	CKT7JL69W	62.33	-0.03	2440	19	1	8.00	7.29	Front	0	0.223	1.178	1.604	0.424	0.263	A1
Body-Worn	2.4 GHz Bluetooth LE	GFSK	CKT7JL69W	62.33	-0.12	2480	39	1	8.00	7.37	Front	0	0.210	1.156	1.604	0.389	0.243	
ANSI/IEEE C95.1 1992 - SAFETY LIMIT											Body							
Spatial Peak											1.6 W/kg (mW/g)							
Uncontrolled Exposure/General Population											averaged over 1 gram							

Note: The reported SAR was scaled to 100% transmission duty factor.

9.2 802.15.4ab-NB Standalone Body-Worn SAR

Table 9-2

Exposure	Band / Mode	Service / Modulation	Serial Number	Duty Cycle [%]	Power Drift [dB]	Frequency [MHz]	Channel #	Data Rate [Mbps]	Max Allowed Power [dBm]	Conducted Power [dBm]	Test Position	Spacing [mm]	Measured 1g SAR [W/kg]	Power Scaling Factor	Duty Cycle Scaling Factor	Reported 1g SAR [W/kg]	Exposure Ratio (1g SAR)	Plot #
Body-Worn	802.15.4ab-NB	O-QPSK	CKT7JL69W	5.27	0.07	5729	Low	1	17.00	15.97	Back	0	0.035	1.268	1.689	0.075	0.047	
Body-Worn	802.15.4ab-NB	O-QPSK	CKT7JL69W	5.27	0.04	5846	High	1	17.00	15.81	Front	0	0.162	1.315	1.689	0.360	0.225	A2
Body-Worn	802.15.4ab-NB	O-QPSK	CKT7JL69W	5.27	0.04	5729	Low	1	17.00	15.97	Front	0	0.140	1.268	1.689	0.300	0.188	
Body-Worn	802.15.4ab-NB	O-QPSK	CKT7JL69W	5.27	0.09	5786	Mid	1	17.00	15.92	Front	0	0.161	1.282	1.689	0.349	0.218	
ANSI/IEEE C95.1 1992 - SAFETY LIMIT											Body							
Spatial Peak											1.6 W/kg (mW/g)							
Uncontrolled Exposure/General Population											averaged over 1 gram							

Note: The reported SAR was scaled to 8.9% transmission duty factor.

9.3 2.4 GHz Bluetooth Standalone Extremity SAR

Table 9-3

Exposure	Band / Mode	Service / Modulation	Serial Number	Duty Cycle [%]	Power Drift [dB]	Frequency [MHz]	Channel #	Data Rate [Mbps]	Max Allowed Power [dBm]	Conducted Power [dBm]	Test Position	Spacing [mm]	Measured 10g SAR [W/kg]	Power Scaling Factor	Duty Cycle Scaling Factor	Reported 10g SAR [W/kg]	Exposure Ratio (10g SAR)	Plot #
Extremity	2.4 GHz Bluetooth LE	GFSK	CKT7JL69W	62.33	-0.01	2480	39	1	8.00	7.37	Back	0	0.042	1.156	1.604	0.078	0.020	
Extremity	2.4 GHz Bluetooth LE	GFSK	CKT7JL69W	62.33	0.00	2402	0	1	8.00	7.12	Front	0	0.095	1.225	1.604	0.187	0.047	
Extremity	2.4 GHz Bluetooth LE	GFSK	CKT7JL69W	62.33	-0.03	2440	19	1	8.00	7.29	Front	0	0.102	1.178	1.604	0.193	0.048	A1
Extremity	2.4 GHz Bluetooth LE	GFSK	CKT7JL69W	62.33	-0.12	2480	39	1	8.00	7.37	Front	0	0.096	1.156	1.604	0.178	0.045	
ANSI/IEEE C95.1 1992 - SAFETY LIMIT											Extremity							
Spatial Peak											4.0 W/kg (mW/g)							
Uncontrolled Exposure/General Population											averaged over 10 grams							

Note: The reported SAR was scaled to 100% transmission duty factor

9.4 802.15.4ab-NB Standalone Extremity SAR

Table 9-4

Exposure	Band / Mode	Service / Modulation	Serial Number	Duty Cycle [%]	Power Drift [dB]	Frequency [MHz]	Channel #	Data Rate [Mbps]	Max Allowed Power [dBm]	Conducted Power [dBm]	Test Position	Spacing [mm]	Measured 10g SAR [W/kg]	Power Scaling Factor	Duty Cycle Scaling Factor	Reported 10g SAR [W/kg]	Exposure Ratio (10g SAR)	Plot #
Extremity	802.15.4ab-NB	O-QPSK	CKT7JL69W	5.27	0.07	5729	Low	1	17.00	15.97	Back	0	0.007	1.268	1.689	0.015	0.004	
Extremity	802.15.4ab-NB	O-QPSK	CKT7JL69W	5.27	0.04	5846	High	1	17.00	15.81	Front	0	0.039	1.315	1.689	0.087	0.022	
Extremity	802.15.4ab-NB	O-QPSK	CKT7JL69W	5.27	0.04	5729	Low	1	17.00	15.97	Front	0	0.030	1.268	1.689	0.064	0.016	
Extremity	802.15.4ab-NB	O-QPSK	CKT7JL69W	5.27	0.09	5786	Mid	1	17.00	15.92	Front	0	0.040	1.282	1.689	0.087	0.022	A3
ANSI/IEEE C95.1 1992 - SAFETY LIMIT											Extremity							
Spatial Peak											4.0 W/kg (mW/g)							
Uncontrolled Exposure/General Population											averaged over 10 grams							

Note: The reported SAR was scaled to 8.9% transmission duty factor.

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9.5 SAR Test Notes

General Notes:

1. Batteries are fully charged at the beginning of the SAR measurements.
2. Liquid tissue depth was at least 15.0 cm for all frequencies.
3. The manufacturer has confirmed that the device(s) tested have the same physical, mechanical, and thermal characteristics and are within operational tolerances expected for production units.
4. SAR results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB Publication 447498 D04v01.
5. Per FCC KDB Publication 865664 D01v01r04, variability SAR tests were not required since measured
6. Unless otherwise noted, when 10g SAR measurement is considered, a factor of 2.5 is applied to the thresholds below.
7. The orange highlights throughout the report represent the highest scaled SAR per Equipment Class.

Bluetooth Notes

1. The reported SAR was scaled to the 100% transmission duty factor to determine compliance for a more conservative exposure analysis. See section 7.2 for the time domain plot and calculation for the duty factor of the device.

802.15.4ab-NB Notes:

1. 802.15.4 ab-NB SAR was scaled to the 8.9% transmission duty factor to determine compliance since the duty factor of the device is limited to 8.9% per manufacturer. See Section 7.2 for the time domain plot and calculation for the duty factor of the device.

UWB notes:

1. Per October 2022 TCB Workshop, the 1 mW test exemption is allowed for 6-8.5 GHz UWB in multitransmitter end products. Since the maximum output power for UWB for this device is 0.05 mW which is less than 1 mW. No further evaluation for UWB is required.

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10 SAR MEASUREMENT VARIABILITY

10.1 Measurement Variability

Per FCC KDB Publication 865664 D01v01r04, variability SAR tests were not required since measured SAR results for all frequency bands were less than 0.8 W/kg and 2.0 W/kg for 10g SAR.

10.2 Measurement Uncertainty

The measured SAR was <1.5 W/kg for 1g and <3.75 W/kg for 10g for all frequency bands. Therefore, per KDB Publication 865664 D01v01r04, the extended measurement uncertainty analysis per IEEE 1528-2013 was not required.

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11 EQUIPMENT LIST

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
Agilent	E4404B	Spectrum Analyzer	N/A	N/A	N/A	MY45113242
Agilent	N5182A	MXG Vector Signal Generator	5/30/2025	Annual	5/30/2026	MY48180366
Agilent	8753ES	S-Parameter Vector Network Analyzer	1/6/2025	Annual	1/6/2026	MY40001472
Agilent	E5515C	Wireless Communications Test Set	CBT	N/A	CBT	GB46310798
Agilent	N4010A	Wireless Connectivity Test Set	N/A	N/A	N/A	GB46170464
Amplifier Research	150A100C	Amplifier	CBT	N/A	CBT	350132
Anritsu	MN8110B	I/O Adaptor	CBT	N/A	CBT	6261747881
Anritsu	ML2496A	Power Meter	6/27/2025	Annual	6/27/2026	1840005
Anritsu	MA2411B	Pulse Power Sensor	10/14/2025	Annual	10/14/2026	1726262
Insize	1108-150	Insize - Digital Caliper	2/25/2025	Annual	2/25/2026	711245294
Anritsu	MA24106A	USB Power Sensor	8/4/2025	Annual	8/4/2026	1827530
Control Company	4052	Long Stem Thermometer	2/27/2024	Biennial	2/27/2026	240171059
Control Company	4040	Therm./ Clock/ Humidity Monitor	7/17/2025	Biennial	7/17/2027	250440182
Agilent	N9020A	MXA Signal Analyzer	7/7/2025	Biennial	7/7/2027	MY56470202
MCL	BW-N6W5+	6dB Attenuator	CBT	N/A	CBT	1139
Mini-Circuits	VLF-6000+	Low Pass Filter DC to 6000 MHz	7/3/2025	Annual	7/3/2026	31634
Mini-Circuits	BW-N20W5+	DC to 18 GHz Precision Fixed 20 dB Attenuator	CBT	N/A	CBT	N/A
Mini-Circuits	NLP-2950+	Low Pass Filter DC to 2700 MHz	CBT	N/A	CBT	N/A
Mini-Circuits	BW-N20W5	Power Attenuator	CBT	N/A	CBT	1226
Mini-Circuits	ZUDC10-83-S+	Directional Coupler	CBT	N/A	CBT	2050
Narda	BW-S3W2	Attenuator (3dB)	CBT	N/A	CBT	120
Pasternack	NC-100	Torque Wrench	5/29/2025	Biennial	5/29/2027	N/A
SPEAG	DAK-3.5	Dielectric Assessment Kit	11/10/2025	Annual	11/10/2026	1277
SPEAG	DAKS-3.5	Portable Dielectric Assessment Kit	8/5/2025	Annual	8/5/2026	1041
SPEAG	MAIA	Modulation and Audio Interference Analyzer	N/A	N/A	N/A	1237
SPEAG	MAIA	Modulation and Audio Interference Analyzer	N/A	N/A	N/A	1331
SPEAG	DAK-12	Dielectric Assessment Kit (4MHz - 3GHz)	3/10/2025	Annual	3/10/2026	1102
GW Instek	GPS-3030DD	DC Power Supply	N/A	N/A	N/A	E1883874
SPEAG	D2450V2	2450 MHz SAR Dipole	5/13/2025	Annual	5/13/2026	750
SPEAG	D5GHzV2	5 GHz SAR Dipole	8/6/2025	Annual	8/6/2026	1123
SPEAG	DAE4	Dasy Data Acquisition Electronics	8/8/2025	Annual	8/8/2026	1681
SPEAG	EX3DV4	SAR Probe	8/11/2025	Annual	8/11/2026	7668
SPEAG	EX3DV4	SAR Probe	12/9/2024	Annual	12/9/2025	7490
SPEAG	DAE4	Dasy Data Acquisition Electronics	12/4/2024	Annual	12/4/2025	1644

Note: CBT (Calibrated Before Testing). Prior to testing, the measurement paths containing a cable, amplifier, attenuator, coupler, or filter were connected to a calibrated source (i.e., a signal generator) to determine the losses of the measurement path. The power meter offset was then adjusted to compensate for the measurement system losses. This level offset is stored within the power meter before measurements are made. This calibration verification procedure applies to the system verification and output power measurements. The calibrated reading is then taken directly from the power meter after compensation of the losses for all final power measurements. All equipment was used solely within its respective calibration period.

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12 MEASUREMENT UNCERTAINTIES

a	b	c	d	e= f(d,k)	f	g	h = c x f/e	i = c x g/e	k
Uncertainty Component	IEEE 1528 Sec.	Tol. (± %)	Prob. Dist.	Div.	c _i 1gm	c _i 10 gms	1gm u _i (± %)	10gms u _i (± %)	v _i
Measurement System									
Probe Calibration	E2.1	7	N	1	1	1	7.0	7.0	∞
Axial Isotropy	E2.2	0.25	N	1	0.7	0.7	0.2	0.2	∞
Hemishperical Isotropy	E2.2	1.3	N	1	0.7	0.7	0.9	0.9	∞
Boundary Effect	E2.3	2	R	1.732	1	1	1.2	1.2	∞
Linearity	E2.4	0.3	N	1	1	1	0.3	0.3	∞
System Detection Limits	E2.4	0.25	R	1.732	1	1	0.1	0.1	∞
Modulation Response	E2.5	4.8	R	1.732	1	1	2.8	2.8	∞
Readout Electronics	E2.6	0.3	N	1	1	1	0.3	0.3	∞
Response Time	E2.7	0.8	R	1.732	1	1	0.5	0.5	∞
Integration Time	E2.8	2.6	R	1.732	1	1	1.5	1.5	∞
RF Ambient Conditions - Noise	E6.1	3	R	1.732	1	1	1.7	1.7	∞
RF Ambient Conditions - Reflections	E6.1	3	R	1.732	1	1	1.7	1.7	∞
Probe Positioner Mechanical Tolerance	E6.2	0.8	R	1.732	1	1	0.5	0.5	∞
Probe Positioning w/ respect to Phantom	E6.3	6.7	R	1.732	1	1	3.9	3.9	∞
Extrapolation, Interpolation & Integration algorithms for Max. SAR Evaluation	E5	4	R	1.732	1	1	2.3	2.3	∞
Test Sample Related									
Test Sample Positioning	E4.2	3.12	N	1	1	1	3.1	3.1	35
Device Holder Uncertainty	E4.1	1.67	N	1	1	1	1.7	1.7	5
Output Power Variation - SAR drift measurement	E2.9	5	R	1.732	1	1	2.9	2.9	∞
SAR Scaling	E6.5	0	R	1.732	1	1	0.0	0.0	∞
Phantom & Tissue Parameters									
Phantom Uncertainty (Shape & Thickness tolerances)	E3.1	7.6	R	1.73	1.0	1.0	4.4	4.4	∞
Liquid Conductivity - measurement uncertainty	E3.3	4.3	N	1	0.78	0.71	3.3	3.0	76
Liquid Permittivity - measurement uncertainty	E3.3	4.2	N	1	0.23	0.26	1.0	1.1	75
Liquid Conductivity - Temperature Uncertainty	E3.4	3.4	R	1.732	0.78	0.71	1.5	1.4	∞
Liquid Permittivity - Temperature Uncertainty	E3.4	0.6	R	1.732	0.23	0.26	0.1	0.1	∞
Liquid Conductivity - deviation from target values	E3.2	5.0	R	1.73	0.64	0.43	1.8	1.2	∞
Liquid Permittivity - deviation from target values	E3.2	5.0	R	1.73	0.60	0.49	1.7	1.4	∞
Combined Standard Uncertainty (k=1)							RSS	12.2	12.0
Expanded Uncertainty (95% CONFIDENCE LEVEL)							k=2	24.4	24.0

The above measurement uncertainties are according to IEEE Std. 1528-2013

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13 CONCLUSION

13.1 Measurement Conclusion

The SAR evaluation indicates that the EUT complies with the RF radiation exposure limits of the FCC and Innovation, Science, and Economic Development Canada, with respect to all parameters subject to this test. These measurements were taken to simulate the RF effects of RF exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The results and statements relate only to the item(s) tested.

Please note that the absorption and distribution of electromagnetic energy in the body are very complex phenomena that depend on the mass, shape, and size of the body, the orientation of the body with respect to the field vectors, and the electrical properties of both the body and the environment. Other variables that may play a substantial role in possible biological effects are those that characterize the environment (e.g., ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g., age, gender, activity level, debilitation, or disease). Because various factors may interact with one another to vary the specific biological outcome of an exposure to electromagnetic fields, any protection guide should consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables. [3]

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