ELEMENT MATERIALS TECHNOLOGY
(formerly PCTEST)
18855 Adams Court, California, CA 95037 USA
Tel. +1.410.290.6652 / Fax +1.410.290.6654
http://www.element.com

WIFI 6 GHz RF EXPOSURE EVALUATION

Applicant Name:
Samsung Electronics Co., Ltd.
129, Samsung-ro, Maetan dong,
Yeongtong-gu, Suwon-si

Gyeonggi-do, 16677, Korea

Date of Testing:
05/01/23 - 05/15/23
Test Site/Location:
Element Materials Technology,
Morgan Hill, CA, USA
Document Serial No.:
1M2303200036-12.A3L

FCC ID: **A3LSMX910**

APPLICANT: **SAMSUNG ELECTRONICS CO., LTD.**

DUT Type: Portable Computing Device
Application Type: Certification
FCC Rule Part(s): CFR §2.1093
Model(s): SM-X910

Band & Mode	Tx Frequency	SAR		APD		PD	
	MHz	1g Body - Tablet (W/kg)	1g Body - Laptop (W/kg)	Body - Tablet (W/m^2)	Body - Laptop (W/m^2)	psPD (W/m^2) - Tablet	psPD (W/m^2) - Laptop
WIFI 6 GHz	5935-7115	0.73	0.37	3.73	2.58	2.96	4.74

Values above represent RF exposure evaluations during MIMO operations.

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 1.9 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.

TABLE OF CONTENTS

1 DEVICE UNDER TEST

1.1 Device Overview

Band & Mode	Tx Frequency
U-NII-5	5935 - 6415 MHz
U-NII-6	6435 - 6515 MHz
U-NII-7	6535 - 6875 MHz
U-NII-8	6895 - 7115 MHz

1.2 Power Reduction for SAR

This device uses a power reduction mechanism for SAR compliance. The power reduction mechanism is activated when the device is used in close proximity to the user's body. FCC KDB Publication 616217 D04v01r02 Section 6 was used as a guideline for selecting SAR test distances for this device. Detailed descriptions of the power reduction mechanism are included in the operational description.

1.3 Nominal and Maximum Output Power Specifications

The 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 D01.

Note: Target powers in the below tables represent worst case targets across LPI and SP options.

1.3.1 6 GHz Maximum MIMO WLAN Output Powers

Mode	Band	IEEE 802.11 (in dBm)			
		MIMO			
		a (CDD + STBC)		ax (SU) (CDD + STBC, SDM)	
		Maximum	Nominal	Maximum	Nominal
6 GHz WIFI (20MHz BW)	UNII-5	16.0 Ch. 2: 7.5	15.0 6.5	16.0 Ch. 2: 7.0	15.0 6.0
	UNII-6	16.0	15.0	16.0	15.0
	UNII-7	16.0	15.0	16.0	15.0
	UNII-8	16.0 Ch. 233: 8.5	15.0 7.5	16.0 Ch. 233: 9.5	15.0 8.5
6 GHz WIFI (40MHz BW)	UNII-5	[redacted]		18.0	17.0
	UNII-6			18.0	17.0
	UNII-7			18.0	17.0
	UNII-8			18.0	17.0
6 GHz WIFI (80MHz BW)	UNII-5			18.0	17.0
	UNII-6			18.0	17.0
	UNII-7			18.0	17.0
	UNII-8			18.0	17.0
6 GHz WIFI (160MHz BW)	UNII-5			17.0	16.0
	UNII-6			17.0	16.0
	UNII-7			17.0	16.0
	UNII-8			17.0	16.0

1.3.2 6 GHz Reduced MIMO WLAN Output Powers

Mode	Band	IEEE 802.11 (in dBm)			
		MIMO			
		a (CDD + STBC)		ax (SU) (CDD + STBC, SDM)	
		Maximum	Nominal	Maximum	Nominal
6 GHz WIFI (20MHz BW)	UNII-5	11.0 Ch. 2: 7.5	10.0 6.5	11.0 Ch. 2: 7	10.0 6.0
	UNII-6	11.0	10.0	11.0	10.0
	UNII-7	11.0	10.0	11.0	10.0
	UNII-8	11.0 Ch. 233: 8.5	10.0 7.5	11.0 Ch. 233: 9.5	10.0 8.5
6 GHz WIFI (40MHz BW)	UNII-5	[redacted]		11.0	10.0
	UNII-6			11.0	10.0
	UNII-7			11.0	10.0
	UNII-8			11.0	10.0
6 GHz WIFI (80MHz BW)	UNII-5			11.0	10.0
	UNII-6			11.0	10.0
	UNII-7			11.0	10.0
	UNII-8			11.0	10.0
6 GHz WIFI (160MHz BW)	UNII-5			11.0	10.0
	UNII-6			11.0	10.0
	UNII-7			11.0	10.0
	UNII-8			11.0	10.0

1.3.3 Maximum 802.11ax RU WLAN Output Powers

Tones			MIMO (in dBm)							
			6GHz/20 MHz LPI	6GHz/40 MHz LPI	6GHz/80 MHz LPI	6GHz/160 MHz LPI	6GHz/20 MHz SP	6GHz/40 MHz SP	6GHz/80 MHz SP	6GHz/160 MHz SP
26T	UNII-5	Maximum	7 ch 2: 5	7 ch 3: 6	7	7	7 ch 2: 5	7 ch 3: 6	7	7
	UNII-6		7	7						
	UNII-7						7	7	7	7
	UNII-8									
	UNII-5	Nominal	6 ch 2: 4	6 ch 3: 5	6	6	6 ch 2: 4	6 ch 3: 5	6	6
	UNII-6		6	6						
	UNII-7						6	6	6	6
	UNII-8									
52T	UNII-5	Maximum	10 ch 2: 7.5 ch 45: 9	10 ch 3: 8.5	10 ch 7: 9.5 ch 39: 9	10 ch 15: 9 ch 47: 9	10 ch 2: 7.5 ch 45: 9	10 ch 3: 8.5	10 ch 7: 9.5 ch 39: 9	10 ch 15: 9 ch 47: 9
	UNII-6		10 ch 233: 9	10	9	10	10	10	10	10
	UNII-7									
	UNII-8									
	UNII-5	Nominal	9 ch 2: 6.5 ch 45: 8	9 ch 3: 7.5	9 ch 7: 8.5 ch 39: 8	9 ch 15: 8 ch 47: 8	9 ch 2: 6.5 ch 45: 8	9 ch 3: 7.5	9 ch 7: 8.5 ch 39: 8	9 ch 15: 8 ch 47: 8
	UNII-6		9 ch: 233 8	9	9	9	9	9	9	9
	UNII-7									
	UNII-8									
106T	UNII-5	Maximum	12 ch 2: 9.5	12	12	12	12 ch 2: 9.5	12	12	12
	UNII-6		12 ch 233: 11							
	UNII-7						12	12	12	12
	UNII-8									
	UNII-5	Nominal	11 ch 2: 8.5	11	11	11	11 ch 2: 8.5	11	11	11
	UNII-6		11 ch 233: 10							
	UNII-7						11	11	11	11
	UNII-8									
242T	UNII-5	Maximum	16 ch 2: 13	16	16	16	16 ch 2: 13	16	16	16
	UNII-6		16 ch 233: 14.5							
	UNII-7						16	16	16	16
	UNII-8									
	UNII-5	Nominal	15 ch 2: 12	15	15	15	15 ch 2: 12	15	15	15
	UNII-6		15 ch 233: 13.5							
	UNII-7						15	15	15	15
	UNII-8									
484T	UNII-5	Maximum		18 ch 3: 17	18	17		18 ch 3: 17	18	17
	UNII-6			18						
	UNII-7							18	18	17
	UNII-8									
	UNII-5	Nominal		17 ch 3: 16	17	16		17 ch 3: 16	17	16
	UNII-6			17						
	UNII-7							17	17	16
	UNII-8									
996T	UNII-5	Maximum			18	17			18	17
	UNII-6									
	UNII-7								18	17
	UNII-8									
	UNII-5	Nominal			17	16			17	16
	UNII-6									
	UNII-7								17	16
	UNII-8									
2x996T	UNII-5	Maximum				17				17
	UNII-6									
	UNII-7									17
	UNII-8									
	UNII-5	Nominal				16				16
	UNII-6									
	UNII-7									16
	UNII-8									

1.3.4 Reduced 802.11ax RU WLAN Output Power

The below table is applicable in the following conditions:

- Grip Sensor active

Tones			MIMO (in dBm)							
			6GHz/20 MHz LPI	6GHz/40 MHz LPI	6GHz/80 MHz LPI	6GHz/160 MHz LPI	6GHz/20 MHz SP	6GHz/40 MHz SP	6GHz/80 MHz SP	6GHz/160 MHz SP
26T	UNII-5	Maximum	7 ch 2: 5	7 ch 3: 6	7	7	7 ch 2: 5	7 ch 3: 6	7	7
	UNII-6		7	7						
	UNII-7						7	7	7	7
	UNII-8									
	UNII-5	Nominal	6 ch 2: 4	6 ch 3: 5	6	6	6 ch 2: 4	6 ch 3: 5	6	6
	UNII-6		6	6						
	UNII-7						6	6	6	6
	UNII-8									
52T	UNII-5	Maximum	10 ch 2: 7.5 ch 45: 9	10 ch 3: 8.5	10 ch 7: 9.5 ch 39: 9	10 ch 15: 9 ch 47: 9	10 ch 2: 7.5 ch 45: 9	10 ch 3: 8.5	10 ch 7: 9.5 ch 39: 9	10 ch 15: 9 ch 47: 9
	UNII-6		10 ch 233: 9	10	10	10				
	UNII-7						10	10	10	10
	UNII-8									
	UNII-5	Nominal	9 ch 2: 6.5 ch 45: 8	9 ch 3: 7.5	9 ch 7: 8.5 ch 39: 8	9 ch 15: 8 ch 47: 8	9 ch 2: 6.5 ch 45: 8	9 ch 3: 7.5	9 ch 7: 8.5 ch 39: 8	9 ch 15: 8 ch 47: 8
	UNII-6		9 ch 233: 8	9	9	9				
	UNII-7						9	9	9	9
	UNII-8									
106T	UNII-5	Maximum	11 ch 2: 9.5	11	11	11	11 ch 2: 9.5	11	11	11
	UNII-6		11							
	UNII-7						11	11	11	11
	UNII-8									
	UNII-5	Nominal	10 ch 2: 8.5	10	10	10	10 ch 2: 8.5	10	10	10
	UNII-6		10							
	UNII-7						10	10	10	10
	UNII-8									
242T	UNII-5	Maximum	11	11	11	11	11	11	11	11
	UNII-6									
	UNII-7						11	11	11	11
	UNII-8									
	UNII-5	Nominal	10	10	10	10	10	10	10	10
	UNII-6									
	UNII-7						10	10	10	10
	UNII-8									
484T	UNII-5	Maximum		11	11	11		11	11	11
	UNII-6									
	UNII-7							11	11	11
	UNII-8									
	UNII-5	Nominal		10	10	10		10	10	10
	UNII-6									
	UNII-7							10	10	10
	UNII-8									
996T	UNII-5	Maximum			11	11			11	11
	UNII-6									
	UNII-7								11	11
	UNII-8									
	UNII-5	Nominal			10	10			10	10
	UNII-6									
	UNII-7								10	10
	UNII-8									
2x996T	UNII-5	Maximum				11				11
	UNII-6									
	UNII-7									11
	UNII-8									
	UNII-5	Nominal				10				10
	UNII-6									
	UNII-7									10
	UNII-8									

1.4 DUT Antenna Locations

The overall diagonal dimension of the device is > 200 mm. A diagram showing the location of the device antennas can be found in SAR Part 1 Report, DUT Antenna Diagram & SAR Test Setup Photographs Appendix. Exact antenna dimensions and separation distances are shown in the Technical Descriptions in the FCC filing.

Table 4-1
Device Surfaces - Tablet

Device Sides/Edges for Testing						
Mode	Back	Front	Top	Bottom	Right	Left
6 GHz WLAN WIFI 1	Yes	Yes	Yes	No	Yes	No
6 GHz WLAN WIFI 2	Yes	Yes	Yes	No	No	Yes

Table 4-2
Device Surfaces – Laptop

Device Sides/Edges for Testing						
Mode	Back	Front	Top	Bottom	Right	Left
6 GHz WLAN WIFI 1	No	No	No	Yes	No	No
6 GHz WLAN WIFI 2	No	No	No	Yes	No	No

Note: Per FCC KDB Publication 616217 D04v01r01, particular edges were not required to be evaluated for SAR based on the SAR exclusion threshold in KDB 447498 D04. Additional edges may have been evaluated for simultaneous transmission analysis.

1.5 Miscellaneous Testing Considerations

Per FCC guidance, SAR was performed using 6.5 GHz SAR probe calibration factors. FCC KDB 616217 and FCC KDB 248227 were followed for test positions, distances, and modes. Per TCB workshop October 2020 notes, 5 channels were tested. Absorbed power density (APD) using a $4cm^2$ averaging area is reported based on SAR measurements. Incident power density is evaluated at 2mm ensuring that the resolution is sufficient such that integrated power density (iPD) between d=2mm and d=λ/5mm is ≥ -1dB per equipment manufacturer guidance. Power density results are scaled up for uncertainty above 30%.

6 GHz WIFI SAR results are used for simultaneous transmission analysis with the other BT/WIFI transmitters. Analysis can be found in the SAR report.

To make the most efficient use of the additional available subcarriers (data tones), IEEE 802.11ax can utilize Orthogonal Frequency-Division Multiple Access (OFDMA) which divides the existing 802.11 channels into smaller subchannels called Resource Units (RUs). Possible RU sizes are: 26T, 52T, 106T, 242T, 484T, 996T and 2x996T.

Per FCC Guidance, 802.11ax RU was considered a higher order 802.11 mode when compared to a/b/g/n/ac to apply KDB Publication 248227 D01v02r02 for OFDM mode selection. Therefore, SAR tests were not required for 802.11ax RU based on the maximum allowed output powers of OFDM modes and the reported SAR values. Per FCC Guidance, maximum conducted powers were performed for each RU size to demonstrate that the output powers would not be higher than the other OFDM 802.11 modes. Please see Measurement Report SN 1M2303200036-09.A3L for 802.11ax RU output powers.

1.6 Guidance Applied

- November 2017, October 2018, April 2019, November 2019, October 2020 TCBC Workshop Notes
- SPEAG DASY6 System Handbook
- SPEAG DASY6 Application Note (Interim Procedures for Devices Operating at 6-10 GHz) (Nov 2021)
- IEEE 1528-2013
- IEC TR 63170:2018
- IEC 62479:2010
- FCC KDB 865664 D02 v01r02
- FCC KDB 248227 D01 v02r02
- FCC KDB 447498 D01
- FCC KDB 865664 D01 v01r04
- April 2019 TCB Workshop Notes (IEEE 802.11ax)
- FCC KDB Publication 616217 D04v01r02

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.

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. [15]

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 [44] and Health Canada RF Exposure Guidelines Safety Code 6 [35]. The measurement procedure described in IEEE/ANSI C95.3-2002 Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave [17] 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/m^3)
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.[20]

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:

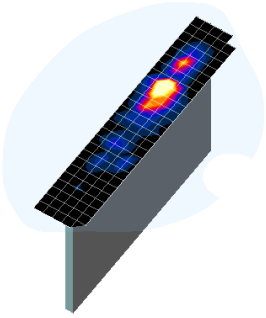

Figure 3-1
Sample SAR Area Scan

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 DASY 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.

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

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

*Also compliant to IEEE 1528-2013 Table 6

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 ε = 3 and loss tangent δ = 0.02.

4.2 SAR Testing for Tablet per KDB Publication 616217 D04v01r02

Per FCC KDB Publication 616217 D04v01r02, the back surface and edges of the tablet should be tested for SAR compliance with the tablet touching the phantom. The SAR Exclusion Threshold in KDB 447498 D01 can be applied to determine SAR test exclusion for adjacent edge configurations. The closest distance from the antenna to an adjacent tablet edge is used to determine if SAR testing is required for the adjacent edges, with the adjacent edge positioned against the phantom and the edge containing the antenna positioned perpendicular to the phantom.

4.3 Proximity Sensor Considerations

This device uses a power reduction mechanism to reduce output powers in certain use conditions when the device is used close the user's body.

When the device's antenna is within a certain distance of the user, the sensor activates and reduces the maximum allowed output power. However, the sensor is not active when the device is moved beyond the sensor triggering distance and the maximum output power is no longer limited. Therefore, additional evaluation is needed in the vicinity of the triggering distance to ensure SAR is compliant when the device is allowed to operate at a non-reduced output power level. FCC KDB Publication 616217 D04v01r02 Section 6 was used as a guideline for selecting SAR test distances for this device at these additional test positions. Sensor triggering distance summary data is included in the Power Reduction Verification Appendix.

The sensor is designed to support sufficient detection range and sensitivity to cover regions of the sensors in all applicable directions since the sensor entirely covers the antennas.

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.

5.3 RF Exposure Limits for Frequencies Below 6 GHz

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

HUMAN EXPOSURE LIMITS		
	UNCONTROLLED ENVIRONMENT *General Population* (W/kg) or (mW/g)	CONTROLLED ENVIRONMENT *Occupational* (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.

5.4 RF Exposure Limits for Frequencies Above 6 GHz

Per §1.1310 (d)(3), the MPE limits are applied for frequencies above 6 GHz. Power Density is expressed in units of W/m^2 or mW/cm^2.

Peak Spatially Averaged Power Density was evaluated over a circular area of 4 cm^2 per interim FCC Guidance for near-field power density evaluations per October 2018 TCB Workshop notes.

Table 5-2
Human Exposure Limits Specified in FCC 47 CFR §1.1310

Human Exposure to Radiofrequency (RF) Radiation Limits		
Frequency Range [MHz]	**Power Density** [mW/cm^2]	**Average Time** [Minutes]
(A) Limits For Occupational / Controlled Environments		
1,500 – 100,000	5.0	6
(B) Limits For General Population / Uncontrolled Environments		
1,500 – 100,000	1.0	30

Note: 1.0 mW/cm^2 is 10 W/m^2

6 FCC MEASUREMENT PROCEDURES

6.1 Measured and Reported SAR

Per FCC KDB Publication 447498 D01v06, 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.

6.2 Procedures Used to Establish RF Signal for SAR

The following procedures are according to FCC KDB Publication 941225 D01v03r01 "3G SAR Measurement Procedures."

The device is placed into a simulated call using a base station simulator in a RF shielded chamber. Establishing connections in this manner ensure a consistent means for testing SAR and are recommended for evaluating SAR [17]. Devices under test are evaluated prior to testing, with a fully charged battery and were configured to operate at maximum output power. In order to verify that the device is tested throughout the SAR test at maximum output power, the SAR measurement system measures a "point SAR" at an arbitrary reference point at the start and end of the 1 gram SAR evaluation, to assess for any power drifts during the evaluation. If the power drift deviates by more than 5%, the SAR test and drift measurements are repeated.

6.3 SAR Testing with 802.11 Transmitters

The normal network operating configurations of 802.11 transmitters are not suitable for SAR measurements. Unpredictable fluctuations in network traffic and antenna diversity conditions can introduce undesirable variations in SAR results. The SAR for these devices should be measured using chipset based test mode software to ensure the results are consistent and reliable. See KDB Publication 248227 D01v02r02 for more details.

6.3.1 General Device Setup

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters.

A periodic duty factor is required for current generation SAR systems to measure SAR. When 802.11 frame gaps are accounted for in the transmission, a maximum transmission duty factor of 92 - 96% is typically achievable in most test mode configurations. A minimum transmission duty factor of 85% is required to avoid certain hardware and device implementation issues related to wide range SAR scaling. The reported SAR is scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit.

6.3.2 Initial Test Position Procedure

For exposure conditions with multiple test positions, such as handset operating next to the ear, devices with hotspot mode or UMPC mini-tablet, procedures for initial test position can be applied. Using the transmission mode determined by the DSSS procedure or initial test configuration, area scans are measured for all positions in an exposure condition. The test position with the highest extrapolated (peak) SAR is used as the initial test position. When reported SAR for the initial test position is ≤ 0.4 W/kg, no additional testing for the remaining test positions is required. Otherwise, SAR is evaluated at the subsequent highest peak SAR positions until the reported SAR result is ≤ 0.8 W/kg or all test positions are measured. When 10g SAR measurement is considered, a factor of 2.5 is applied to the thresholds above.

6.3.3 OFDM Transmission Mode and SAR Test Channel Selection

When the same maximum output power was specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration with the largest channel bandwidth, lowest order modulation and lowest data rate. When the maximum output power of a channel is the same for equivalent OFDM configurations; for example, 802.11a, 802.11n and 802.11ac or 802.11g and 802.11n with the same channel bandwidth, modulation and data rate etc., the lower order 802.11 mode i.e., 802.11a, then 802.11n and 802.11ac or 802.11g then 802.11n, is used for SAR measurement. Per April 2019 TCB Workshop guidance, 802.11ax was considered the highest order 802.11 mode. When the maximum output power are the same for multiple test channels, either according to the default or additional power measurement requirements, SAR is measured using the channel closest to the middle of the frequency band or aggregated band. When there are multiple channels with the same maximum output power, SAR is measured using the higher number channel.

6.3.4 Initial Test Configuration Procedure

For OFDM, an initial test configuration is determined for each frequency band and aggregated band, according to the transmission mode with the highest maximum output power specified for SAR measurements. When the same maximum output power is specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration(s) with the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order IEEE 802.11 mode. The channel of the transmission mode with the highest average RF output conducted power will be the initial test configuration.

When the reported SAR is ≤ 0.8 W/kg, no additional measurements on other test channels are required. Otherwise, SAR is evaluated using the subsequent highest average RF output channel until the reported SAR result is ≤ 1.2 W/kg or all channels are measured. When there are multiple untested channels having the same subsequent highest average RF output power, the channel with higher frequency from the lowest 802.11 mode is considered for SAR measurements (See Section 0). When 10g SAR measurement is considered, a factor of 2.5 is applied to the thresholds above.

6.3.5 Subsequent Test Configuration Procedures

For OFDM configurations in each frequency band and aggregated band, SAR is evaluated for initial test configuration using the fixed test position or the initial test position procedure. When the highest reported SAR (for the initial test configuration), adjusted by the ratio of the specified maximum output power of the subsequent test configuration to initial test configuration, is ≤ 1.2 W/kg, no additional SAR tests for the subsequent test configurations are required. When 10g SAR measurement is considered, a factor of 2.5 is applied to the thresholds above.

6.3.6 MIMO SAR considerations

Per KDB Publication 248227 D01v02r02, the simultaneous SAR provisions in KDB Publication 447498 D01v06 should be applied to determine simultaneous transmission SAR test exclusion for WIFI MIMO. If the sum of 1g single transmission chain SAR measurements is <1.6 W/kg, no additional SAR measurements for MIMO are required. Alternatively, SAR for MIMO can be measured with all antennas transmitting simultaneously at the specified maximum output power of MIMO operation. When 10g SAR measurement is considered, a factor of 2.5 is applied to the thresholds above.

7 RF CONDUCTED POWERS

Table 7- 1
6 GHz WLAN Maximum Average RF Power – MIMO

6GHz (80MHz) 802.11ax Conducted Power [dBm]				
Freq [MHz]	**Channel**	**ANT1**	**ANT2**	**MIMO**
5985	7	14.90	14.22	17.58
6305	71	13.25	14.85	17.13
6545	119	14.16	14.92	17.57
6785	167	14.76	14.73	17.86
7025	215	14.91	13.98	17.48

Table 7- 2
6 GHz WLAN Reduced Average RF Power with Grip Sensor Active – MIMO

6GHz (80MHz) 802.11ax Conducted Power [dBm]				
Freq [MHz]	**Channel**	**ANT1**	**ANT2**	**MIMO**
5985	7	7.88	7.26	10.59
6305	71	6.55	7.96	10.32
6545	119	6.92	7.9	10.45
6785	167	7.63	7.83	10.74
7025	215	7.43	6.81	10.14

Justification for test configurations for WLAN per KDB Publication 248227 D01v02r02:

- Power measurements were performed for the transmission mode configuration with the highest maximum output power specified for production units.
- For transmission modes with identical maximum specified output power, channel bandwidth, modulation and data rates, power measurements were required for all identical configurations.

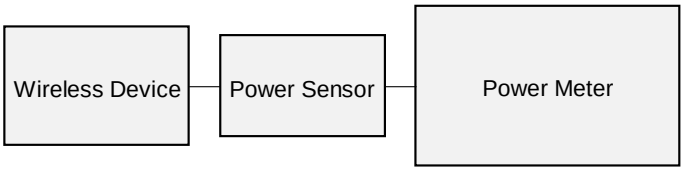

Figure 7-1
Power Measurement Setup

8 SYSTEM VERIFICATION

8.1 SAR Test System Verification

Table 8-1
Measured 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
05/01/2023	6000 Head	20.5	5935	5.649	34.854	5.411	35.143	4.40%	-0.82%
			5970	5.691	34.773	5.448	35.120	4.46%	-0.99%
			5985	5.708	34.737	5.464	35.110	4.47%	-1.06%
			6000	5.725	34.697	5.480	35.100	4.47%	-1.15%
			6025	5.760	34.622	5.510	35.070	4.54%	-1.28%
			6065	5.816	34.524	5.557	35.022	4.66%	-1.42%
			6075	5.830	34.501	5.569	35.010	4.69%	-1.45%
			6085	5.844	34.481	5.580	34.998	4.73%	-1.48%
			6185	5.972	34.315	5.698	34.878	4.81%	-1.61%
			6275	6.074	34.191	5.805	34.770	4.63%	-1.67%
			6285	6.087	34.178	5.816	34.758	4.66%	-1.67%
			6305	6.112	34.150	5.840	34.734	4.66%	-1.68%
			6345	6.160	34.080	5.887	34.686	4.64%	-1.75%
			6475	6.315	33.753	6.041	34.530	4.54%	-2.25%
			6485	6.327	33.727	6.052	34.518	4.54%	-2.29%
			6500	6.347	33.690	6.070	34.500	4.56%	-2.35%
			6505	6.353	33.678	6.076	34.494	4.56%	-2.37%
			6545	6.405	33.581	6.122	34.446	4.62%	-2.51%
			6665	6.554	33.407	6.265	34.302	4.61%	-2.61%
			6675	6.568	33.395	6.273	34.290	4.70%	-2.61%
			6685	6.581	33.384	6.285	34.278	4.71%	-2.61%
			6715	6.618	33.353	6.319	34.242	4.73%	-2.60%
			6785	6.699	33.249	6.400	34.158	4.67%	-2.66%
			6825	6.747	33.163	6.447	34.110	4.65%	-2.78%
			6985	6.923	32.745	6.633	33.918	4.37%	-3.46%
			6995	6.935	32.723	6.644	33.906	4.38%	-3.49%
			7000	6.941	32.711	6.650	33.900	4.38%	-3.51%
			7005	6.946	32.700	6.656	33.894	4.36%	-3.52%
			7025	6.970	32.660	6.680	33.870	4.34%	-3.57%
05/08/2023	6000 Head	20.5	5935	5.654	35.099	5.411	35.143	4.49%	-0.13%
			5970	5.698	35.040	5.448	35.120	4.59%	-0.23%
			5985	5.716	35.020	5.464	35.110	4.61%	-0.26%
			6000	5.732	35.000	5.480	35.100	4.60%	-0.28%
			6025	5.763	34.944	5.510	35.070	4.59%	-0.36%
			6065	5.816	34.856	5.557	35.022	4.66%	-0.47%
			6075	5.831	34.835	5.569	35.010	4.70%	-0.50%
			6085	5.845	34.817	5.580	34.998	4.75%	-0.52%
			6185	5.975	34.633	5.698	34.878	4.86%	-0.70%
			6275	6.091	34.479	5.805	34.770	4.93%	-0.84%
			6285	6.103	34.464	5.816	34.758	4.93%	-0.85%
			6305	6.125	34.437	5.840	34.734	4.88%	-0.86%
			6345	6.170	34.348	5.887	34.686	4.81%	-0.97%
			6475	6.319	34.101	6.041	34.530	4.60%	-1.24%
			6485	6.332	34.081	6.052	34.518	4.63%	-1.27%
			6500	6.348	34.058	6.070	34.500	4.58%	-1.28%
			6505	6.354	34.049	6.076	34.494	4.58%	-1.29%
			6545	6.406	33.954	6.122	34.446	4.64%	-1.43%
			6665	6.563	33.717	6.265	34.302	4.76%	-1.71%
			6675	6.578	33.696	6.273	34.290	4.86%	-1.73%
			6685	6.593	33.678	6.285	34.278	4.90%	-1.75%
			6715	6.633	33.634	6.319	34.242	4.97%	-1.78%
			6785	6.710	33.536	6.400	34.158	4.84%	-1.82%
			6825	6.762	33.467	6.447	34.110	4.89%	-1.89%
			6985	6.916	33.204	6.633	33.918	4.27%	-2.11%
			6995	6.927	33.176	6.644	33.906	4.26%	-2.15%
			7000	6.935	33.162	6.650	33.900	4.29%	-2.18%
			7005	6.942	33.151	6.656	33.894	4.30%	-2.19%
			7025	6.971	33.114	6.680	33.870	4.36%	-2.23%

The above measured tissue parameters were used in the DASY software. The DASY 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.

Prior to SAR assessment, the system is verified to ±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 SAR System Validation Appendix.

Table 8-2
System Verification Results – 1g

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	Measured SAR_{1g} (W/kg)	1 W Target SAR_{1g} (W/kg)	1 W Normalized SAR_{1g} (W/kg)	$Deviation_{1g}$ (%)	Measured SAR_{10g} (W/kg)	1 W Target SAR_{10g} (W/kg)	1 W Normalized SAR_{10g} (W/kg)	$Deviation_{10g}$ (%)	Measured 4cm² APD (W/m²)	1W Target 4cm² APD (W/m²)	1 W Normalized 4cm² APD (W/m²)	Deviation 4cm² APD (%)
AM7	6500	Head	05/01/2023	22.1	19.5	0.025	1019	7532	6.800	295.000	272.000	-7.80%	1.250	54.000	50.000	-7.41%	30.5000	1310.0000	1220.000	-6.87%
AM7	6500	Head	05/08/2023	21.0	20.6	0.025	1019	7532	7.550	295.000	302.000	2.37%	1.370	54.000	54.800	1.48%	33.5000	1310.0000	1340.000	2.29%

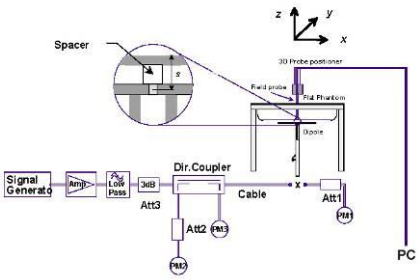

Figure 8-1
System Verification Setup Diagram

Figure 8-2
System Verification Setup Photo

8.2 Power Density Test System Verification

The system was verified to be within ±0.66 dB of the power density targets on the calibration certificate according to the test system specification in the user's manual and calibration facility recommendation. The 0.66 dB deviation threshold represents the expanded uncertainty for system performance checks using SPEAG's mmWave verification sources. The same spatial resolution and measurement region used in the source calibration was applied during the system check.

The measured power density distribution of verification source was also confirmed through visual inspection to have no noticeable differences, both spatially (shape) and numerically (level) from the distribution provided by the manufacturer, per November 2017 TCBC Workshop Notes.

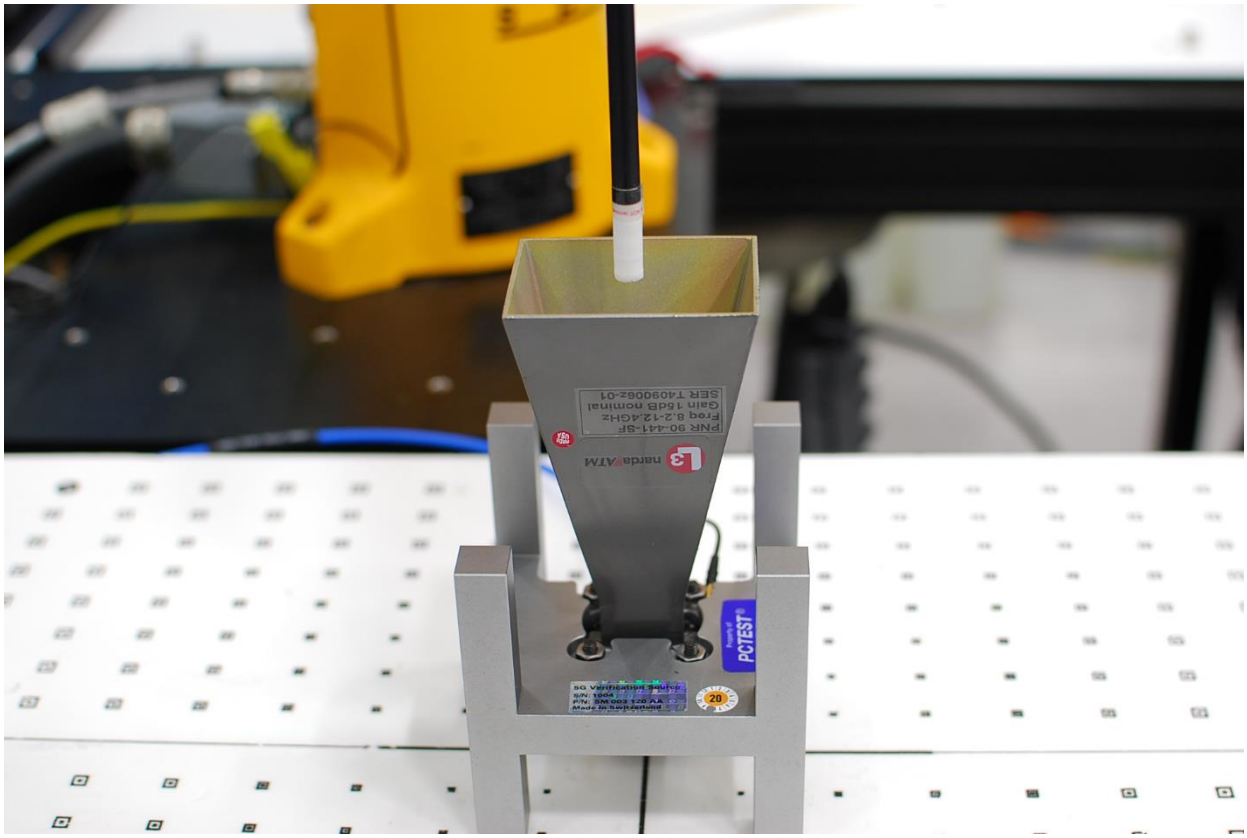

Figure 8-3
System Verification Setup Photo

Table 8-3
10 GHz Verifications

System Verification											
System	Frequency (GHz)	Date	Source S/N	Probe S/N	Prad (mW)	Normal psPD (W/m² over 4 cm²)		Deviation (dB)	Total psPD (W/m² over 4 cm²)		Deviation (dB)
						Measured	Target		Measured	Target	
AM5	10	05/08/2023	1006	9364	86.1	54.20	51.10	0.2558	54.50	51.10	0.2798
AM5	10	05/09/2023	1006	9364	86.1	55.30	51.10	0.3430	55.50	51.10	0.3587
AM5	10	05/11/2023	1006	9364	86.1	54.10	51.10	0.2478	54.30	51.10	0.2638
AM5	10	05/15/2023	1006	9364	86.1	53.20	51.10	0.1749	53.40	51.10	0.1912

Note: A **10 mm distance spacing** was used from the reference horn antenna aperture to the probe element.

9 DATA SUMMARY

9.1 SAR and Absorbed Power Density Results

Table 9-1
6 GHz WLAN Body MIMO SAR – Tablet

MEASUREMENT RESULTS																						
FREQUENCY		Mode	Service	Bandwidth [MHz]	Maximum Allowed Power (Ant 1) [dBm]	Conducted Power (Ant 1) [dBm]	Maximum Allowed Power (Ant 2) [dBm]	Conducted Power (Ant 2) [dBm]	Power Drift [dB]	Spacing (mm)	Antenna Config.	Device Serial Number	Data Rate (Mbps)	Side	Peak	Keyboard Variant	Duty Cycle (%)	SAR (1g)	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Reported SAR (1g)	Plot #
MHz	Ch.																	(W/kg)			(W/kg)	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	-0.15	15	MIMO	R32W3001GYK	68.1	Back	1	-	99.6	0.016	1.064	1.004	0.017	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	0.16	15	MIMO	R32W3001GYK	68.1	Back	2	-	99.6	0.022	1.064	1.004	0.024	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	0.18	15	MIMO	R32W3001GYK	68.1	Front	1	-	99.6	0.022	1.064	1.004	0.024	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	0.15	15	MIMO	R32W3001GYK	68.1	Front	2	-	99.6	0.017	1.064	1.004	0.018	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	0.03	19	MIMO	R32W3001GYK	68.1	Top	1	-	99.6	0.006	1.064	1.004	0.006	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	-0.15	19	MIMO	R32W3001GYK	68.1	Top	2	-	99.6	0.006	1.064	1.004	0.006	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	0.11	7	MIMO	R32W3001GYK	68.1	Right	-	-	99.6	0.044	1.064	1.004	0.047	
5985	7	802.11ax	OFDM	80	15.00	14.90	15.00	14.22	-0.04	7	MIMO	R32W3001GYK	68.1	Right	-	-	99.6	0.167	1.197	1.004	0.201	
6305	71	802.11ax	OFDM	80	15.00	13.25	15.00	14.85	0.07	7	MIMO	R32W3001GYK	68.1	Right	-	-	99.6	0.054	1.496	1.004	0.081	
6545	119	802.11ax	OFDM	80	15.00	14.16	15.00	14.92	-0.14	7	MIMO	R32W3001GYK	68.1	Right	-	-	99.6	0.072	1.213	1.004	0.088	
7025	215	802.11ax	OFDM	80	15.00	14.91	15.00	13.98	-0.12	7	MIMO	R32W3001GYK	68.1	Right	-	-	99.6	0.098	1.265	1.004	0.124	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	-0.13	9	MIMO	R32W3001GYK	68.1	Left	-	-	99.6	0.038	1.064	1.004	0.041	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	-0.19	0	MIMO	R32W3001GVA	68.1	Back	1	-	99.6	0.097	1.089	1.004	0.106	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	-0.05	0	MIMO	R32W3001GVA	68.1	Back	2	-	99.6	0.312	1.089	1.004	0.341	
5985	7	802.11ax	OFDM	80	8.00	7.88	8.00	7.26	0.05	0	MIMO	R32W3001GVA	68.1	Back	2	-	99.6	0.473	1.186	1.004	0.563	
6305	71	802.11ax	OFDM	80	8.00	6.55	8.00	7.96	0.02	0	MIMO	R32W3001GVA	68.1	Back	2	-	99.6	0.520	1.396	1.004	0.729	A1
6545	119	802.11ax	OFDM	80	8.00	6.92	8.00	7.90	0.19	0	MIMO	R32W3001GVA	68.1	Back	2	-	99.6	0.159	1.282	1.004	0.205	
7025	215	802.11ax	OFDM	80	8.00	7.43	8.00	6.81	-0.14	0	MIMO	R32W3001GVA	68.1	Back	2	-	99.6	0.129	1.315	1.004	0.170	
6305	71	802.11ax	OFDM	80	8.00	6.55	8.00	7.96	-0.09	0	MIMO	R32W3001GVA	68.1	Back	2	1	99.6	0.030	1.396	1.004	0.042	
6305	71	802.11ax	OFDM	80	8.00	6.55	8.00	7.96	0.04	0	MIMO	R32W3001GVA	68.1	Back	2	2	99.6	0.033	1.396	1.004	0.046	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	-0.20	0	MIMO	R32W3001GVA	68.1	Front	1	-	99.6	0.100	1.089	1.004	0.109	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	0.09	0	MIMO	R32W3001GVA	68.1	Front	2	-	99.6	0.155	1.089	1.004	0.169	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	0.11	0	MIMO	R32W3001GVA	68.1	Top	1	-	99.6	0.012	1.089	1.004	0.013	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	0.00	0	MIMO	R32W3001GVA	68.1	Top	2	-	99.6	0.018	1.089	1.004	0.020	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	-0.17	0	MIMO	R32W3001GVA	68.1	Right	-	-	99.6	0.143	1.089	1.004	0.156	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	0.21	0	MIMO	R32W3001GVA	68.1	Left	-	-	99.6	0.206	1.089	1.004	0.225	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population										Body 1.6 W/kg (mW/g) averaged over 1 gram												

Note 1: Peak 1/2 correspond to hotspot location on WIFI1/WIFI2 ant of the DUT respectively.

Note 2: To achieve the 18.0 dBm and 11.00 dBm maximum allowed MIMO power shown in the documentation, each antenna transmits at a maximum allowed power of 15.0 dBm and 8.0 dBm respectively.

Table 9-2
6 GHz WLAN Body MIMO SAR– Laptop

MEASUREMENT RESULTS																						
FREQUENCY		Mode	Service	Bandwidth [MHz]	Maximum Allowed Power (Ant 1) [dBm]	Conducted Power (Ant 1) [dBm]	Maximum Allowed Power (Ant 2) [dBm]	Conducted Power (Ant 2) [dBm]	Power Drift [dB]	Spacing (mm)	Antenna Config.	Device Serial Number	Data Rate (Mbps)	Side	Keyboard Variant	Duty Cycle (%)	SAR (1g)	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Reported SAR (1g)	Plot #
MHz	Ch.																(W/kg)			(W/kg)	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	0.18	0	MIMO	R32W3001FXT	68.1	Bottom	1	99.6	0.083	1.064	1.004	0.089	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	0.02	0	MIMO	R32W3001FXT	68.1	Bottom	2	99.6	0.122	1.064	1.004	0.130	
5985	7	802.11ax	OFDM	80	15.00	14.90	15.00	14.22	-0.20	0	MIMO	R32W3001FXT	68.1	Bottom	2	99.6	0.250	1.197	1.004	0.300	A2
6305	71	802.11ax	OFDM	80	15.00	13.25	15.00	14.85	-0.05	0	MIMO	R32W3001FXT	68.1	Bottom	2	99.6	0.246	1.496	1.004	0.369	
6545	119	802.11ax	OFDM	80	15.00	14.16	15.00	14.92	-0.15	0	MIMO	R32W3001FXT	68.1	Bottom	2	99.6	0.077	1.213	1.004	0.094	
7025	215	802.11ax	OFDM	80	15.00	14.91	15.00	13.98	-0.03	0	MIMO	R32W3001FXT	68.1	Bottom	2	99.6	0.135	1.265	1.004	0.171	
ANSI / IEEE C95.1 1992 - SAFETY LIMIT Spatial Peak Uncontrolled Exposure/General Population														Body 1.6 W/kg (mW/g) averaged over 1 gram							

Note 1: To achieve the 18.0 dBm maximum allowed MIMO power shown in the documentation, each antenna transmits at a maximum allowed power of 15.0 dBm.

Table 9-3
6 GHz WLAN Body MIMO Absorbed Power Density - Tablet

MEASUREMENT RESULTS																						
FREQUENCY		Mode	Service	Bandwidth [MHz]	Maximum Allowed Power (Ant 1) [dBm]	Conducted Power (Ant 1) [dBm]	Maximum Allowed Power (Ant 2) [dBm]	Conducted Power (Ant 2) [dBm]	Power Drift [dB]	Spacing (mm)	Antenna Config.	Device Serial Number	Data Rate (Mbps)	Side	Peak	Keyboard Variant	Duty Cycle (%)	Measured APD	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Scaled APD	Plot #
MHz	Ch.																	W/m^2 ($4cm^2$)			W/m^2 ($4cm^2$)	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	-0.15	15	MIMO	R32W3001GYK	68.1	Back	1	-	99.6	0.136	1.064	1.004	0.145	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	0.16	15	MIMO	R32W3001GYK	68.1	Back	2	-	99.6	0.185	1.064	1.004	0.198	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	0.18	15	MIMO	R32W3001GYK	68.1	Front	1	-	99.6	0.181	1.064	1.004	0.193	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	0.15	15	MIMO	R32W3001GYK	68.1	Front	2	-	99.6	0.139	1.064	1.004	0.148	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	0.03	19	MIMO	R32W3001GYK	68.1	Top	1	-	99.6	0.049	1.064	1.004	0.052	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	-0.15	19	MIMO	R32W3001GYK	68.1	Top	2	-	99.6	0.042	1.064	1.004	0.045	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	0.11	7	MIMO	R32W3001GYK	68.1	Right	-	-	99.6	0.320	1.064	1.004	0.342	
5985	7	802.11ax	OFDM	80	15.00	14.90	15.00	14.22	-0.04	7	MIMO	R32W3001GYK	68.1	Right	-	-	99.6	1.270	1.197	1.004	1.526	
6305	71	802.11ax	OFDM	80	15.00	13.25	15.00	14.85	0.07	7	MIMO	R32W3001GYK	68.1	Right	-	-	99.6	0.435	1.496	1.004	0.653	
6545	119	802.11ax	OFDM	80	15.00	14.16	15.00	14.92	-0.14	7	MIMO	R32W3001GYK	68.1	Right	-	-	99.6	0.578	1.213	1.004	0.704	
7025	215	802.11ax	OFDM	80	15.00	14.91	15.00	13.98	-0.12	7	MIMO	R32W3001GYK	68.1	Right	-	-	99.6	0.738	1.265	1.004	0.937	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	-0.13	9	MIMO	R32W3001GYK	68.1	Left	-	-	99.6	0.297	1.064	1.004	0.317	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	-0.19	0	MIMO	R32W3001GVA	68.1	Back	1	-	99.6	0.559	1.089	1.004	0.611	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	-0.05	0	MIMO	R32W3001GVA	68.1	Back	2	-	99.6	1.470	1.089	1.004	1.607	
5985	7	802.11ax	OFDM	80	8.00	7.88	8.00	7.26	0.05	0	MIMO	R32W3001GVA	68.1	Back	2	-	99.6	2.390	1.186	1.004	2.846	
6305	71	802.11ax	OFDM	80	8.00	6.55	8.00	7.96	0.02	0	MIMO	R32W3001GVA	68.1	Back	2	-	99.6	2.660	1.396	1.004	3.728	A1
6545	119	802.11ax	OFDM	80	8.00	6.92	8.00	7.90	0.19	0	MIMO	R32W3001GVA	68.1	Back	2	-	99.6	0.702	1.282	1.004	0.904	
7025	215	802.11ax	OFDM	80	8.00	7.43	8.00	6.81	-0.14	0	MIMO	R32W3001GVA	68.1	Back	2	-	99.6	0.521	1.315	1.004	0.688	
6305	71	802.11ax	OFDM	80	8.00	6.55	8.00	7.96	-0.09	0	MIMO	R32W3001GVA	68.1	Back	2	1	99.6	0.243	1.396	1.004	0.341	
6305	71	802.11ax	OFDM	80	8.00	6.55	8.00	7.96	0.04	0	MIMO	R32W3001GVA	68.1	Back	2	2	99.6	0.265	1.396	1.004	0.371	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	-0.20	0	MIMO	R32W3001GVA	68.1	Front	1	-	99.6	0.502	1.089	1.004	0.549	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	0.09	0	MIMO	R32W3001GVA	68.1	Front	2	-	99.6	0.718	1.089	1.004	0.785	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	0.11	0	MIMO	R32W3001GVA	68.1	Top	1	-	99.6	0.086	1.089	1.004	0.094	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	0.00	0	MIMO	R32W3001GVA	68.1	Top	2	-	99.6	0.106	1.089	1.004	0.116	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	-0.17	0	MIMO	R32W3001GVA	68.1	Right	-	-	99.6	0.752	1.089	1.004	0.822	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	0.21	0	MIMO	R32W3001GVA	68.1	Left	-	-	99.6	1.010	1.089	1.004	1.104	

Note 1: Peak 1/2 correspond to hotspot location on WIFI1/WIFI2 ant of the DUT respectively.

Note 2: To achieve the 18.0 dBm and 11.00 dBm maximum allowed MIMO power shown in the documentation, each antenna transmits at a maximum allowed power of 15.0 dBm and 8.0 dBm respectively.

Table 9-4
6 GHz WLAN Body MIMO Absorbed Power Density - Laptop

MEASUREMENT RESULTS																					
FREQUENCY		Mode	Service	Bandwidth [MHz]	Maximum Allowed Power (Ant 1) [dBm]	Conducted Power (Ant 1) [dBm]	Maximum Allowed Power (Ant 2) [dBm]	Conducted Power (Ant 2) [dBm]	Power Drift [dB]	Spacing (mm)	Antenna Config.	Device Serial Number	Data Rate (Mbps)	Side	Keyboard Variant	Duty Cycle (%)	Measured APD	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Scaled APD	Plot #
MHz	Ch.																W/m^2 (4cm^2)			W/m^2 (4cm^2)	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	0.18	0	MIMO	R32W3001FXT	68.1	Bottom	1	99.6	0.688	1.064	1.004	0.735	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	0.02	0	MIMO	R32W3001FXT	68.1	Bottom	2	99.6	0.906	1.064	1.004	0.968	
5985	7	802.11ax	OFDM	80	15.00	14.90	15.00	14.22	-0.20	0	MIMO	R32W3001FXT	68.1	Bottom	2	99.6	1.99	1.197	1.004	2.392	A2
6305	71	802.11ax	OFDM	80	15.00	13.25	15.00	14.85	-0.05	0	MIMO	R32W3001FXT	68.1	Bottom	2	99.6	1.72	1.496	1.004	2.583	
6545	119	802.11ax	OFDM	80	15.00	14.16	15.00	14.92	-0.15	0	MIMO	R32W3001FXT	68.1	Bottom	2	99.6	0.56	1.213	1.004	0.682	
7025	215	802.11ax	OFDM	80	15.00	14.91	15.00	13.98	-0.03	0	MIMO	R32W3001FXT	68.1	Bottom	2	99.6	0.969	1.265	1.004	1.231	

Note 1: To achieve the 18.0 dBm maximum allowed MIMO power shown in the documentation, each antenna transmits at a maximum allowed power of 15.0 dBm.

SAR and Absorbed Power Density General Notes

1. The test data reported are the worst-case SAR values according to test procedures specified in IEEE 1528-2013, and FCC KDB Publication 447498 D01.
2. Batteries are fully charged at the beginning of the SAR measurements.
3. Liquid tissue depth was at least 15.0 cm for all frequencies.
4. 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.
5. SAR and APD results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB Publication 447498 D01.
6. Per FCC guidance, SAR was performed using 6.5 GHz SAR probe calibration factors. Per October 2020 TCB Workshop notes, 5 channels were tested. Absorbed power density (APD) using a 4cm^2 averaging area is reported based on SAR measurements.
7. 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.
8. Per FCC KDB 616217 D04, SAR is evaluated for the bottom surface of a keyboard when it is attached to the DUT in laptop configuration.
9. Per FCC KDB 648474 D04, highest reported SAR tablet configuration for a transmission band on an antenna was additionally evaluated with keyboard accessory attached and folded back at 360˚.

WLAN Notes:

1. Per KDB Publication 248227 D01v02r02, SAR for MIMO was evaluated by following the simultaneous SAR provisions from KDB Publication 447498 D01v06 by either evaluating the sum of the 1g SAR values of each antenna transmitting independently or making a SAR measurement with both antennas transmitting simultaneously. Please see the Simultaneous Numerical Calculations Appendix for complete analysis
2. When the maximum reported 1g averaged SAR is ≤0.8 W/kg, SAR testing on additional channels was not required. Otherwise, SAR for the next highest output power channel was required until the reported SAR result was ≤ 1.20 W/kg for 1g evaluations or all test channels were measured.
3. The device was configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools. The reported SAR was scaled to the 100% transmission duty factor to determine compliance. Procedures used to measure the duty factor are identical to that in the associated EMC test reports.

9.2 Power Density Results

Table 9-5
6 GHz WLAN Body MIMO Power Density - Tablet

MEASUREMENT RESULTS																													
Frequency (MHz)	Channel	Mode	Service	Bandwidth (MHz)	Maximum Allowed Power (Ant 1) [dBm]	Conducted Power (Ant 1) [dBm]	Maximum Allowed Power (Ant 2) [dBm]	Conducted Power (Ant 2) [dBm]	Power Drift (dB)	Spacing (mm)	Antenna Config.	DUT Serial Number	Data Rate (Mbps)	Side	Peak	Keyboard Variant	Duty Cycle (%)	Grid Step (λ)	IPD (W/m²)	Scaling Factor for Measurement Uncertainty per IEC 62479	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Normal psPD (W/m²)	Scaled Normal psPD (W/m²)	Total psPD (W/m²)	Scaled Total psPD (W/m²)	Plot #
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	0.04	15	MIMO	R32W3001GVA	68.1	Back	1	-	99.6	0.25	-	1.554	1.064	1.004	0.205	0.340	0.219	0.364	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	0.02	15	MIMO	R32W3001GVA	68.1	Back	2	-	99.6	0.25	-	1.554	1.064	1.004	0.254	0.422	0.310	0.515	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	-0.07	15	MIMO	R32W3001GVA	68.1	Front	1	-	99.6	0.25	-	1.554	1.064	1.004	0.222	0.369	0.241	0.400	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	0.18	15	MIMO	R32W3001GVA	68.1	Front	2	-	99.6	0.25	-	1.554	1.064	1.004	0.464	0.770	0.476	0.790	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	-0.20	19	MIMO	R32W3001GVA	68.1	Top	1	-	99.6	0.25	-	1.554	1.064	1.004	0.145	0.241	0.165	0.274	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	-0.07	19	MIMO	R32W3001GVA	68.1	Top	2	-	99.6	0.25	-	1.554	1.064	1.004	0.155	0.257	0.163	0.271	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	0.05	7	MIMO	R32W3001GVA	68.1	Right	-	-	99.6	0.25	-	1.554	1.064	1.004	0.597	0.991	0.684	1.135	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	-0.04	9	MIMO	R32W3001GVA	68.1	Left	-	-	99.6	0.25	-	1.554	1.064	1.004	0.724	1.202	0.812	1.348	
5985	7	802.11ax	OFDM	80	15.00	14.90	15.00	14.22	-0.09	9	MIMO	R32W3001GYK	68.1	Left	-	-	99.6	0.25	-	1.554	1.197	1.004	0.990	1.849	1.210	2.260	
6305	71	802.11ax	OFDM	80	15.00	13.25	15.00	14.85	0.12	9	MIMO	R32W3001GYK	68.1	Left	-	-	99.6	0.25	-	1.554	1.496	1.004	1.170	2.731	1.270	2.964	A3
6545	119	802.11ax	OFDM	80	15.00	14.16	15.00	14.92	-0.17	9	MIMO	R32W3001GYK	68.1	Left	-	-	99.6	0.25	-	1.554	1.213	1.004	0.412	0.780	0.429	0.812	
7025	215	802.11ax	OFDM	80	15.00	14.91	15.00	13.98	-0.14	9	MIMO	R32W3001GYK	68.1	Left	-	-	99.6	0.25	-	1.554	1.265	1.004	0.307	0.606	0.326	0.643	
6305	71	802.11ax	OFDM	80	15.00	13.25	15.00	14.85	0.20	9	MIMO	R32W3001GYK	68.1	Left	-	1	99.6	0.25	-	1.554	1.496	1.004	0.447	1.043	0.537	1.253	
6305	71	802.11ax	OFDM	80	15.00	13.25	15.00	14.85	-0.20	9	MIMO	R32W3001GYK	68.1	Left	-	2	99.6	0.25	-	1.554	1.496	1.004	0.525	1.225	0.562	1.312	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	0.19	2	MIMO	R32W3001GYK	68.1	Back	1	-	99.6	0.25	-	1.554	1.089	1.004	0.310	0.527	0.372	0.632	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	-0.16	2	MIMO	R32W3001GYK	68.1	Back	2	-	99.6	0.25	3.160	1.554	1.089	1.004	0.332	0.564	0.362	0.615	
5985	7	802.11ax	OFDM	80	8.00	7.88	8.00	7.26	0.01	2	MIMO	R32W3001GYK	68.1	Back	2	-	99.6	0.25	-	1.554	1.186	1.004	0.247	0.457	0.326	0.603	
6305	71	802.11ax	OFDM	80	8.00	6.55	8.00	7.96	-0.07	2	MIMO	R32W3001GYK	68.1	Back	2	-	99.6	0.25	-	1.554	1.396	1.004	0.496	1.080	0.518	1.128	
6545	119	802.11ax	OFDM	80	8.00	6.92	8.00	7.90	-0.08	2	MIMO	R32W3001GYK	68.1	Back	2	-	99.6	0.25	-	1.554	1.282	1.004	0.463	0.926	0.492	0.984	
7025	215	802.11ax	OFDM	80	8.00	7.43	8.00	6.81	0.07	2	MIMO	R32W3001GYK	68.1	Back	2	-	99.6	0.25	-	1.554	1.315	1.004	0.189	0.388	0.215	0.441	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	0.05	8.84	MIMO	R32W3001GYK	68.1	Back	2	-	99.6	0.25	0.563	1.554	1.089	1.004	0.129	0.219	0.133	0.226	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	-0.21	2	MIMO	R32W3001GYK	68.1	Front	1	-	99.6	0.25	-	1.554	1.089	1.004	0.285	0.484	0.389	0.661	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	-0.20	2	MIMO	R32W3001GYK	68.1	Front	2	-	99.6	0.25	-	1.554	1.089	1.004	0.327	0.556	0.389	0.661	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	0.12	2	MIMO	R32W3001GYK	68.1	Top	1	-	99.6	0.25	-	1.554	1.089	1.004	0.125	0.212	0.171	0.291	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	0.05	2	MIMO	R32W3001GYK	68.1	Top	2	-	99.6	0.25	-	1.554	1.089	1.004	0.092	0.156	0.102	0.173	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	-0.18	2	MIMO	R32W3001GYK	68.1	Right	-	-	99.6	0.25	-	1.554	1.089	1.004	0.124	0.211	0.157	0.267	
6785	167	802.11ax	OFDM	80	8.00	7.63	8.00	7.83	0.17	2	MIMO	R32W3001GYK	68.1	Left	-	-	99.6	0.25	-	1.554	1.089	1.004	0.228	0.387	0.257	0.437	
47 CFR §1.1310 - SAFETY LIMIT Spatial Average Uncontrolled Exposure / General Population																	Power Density 10 W/m² averaged over 4 cm²											

Note 1: Peak 1/2 correspond to hotspot location on WIFI1/WIFI2 ant of the DUT respectively.

Note 2: To achieve the 18.0 dBm and 11.00 dBm maximum allowed MIMO power shown in the documentation, each antenna transmits at a maximum allowed power of 15.0 dBm and 8.0 dBm respectively.

Table 9-6
6 GHz WLAN Body MIMO Power Density – Laptop

MEASUREMENT RESULTS																												
Frequency (MHz)	Channel	Mode	Service	Bandwidth [MHz]	Maximum Allowed Power (Ant 1) [dBm]	Conducted Power (Ant 1) [dBm]	Maximum Allowed Power (Ant 2) [dBm]	Conducted Power (Ant 2) [dBm]	Keyboard Variant	Power Drift (dB)	Spacing (mm)	Antenna Config.	DUT Serial Number	Data Rate (Mbps)	Side	Duty Cycle (%)	Grid Step (λ)	IPD (W/m²)	Scaling Factor for Measurement Uncertainty per IEC 62479	Scaling Factor (Power)	Scaling Factor (Duty Cycle)	Normal psPD (W/m²)	Scaled Normal psPD (W/m²)	Total psPD (W/m²)	Scaled Total psPD (W/m²)	Plot #
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	1	-0.09	2	MIMO	R32W3001GYK	68.1	Bottom	99.6	0.25	1.31	1.554	1.064	1.004	1.060	1.760	1.280	2.125	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	1	-0.21	8.84	MIMO	R32W3001GYK	68.1	Bottom	99.6	0.25	1.49	1.554	1.064	1.004	0.311	0.516	0.399	0.662	
5985	7	802.11ax	OFDM	80	15.00	14.90	15.00	14.22	1	-0.20	2	MIMO	R32W3001GYK	68.1	Bottom	99.6	0.25	3.25	1.554	1.197	1.004	1.810	3.380	2.340	4.370	A4
6305	71	802.11ax	OFDM	80	15.00	13.25	15.00	14.85	1	-0.03	2	MIMO	R32W3001GYK	68.1	Bottom	99.6	0.25	1.64	1.554	1.496	1.004	1.480	3.454	2.030	4.738	
6545	119	802.11ax	OFDM	80	15.00	14.16	15.00	14.92	1	-0.01	2	MIMO	R32W3001GYK	68.1	Bottom	99.6	0.25	1.66	1.554	1.213	1.004	0.381	0.721	0.431	0.816	
7025	215	802.11ax	OFDM	80	15.00	14.91	15.00	13.98	1	-0.12	2	MIMO	R32W3001GYK	68.1	Bottom	99.6	0.25	1.52	1.554	1.265	1.004	0.468	0.924	0.849	1.676	
6785	167	802.11ax	OFDM	80	15.00	14.76	15.00	14.73	2	0.08	2	MIMO	R32W3001GYK	68.1	Bottom	99.6	0.25	2.37	1.554	1.064	1.004	0.995	1.652	1.090	1.809	
47 CFR §1.1310 - SAFETY LIMIT Spatial Average Uncontrolled Exposure / General Population													Power Density 10 W/m² averaged over 4 cm²													

Note 1: To achieve the 18.0 dBm maximum allowed MIMO power shown in the documentation, each antenna transmits at a maximum allowed power of 15.0 dBm.

Power Density General Notes

1. The manufacturer has confirmed that the devices tested have the same physical, mechanical and thermal characteristics and are within operational tolerances expected for production units.
2. Batteries are fully charged at the beginning of the measurements. The DUT was connected to a wall charger for some measurements due to the test duration. It was confirmed that the charger plugged into this DUT did not impact the near-field PD test results.
3. Power density was calculated by repeated E-field measurements on two measurement planes separated by λ/4.
4. The device was configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools.
5. Per FCC guidance and equipment manufacturer guidance, power density results were scaled according to IEC 62479:2010 for the portion of the measurement uncertainty > 30%. Total expanded uncertainty of 2.68 dB (85.4%) was used to determine the psPD measurement scaling factor.
6. Per equipment manufacturer guidance, power density was measured at d=2mm and d=λ/5mm using the same grid size and grid step size for some frequencies and surfaces. The integrated Power Density (iPD) was calculated based on these measurements. Since iPD ratio between the two distances is ≥ -1dB, the grid step was sufficient for determining compliance at d=2mm.
7. PD results were scaled to the maximum allowed power to demonstrate compliance per FCC KDB Publication 447498 D04.
8. PTP-PR algorithm was used during psPD measurement and calculations.
9. WIFI 6 GHz operations are limited to MIMO operations only (does not support stand-alone mode). psPD for MIMO was evaluated by making a measurement with both antennas transmitting simultaneously

10 EQUIPMENT LIST

Manufacturer	Model	Description	Cal Date	Cal Interval	Cal Due	Serial Number
-	WL25-1	Conducted Cable Set (25GHz)	1/12/2023	Annual	1/12/2024	WL25-1
Agilent	N9038A	MXE EMI Receiver	N/A	N/A	N/A	MY51210133
Rohde & Schwarz	FSW67	Signal / Spectrum Analyzer	N/A	N/A	N/A	103200
Sunol	JB5	Bi-Log Antenna (30M - 5GHz)	N/A	N/A	N/A	A051107
Emco	3115	Horn Antenna (1-18GHz)	N/A	N/A	N/A	A051107
Amplifier Research	15S1G6	Amplifier	CBT	N/A	CBT	433975
Keysight Technologies	N9030A	3Hz-44GHz PXA Signal Analyzer	8/18/2022	Annual	8/18/2023	MY49430494
Rohde & Schwarz	NRX	Power Meter	1/31/2023	Annual	1/31/2024	102582
Rohde & Schwarz	NRP-Z81	Wide Band Power Sensor	1/19/2023	Annual	1/19/2024	106560
SPEAG	EUmmWV3	EUmmWV3 Probe	6/16/2022	Annual	6/16/2023	9364
SPEAG	SM 003 100 AA	10 GHz System Verification Antenna	10/12/2022	Annual	10/12/2023	1006
SPEAG	DAE4	Dasy Data Acquisition Electronics	11/10/2022	Annual	11/10/2023	1646
SPEAG	EX3DV4	SAR Probe	4/18/2023	Annual	4/18/2024	7532
SPEAG	DAE4	Dasy Data Acquisition Electronics	4/14/2023	Annual	4/14/2024	501
SPEAG	D6.5GHzV2	6.5GHz SAR Dipole	12/7/2022	Annual	12/7/2023	1019
Control Company	4352	Long Stem Thermometer	9/10/2021	Biennial	9/10/2023	210774678
Control Company	4040	Therm./Clock/Humidity Monitor	5/11/2022	Biennial	5/11/2024	221514974
Agilent	SMF100A	Signal Generator	3/28/2022	Biennial	3/28/2024	101590
Rhode & Shwarz	ZNB40	Vector Network Analyzer 2 Port	10/12/2022	Annual	10/12/2023	101412
SPEAG	DAKS-3.5	Portable Dielectric Assessment Kit	9/23/2022	Annual	9/23/2023	1045
Insize	1108-150	Digital Caliper	4/5/2022	Biennial	4/5/2024	409193536
MCL	BW-N6W5+	6dB Attenuator	CBT	N/A	CBT	1139
Narda	BW-S3W2	Attenuator (3dB)	CBT	N/A	CBT	120
Pasternack	PE87FL1017	Low Pass Filter	CBT	N/A	CBT	N/A
MiniCircuits	ZUDC10-83-S+	Directional Coupler	7/4/2022	Annual	7/4/2023	2111
Pasternack	PE5011-1	Torque Wrench	12/21/2021	Biennial	12/21/2023	82475
Anritsu	MA2411B	Pulse Power Sensor	1/10/2023	Annual	1/10/2024	1315051
Anritsu	MA2411B	Pulse Power Sensor	10/21/2022	Annual	10/21/2023	1207364
SPEAG	MAIA	Modulation and Audio Interference Analyzer	N/A	N/A	N/A	1243

Note:

1. Each equipment item was used solely within its respective calibration period.
2. 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.

11 MEASUREMENT UNCERTAINTIES

Applicable for SAR measurements:

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	9.3	N	1	1	1	9.3	9.3	∞
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 Unceritainty	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				13.8	13.6	191
Expanded Uncertainty (95% CONFIDENCE LEVEL)			k=2				27.6	27.1	

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

Applicable for Power Density Measurements:

a	b	c	d	e	f = c x f/e	g
Uncertainty Component	Unc. (± dB)	Prob. Dist.	Div.	c_i	u_i (± dB)	v_i
Measurement System						
Calibration	0.49	N	1	1	0.49	∞
Probe Correction	0.00	R	1.73	1	0.00	∞
Frequency Response	0.20	R	1.73	1	0.12	∞
Sensor Cross Coupling	0.00	R	1.73	1	0.00	∞
Isotropy	0.50	R	1.73	1	0.29	∞
Linearity	0.20	R	1.73	1	0.12	∞
Probe Scattering	0.00	R	1.73	1	0.00	∞
Probe Positioning offset	0.30	R	1.73	1	0.17	∞
Probe Positioning Repeatability	0.04	R	1.73	1	0.02	∞
Sensor Mechanical Offset	0.00	R	1.73	1	0.00	∞
Probe Spatial Resolution	0.00	R	1.73	1	0.00	∞
Field Impedence Dependance	0.00	R	1.73	1	0.00	∞
Amplitude and Phase Drift	0.00	R	1.73	1	0.00	∞
Amplitude and Phase Noise	0.04	R	1.73	1	0.02	∞
Measurement Area Truncation	0.00	R	1.73	1	0.00	∞
Data Acquisition	0.03	N	1	1	0.03	∞
Sampling	0.00	R	1.73	1	0.00	∞
Field Reconstruction	2.00	R	1.73	1	1.15	∞
Forward Transformation	0.00	R	1.73	1	0.00	∞
Power Density Scaling	0.00	R	1.73	1	0.00	∞
Spatial Averaging	0.10	R	1.73	1	0.06	∞
System Detection Limit	0.04	R	1.73	1	0.02	∞
Test Sample Related						
Probe Coupling with DUT	0.00	R	1.73	1	0.00	∞
Modulation Response	0.40	R	1.73	1	0.23	∞
Integration Time	0.00	R	1.73	1	0.00	∞
Response Time	0.00	R	1.73	1	0.00	∞
Device Holder Influence	0.10	R	1.73	1	0.06	∞
DUT alignment	0.00	R	1.73	1	0.00	∞
RF Ambient Conditions	0.04	R	1.73	1	0.02	∞
Ambient Reflections	0.04	R	1.73	1	0.02	∞
Immunity/Secondary Reception	0.00	R	1.73	1	0.00	∞
Drift of DUT	0.21	R	1.73	1	0.12	∞
Combined Standard Uncertainty (k=1)		RSS			1.34	∞
Expanded Uncertainty (95% CONFIDENCE LEVEL)		k=2			2.68	

12 CONCLUSION

12.1 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.

13 REFERENCES

[1] ANSI/IEEE C95.1-1992, American National Standard safety levels with respect to human exposure to radio frequency electromagnetic fields, 3kHz to 300GHz, New York: IEEE, Sept. 1992.

[2] IEC TR 63170:2018, Measurement Procedure for the Evaluation of Power Density Related to Human Exposure to Radiofrequency Fields from Wireless Communication Devices Operating between 6 GHz and 100 GHz

[3] IEC TR 62630: 2010, Guidance for Evaluating Exposure from Multiple Electromagnetic Sources

[4] K. Pokovic, T. Schmid, J. Frohlich, and N. Kuster. Novel Probes and Evaluation Procedures to Assess Field Magnitude and Polarization. IEEE Transactions on Electromagnetic Compatibility 42(2): 240 -244, 2000

[5] R. W. Gerchberg and W. O. Saxton. A Practical Algorithm for the Determination of Phase from Image and Diffraction Plane Pictures. Optik 35(2): 237 – 246, 1972

[6] A. P. Anderson and S. Sali. New Possibilities for Phaseless Microwave Diagnostics. Part 1: Error Reduction Techniques. IEE Proceedings H – Microwaves, Antennas and Propagation 132(5): 290 – 298, 1985

[7] FCC KDB 865664 D02 v01r04: SAR Measurement Requirements for 100 MHz to 6 GHz. Federal Communications Commission – Office of Engineering and Technology, Laboratory Division.

[8] FCC KDB 447498 D01 v02r01: RF Exposure Procedures and Equipment Authorization Policies for Mobile and Portable Devices. Federal Communications Commission – Office of Engineering and Technology, Laboratory Division.

[9] November 2017 Telecommunications Certification Body Council (TCBC) Workshop Notes

[10] October 2018 Telecommunications Certification Body Council (TCBC) Workshop Notes

[11] April 2019 Telecommunications Certification Body Council (TCBC) Workshop Notes

[12] November 2019 Telecommunications Certification Body Council (TCBC) Workshop Notes

[13] SPEAG DASY6 System Handbook (September 2019)

[14] SPEAG DASY6 Application Note (Interim Procedures for Devices Operating at 6-10 GHz)

[15] Federal Communications Commission, ET Docket 93-62, Guidelines for Evaluating the Environmental Effects of Radiofrequency Radiation, Aug. 1996.

[16] ANSI/IEEE C95.1-2005, American National Standard safety levels with respect to human exposure to radio frequency electromagnetic fields, 3kHz to 300GHz, New York: IEEE, 2006.

[17] ANSI/IEEE C95.3-2002, IEEE Recommended Practice for the Measurement of Potentially Hazardous Electromagnetic Fields - RF and Microwave, New York: IEEE, December 2002.

[18] IEEE Standards Coordinating Committee 39 –Standards Coordinating Committee 34 – IEEE Std. 1528-2013, IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques.

[19] NCRP, National Council on Radiation Protection and Measurements, Biological Effects and Exposure Criteria for RadioFrequency Electromagnetic Fields, NCRP Report No. 86, 1986. Reprinted Feb. 1995.

[20] T. Schmid, O. Egger, N. Kuster, Automated E-field scanning system for dosimetric assessments, IEEE Transaction on Microwave Theory and Techniques, vol. 44, Jan. 1996, pp. 105-113.

[21] K. Pokovic, T. Schmid, N. Kuster, Robust setup for precise calibration of E-field probes in tissue simulating liquids at mobile communications frequencies, ICECOM97, Oct. 1997, pp. 1 -124.

[22] K. Pokovic, T. Schmid, and N. Kuster, E-field Probe with improved isotropy in brain simulating liquids, Proceedings of the ELMAR, Zadar, Croatia, June 23-25, 1996, pp. 172-175.

[23] Schmid & Partner Engineering AG, Application Note: Data Storage and Evaluation, June 1998, p2.

[24] V. Hombach, K. Meier, M. Burkhardt, E. Kuhn, N. Kuster, The Dependence of EM Energy Absorption upon Human Modeling at 900 MHz, IEEE Transaction on Microwave Theory and Techniques, vol. 44 no. 10, Oct. 1996, pp. 1865-1873.

[25] N. Kuster and Q. Balzano, Energy absorption mechanism by biological bodies in the near field of dipole antennas above 300MHz, IEEE Transaction on Vehicular Technology, vol. 41, no. 1, Feb. 1992, pp. 17-23.

[26] G. Hartsgrove, A. Kraszewski, A. Surowiec, Simulated Biological Materials for Electromagnetic Radiation Absorption Studies, University of Ottawa, Bioelectromagnetics, Canada: 1987, pp. 29-36.

[27] Q. Balzano, O. Garay, T. Manning Jr., Electromagnetic Energy Exposure of Simulated Users of Portable Cellular Telephones, IEEE Transactions on Vehicular Technology, vol. 44, no.3, Aug. 1995.

[28] W. Gander, Computermathematick, Birkhaeuser, Basel, 1992.

[29] W.H. Press, S.A. Teukolsky, W.T. Vetterling, and B.P. Flannery, Numerical Recipes in C, The Art of Scientific Computing, Second edition, Cambridge University Press, 1992.

[30] N. Kuster, R. Kastle, T. Schmid, Dosimetric evaluation of mobile communications equipment with known precision, IEEE Transaction on Communications, vol. E80-B, no. 5, May 1997, pp. 645-652.

[31] CENELEC CLC/SC111B, European Prestandard (prENV 50166-2), Human Exposure to Electromagnetic Fields High-frequency: 10kHz-300GHz, Jan. 1995.

[32] Prof. Dr. Niels Kuster, ETH, Eidgenössische Technische Hoschschule Zürich, Dosimetric Evaluation of the Cellular Phone.

[33] IEC 62209-1, Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Part 1: Devices used next to the ear (Frequency range of 300 MHz to 6 GHz), July 2016.

[34] Innovation, Science, Economic Development Canada RSS-102 Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands) Issue 5, March 2015.

[35] Health Canada Safety Code 6 Limits of Human Exposure to Radio Frequency Electromagnetic Fields in the Frequency Range from 3 kHz – 300 GHz, 2015

[36] FCC SAR Test Procedures for 2G-3G Devices, Mobile Hotspot and UMPC Devices KDB Publications 941225, D01-D07

[37] SAR Measurement Guidance for IEEE 802.11 Transmitters, KDB Publication 248227 D01

[38] FCC SAR Considerations for Handsets with Multiple Transmitters and Antennas, KDB Publications 648474 D03-D04

[39] FCC SAR Evaluation Considerations for Laptop, Notebook, Netbook and Tablet Computers, FCC KDB Publication 616217 D04

[40] FCC SAR Measurement and Reporting Requirements for 100MHz – 6 GHz, KDB Publications 865664 D01-D02

[41] FCC General RF Exposure Guidance and SAR Procedures for Dongles, KDB Publication 447498, D01-D02

[42] Anexo à Resolução No. 533, de 10 de Septembro de 2009.

[43] IEC 62209-2, Human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Human models, instrumentation, and procedures - Part 2: Procedure to determine the specific absorption rate (SAR) for wireless communication devices used in close proximity to the human body (frequency range of 30 MHz to 6 GHz), Mar. 2010.

[44] ANSI/IEEE C95.1-1992, American National Standard safety levels with respect to human exposure to radio frequency electromagnetic fields, 3kHz to 300GHz, New York: IEEE, Sept. 1992.