SAR EVALUATION REPORT

FCC 47 CFR § 2.1093
IEEE Std. 1528-2013
RSS-102 ISSUE 5
IEC/IEEE 62209-1528:2020

For
Vest Personnel Terminal, Vest Clothing Personnel

FCC ID: 2BBEG-VPTA1H
IC: 31079-VPTA1H

MODEL NUMBER: VPTA1H
SERIAL MODEL: VCPA01H

Report Number: 4791107348-SAR-1

Issue Date: Nov. 27, 2023

Prepared for
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Revision History

Rev.	Date	Revisions	Revised By
V1.0	Nov. 27, 2023	Initial Issue	\

Note:

1. The Measurement result for the sample received is<Pass> according to < IEEE Std. 1528> , < RSS-102 Issue 5> when <Accuracy Method> decision rule is applied.
2. This report is only published to and used by the applicant, and it is not for evidence purpose in China.
3. VCPA01H consists of two VPTA1H. The two VPTA1H are connected through communica tion cables.

Table of Contents

1. Attestation of Test Results

Applicant Name	HAI ROBOTICS Co., Ltd.

Address	Room 201, 301, 401, Building B, Anluo Technology Industrial Park, Nanchang Community, Xixiang Street, Bao'an District, Shenzhen City, Guangdong Province, P.R. China	
Manufacturer	HAI ROBOTICS Co., Ltd.	
Address	Room 201, 301, 401, Building B, Anluo Technology Industrial Park, Nanchang Community, Xixiang Street, Bao'an District, Shenzhen City, Guangdong Province, P.R. China	
EUT Name	Vest Personnel Terminal, Vest Clothing Personnel	
Model	VPTA1H	
Serial Model	VCPA01H	
Sample Status	Normal	
Sample Received Date	Nov. 20, 2023	
Date of Tested	Nov. 21, 2023	
Applicable Standards	FCC 47 CFR § 2.1093 IEEE Std. 1528-2013 RSS-102 ISSUE 5 IEC/IEEE 62209-1528:2020 KDB publication	
SAR Limits (W/Kg)		
Exposure Category	Peak spatial-average (1g of tissue)	Extremities (hands, wrists, ankles, etc.) (10g of tissue)
General population / Uncontrolled exposure	1.6	4
The Highest Reported SAR (W/kg)		
RF Exposure Conditions	**Equipment Class**	
	NII	
Body 1-g (5mm)	0.602	
Simultaneous Transmission (1-g)	0.615 (VPTA1H)	
Simultaneous Transmission (1-g)	1.230 (VCPA01H) Worst-case scenario of simultaneous transmission of two VPTA1H	
Test Results	Pass	
Prepared By: Burt Hu Burt Hu Laboratory Engineer	Reviewed By: Denny Huang Denny Huang Senior Project Engineer	Approved By: Stephen Guo Stephen Guo Laboratory Manager

2. Test Specification, Methods and Procedures

The tests documented in this report were performed in accordance with IEEE Std.1528-2013, the following FCC Published RF exposure KDB procedures:

- 248227 D01 802.11 Wi-Fi SAR
- 447498 D01 General RF Exposure Guidance
- 690783 D01 SAR Listings on Grants
- 865664 D01 SAR measurement 100 MHz to 6 GHz
- 865664 D02 RF Exposure Reporting

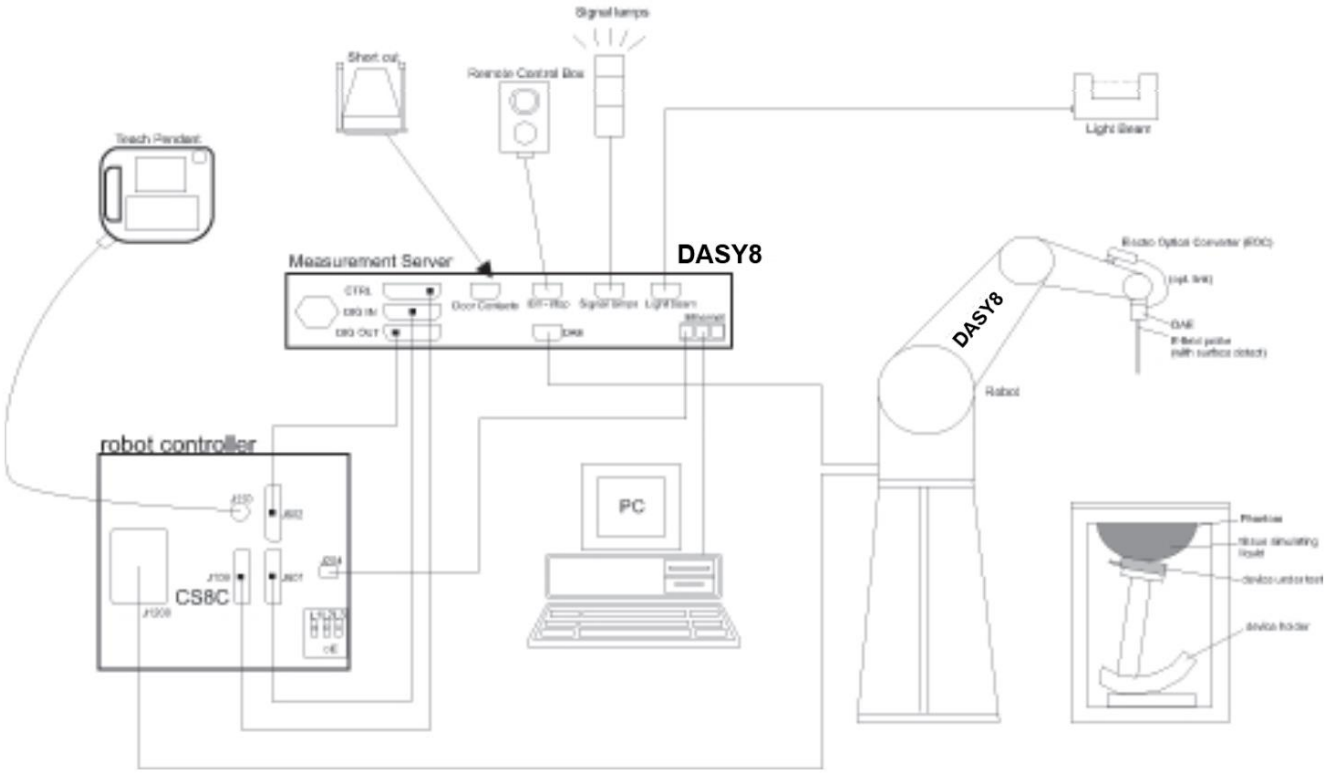
3. Facilities and Accreditation

Test Location	UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch.
Address	Building 10, Innovation Technology Park, Song Shan Lake Hi-tech Development Zone, Dongguan, 523808, China
Accreditation Certificate	**A2LA (Certificate No.: 4102.01)** UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch has been assessed and proved to be in compliance with A2LA. **FCC (FCC Recognized No.: CN1187)** UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch has been recognized to perform compliance testing on equipment subject to the Commission's Declaration of Conformity (DoC) and Certification rules **ISED (Company No.: 21320)** UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch. has been registered and fully described in a report filed with ISED. The Company Number is 21320 and the test lab Conformity Assessment Body Identifier (CABID) is CN0046. **VCCI (Registration No.: G-20192, C-20153, T-20155 and R-20202)** UL Verification Services (Guangzhou) Co., Ltd. Song Shan Lake Branch. has been assessed and proved to be in compliance with VCCI, the Membership No. is 3793. Facility Name: Chamber D, the VCCI registration No. is G-20192 and R-20202 Shielding Room B, the VCCI registration No. is C-20153 and T-20155
Description	All measurement facilities use to collect the measurement data are located at Building 10, Innovation Technology Park, Song Shan Lake Hi tech Development Zone, Dongguan, 523808, China

4. SAR Measurement System & Test Equipment

4.1. SAR Measurement System

The DASY8 system used for performing compliance tests consists of the following items:



- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running Win10 and the DASY8 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

4.2. SAR Scan Procedures

Step 1: Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 2.1 mm. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

Step 2: Area Scan

The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum locations even in relatively coarse grids. When an Area Scan has measured all reachable points, it computes the field maximal found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE Standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan). If only one Zoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of Zoom Scans has to be increased accordingly.

Area Scan Parameters extracted from KDB 865664 D01 v01r04 SAR Measurement 100 MHz to 6 GHz

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 mm ± 1 mm	$½ \cdot \delta \cdot \ln(2)$ mm ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}	≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
	When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	

Step 3: Zoom Scan

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. The Zoom Scan measures points (refer to table below) within a cube whose base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the Zoom Scan evaluates the averaged SAR for 1 g and 10 g and displays these values next to the job's label.

Zoom Scan Parameters extracted from KDB 865664 D01 v01r04 SAR Measurement 100 MHz to 6 GHz

Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{Zoom}(n>1)$: between subsequent points	≤ 1.5·$\Delta z_{Zoom}(n-1)$ mm	
Minimum zoom scan volume	x, y, z		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm

Step 4: Power drift measurement

The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

Step 5: Z-Scan (FCC only)

The Z Scan measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. In order to get a reasonable extrapolation the extrapolated distance should not be greater than the step size in Z-direction.

4.3. Test Equipment

The measuring equipment used to perform the tests documented in this report has been calibrated in accordance with the manufacturers' recommendations, and is traceable to recognized national standards.

Name of equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
ENA Network Analyzer	Keysight	E5080A	MY55100583	2024.10.11
Dielectric Probe kit	SPEAG	SM DAK 040 SA	1155	2025.02.27
DC power supply	Keysight	E36103A	MY55350020	2024.10.11
Signal Generator	Rohde & Schwarz	SME06	837633\001	2024.08.06
BI-Directional Coupler	KRYTAR	1850	54733	2024.10.11
Peak and Average Power Sensor	Keysight	E9325A	MY62220002	2024.10.11
Peak and Average Power Sensor	Keysight	E9325A	MY62220003	2024.10.11
Dual Channel PK Power Meter	Keysight	N1912A	MY55416024	2024.10.11
Amplifier	CORAD TECHNOLOGY LTD	AMF-4D-00400600-50-30P	1983561	NCR
Dosimetric E-Field Probe	SPEAG	EX3DV4	7383	2024.06.04
Data Acquisition Electronic	SPEAG	DAE3	427	2024.05.16
Dipole Kit 5 GHz	SPEAG	D5GHzV2	1231	2024.12.15
Software	SPEAG	DASY8	N/A	NCR
ELI Phantom	SPEAG	ELI V8.0	2178	NCR
Thermometer	/	GX-138	150709653	2024.10.18
Thermometer	VICTOR	ITHX-SD-5	18470005	2024.10.18

Note:

1) As per KDB865664D01 requirements for dipole calibration, the test laboratory has adopted three-year extended calibration interval. Each measured dipole is expected to evaluate with the following criteria at least on annual interval in Appendix C.
   a) There is no physical damage on the dipole;
   b) System check with specific dipole is within 10% of calibrated value;
   c) The most recent return-loss result, measured at least annually, deviates by no more than 20% from the previous measurement.
   d) The most recent measurement of the real or imaginary parts of the impedance, measured at least annually is within 5Ω from the previous measurement.
2) Dielectric assessment kit is calibrated against air, distilled water and a shorting block performed before measuring liquid parameters.
3) NCR is short for "No Calibration Requirement".

5. Measurement Uncertainty

5.1. Uncertainty budget list (4MHz to 10GHz)

Symbol	Input quantity X_i (source of uncertainty)	Unc. (±)	Prob. Dist. PDF_i	Unc. $a(x_i)$	c_i (1g)	c_i (10g)	U_i (1g) (%)	U_i (10g) (%)
Measurement system errors								
CF	Probe calibration	18.6	N (k = 2)	2	1	1	9.3	9.3
CF_{drift}	Probe calibration drift	1.7	R	√3	1	1	1.0	1.0
LIN	Probe linearity and detection limit	0.6	R	√3	1	1	0.3	0.3
BBS	Broadband signal	0.5	R	√3	1	1	0.3	0.3
ISO	Probe isotropy	0.5	R	√3	1	1	0.3	0.3
DAE	Other probe and data acquisition errors	2.4	N	1	1	1	2.4	2.4
AMB	RF ambient and noise	3.0	R	√3	1	1	1.7	1.7
Δ_{xyz}	Probe positioning errors	0.5	N	1	0.33	0.33	0.2	0.2
DAT	Data processing errors	4.0	R	√3	1	1	2.3	2.3
Phantom and device (DUT or validation antenna) errors								
LIQ(σ)	Measurement of phantom conductivity(σ)	2.5	N	1	0.78	0.71	2.0	1.8
LIQ(Tc)	Temperature effects (medium)	2.7	R	√3	0.78	0.71	1.2	1.1
EPS	Shell permittivity	14.0	R	√3	0.5	0.5	4.0	4.0
DIS	Distance between the radiating element of the DUT and the phantom medium	2.0	N	1	2	2	4.0	4.0
Dxyz	Repeatability of positioning the DUT or source against the phantom	2.9	N	1	1	1	2.9	2.9
H	Device holder effects	3.6	N	1	1	1	3.6	3.6
MOD	Effect of operating mode on probe sensitivity	2.4	R	√3	1	1	1.4	1.4
TAS	Time-average SAR	0.0	R	√3	1	1	0.0	0.0
RF_{drift}	Variation in SAR due to drift in output of DUT	2.5	N	1	1	1	2.5	2.5
VAL	Validation antenna uncertainty (validation measurement only)	0.0	N	1	1	1	0.0	0.0
P_{in}	Uncertainty in accepted power (validation measurement only)	0.0	N	1	1	1	0.0	0.0
Corrections to the SAR result (if applied)								
C(ε',σ)	Phantom deviation from target (ε',σ)	1.9	N	1	1	0.84	1.9	1.6
C(R)	SAR scaling	0.0	R	√3	1	1	0.0	0.0
u(ΔSAR)	Combined uncertainty	\					14.36	14.26
U	Expanded uncertainty and effective degrees of freedom (k = 2)	\					28.73	28.53

6. Device Under Test (DUT) Information

6.1. DUT Description

The DUT is a Vest Personnel Terminal with a Wi-Fi 5GHz and SRD/UWB radio.	
DUT Dimension	Overall (Length x Width x Height): 107.2 mm x 63.99 mm x 25.5mm

6.2. Wireless Technology

Wireless technology	Frequency band
Wi-Fi	5 GHz
SRD	915MHz
SRD	125kHz
UWB	6.4896 GHz

7. Conducted Output Power Measurement and tune-up tolerance

7.1. Power measurement result of 5G Wi-Fi

According to KDB 248227 D01,When the same transmission mode configurations have the same maximum output power on the same channel for the 802.11 a/n/ac modes, the channel in the lower order/sequence 802.11 mode (a, n, ac) is selected. Therefore the SAR measurements performed for the 802.11a modes

When the specified maximum output power is the same for both UNII 1 and UNII 2A, begin SAR measurements in UNII 2A with the channel with the highest measured output power. If the reported SAR for UNII 2A is ≤ 1.2 W/kg, SAR is not required for UNII 1; otherwise treat the remaining bands separately and test them independently for SAR.

Band	Mode Data Rate	BW[MHz]	Channel	Freq[MHz]	Ant 1		Duty Cycle (%)
					Avg Pwr(dBm)	Tune-up (dBm)	
5.3GHz	802.11a 6Mbps	20M	36	5180	Not Required	9.0	/
			40	5200			
			44	5220			
			48	5240			
			52	5260	12.31	13.0	100
			56	5280	12.26		
			60	5300	11.93		
			64	5320	11.81		
	802.11n HT0	20M	36	5180	Not Required	9.0	/
			40	5200			
			44	5220			
			48	5240			
			52	5260		13.0	
			56	5280			
			60	5300			
			64	5320			
	802.11ac VHT0	20M	36	5180		9.0	
			40	5200			
			44	5220			
			48	5240			
			52	5260		13.0	
			56	5280			
			60	5300			
			64	5320			
	802.11n HT0	40M	38	5190		10.0	
			46	5230			
			54	5270		10.0	
			62	5310			
	802.11ac VHT0	40M	38	5190		10.0	
			46	5230			
			54	5270		10.0	
			62	5310			

Note:
1) As per KDB 447498 D01 sec.4.1.d at the maximum rated output power and within the tune-up tolerance range specified for the product, but not more than 2 dB lower than the maximum tune-up tolerance limit.

Band	Mode Data Rate	BW[MHz]	Channel	Freq[MHz]	Ant 1		Duty Cycle (%)
					Avg Pwr(dBm)	Tune-up (dBm)	
5.6GHz	802.11a 6Mbps	20M	100	5500	13.08	13.5	100
			104	5520	13.02		
			108	5540	13.05		
			112	5560	12.98		
			116	5580	13.18		
			120	5600	13.07		
			124	5620	12.85		
			128	5640	13.01		
			132	5660	12.88		
			136	5680	10.01	10.5	
			140	5700	10.02		
	802.11n HT0	20M	100	5500	Not Required	13.5	/
			104	5520			
			108	5540			
			112	5560			
			116	5580			
			120	5600			
			124	5620			
			128	5640			
			132	5660			
			136	5680		10.0	
			140	5700			
	802.11ac VHT0	20M	100	5500		13.5	/
			104	5520			
			108	5540			
			112	5560			
			116	5580			
			120	5600			
			124	5620			
			128	5640			
			132	5660			
			136	5680		10.0	
			140	5700			
	802.11n	40M	102	5510		12.0	

	HT0		110	5550			
			118	5590			
			126	5630			
			134	5670			
	802.11ac VHT0	40M	102	5510		12.0	
			110	5550			
			118	5590			
			126	5630			
			134	5670			

Note:
2) As per KDB 447498 D01 sec.4.1.d at the maximum rated output power and within the tune-up tolerance range specified for the product, but not more than 2 dB lower than the maximum tune-up tolerance limit.

Band	Mode Data Rate	BW[MHz]	CH	Freq[MHz]	Ant 1		Duty Cycle (%)
					Avg Pwr(dBm)	Tune-up (dBm)	
5.8G	802.11a 6Mbps	20	149	5745	13.71	14.5	100
			153	5765	13.25		
			157	5785	13.65		
			161	5805	13.53		
			165	5825	13.98		
	802.11n20 HT0		149	5745	Not Required	14.5	/
			153	5765			
			157	5785			
			161	5805			
			165	5825			
	802.11ac20 VHT0		149	5745		14.5	
			153	5765			
			157	5785			
			161	5805			
			165	5825			
	802.11n40 HT0	40	151	5755		12.0	
			159	5795			
	802.11ac40 VHT0		151	5755		12.0	
			159	5795			

Note:
3) As per KDB 447498 D01 sec.4.1.d at the maximum rated output power and within the tune-up tolerance range specified for the product, but not more than 2 dB lower than the maximum tune-up tolerance limit.

7.2. Power measurement result of SRD/UWB

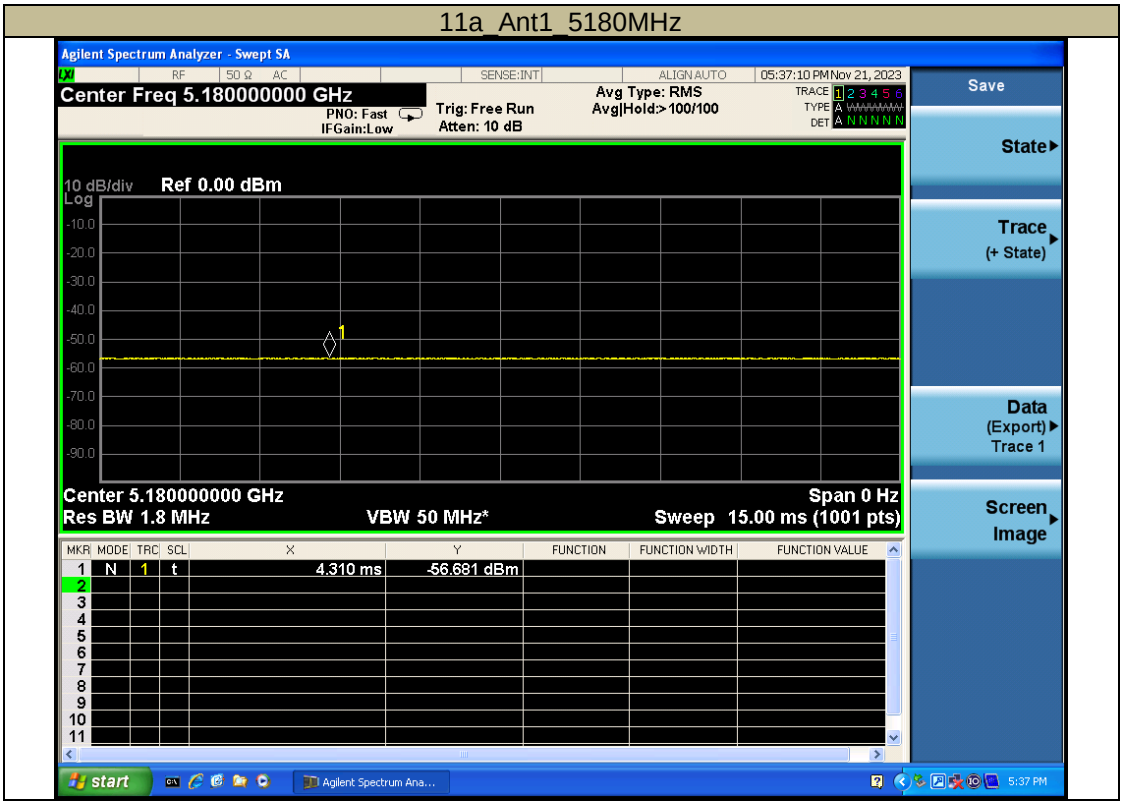
Band	Freq	Pwr(dBm)	Tune-up(dBm)
SRD	915MHz	-15.28	-15.0

SRD	125kHz	3.45	3.5
UWB	6.4896GHz	-7.54	-7.5

7.3. Duty Cycle

Test Mode	Duty Cycle (%)
802.11a	100

11a_Ant1_5180MHz



8. Test Configuration

8.1. Wi-Fi Test Configuration

For Wi-Fi SAR testing, a communication link is set up with the testing software for Wi-Fi mode test. During the test, at the each test frequency channel, the EUT is operated at the RF continuous emission mode. The test procedures in KDB 248227D01 are applied.

8.1.1. Initial Test Position Procedure

For exposure condition with multiple test position, such as handsets 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 position 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 ≤ 0.4W/kg, no additional testing for the remaining test position is required. Otherwise, SAR is evaluated at the subsequent highest peak SAR position until the reported SAR result is ≤ 0.8W/kg or all test position are measured. For all positions/configurations tested using the initial test position and subsequent test positions, when the reported SAR is > 0.8 W/kg, SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel(s) until the reported SAR is ≤ 1.2 W/kg or all required channels are tested.

8.1.2. Initial Test Configuration Procedure

An initial test configuration is determined for OFDM transmission modes according to the channel bandwidth, modulation and data rate combination(s) with the highest maximum output power specified for production units in each standalone and aggregated frequency band. SAR is measured using the highest measured maximum output power channel. For configurations with the same specified or measured maximum output power, additional transmission mode and test channel selection procedures are required (see section 5.3.2 of KDB 248227D01). SAR test reduction of subsequent highest output test channels is based on the reported SAR of the initial test configuration.

For next to the ear, hotspot mode and UMC mini-tablet exposure configurations where multiple test positions are required, the initial test position procedure is applied to minimize the number of test positions required for SAR measurement using the initial test configuration transmission mode. For fixed exposure conditions that do not have multiple SAR test positions, SAR is measured in the transmission mode determined by the initial test configuration.

When the reported SAR of the initial test configuration is > 0.8 W/kg, SAR measurement is required for the subsequent next highest measured output power channel(s) in the initial test configuration until the reported SAR is ≤ 1.2 W/kg or all required channels are tested.

8.1.3. Sub Test Configuration Procedure

SAR measurement requirements for the remaining 802.11 transmission mode configurations that have not been tested in the initial test configuration are determined separately for each standalone and aggregated frequency band, in each exposure condition, according to the maximum output power specified for production units.

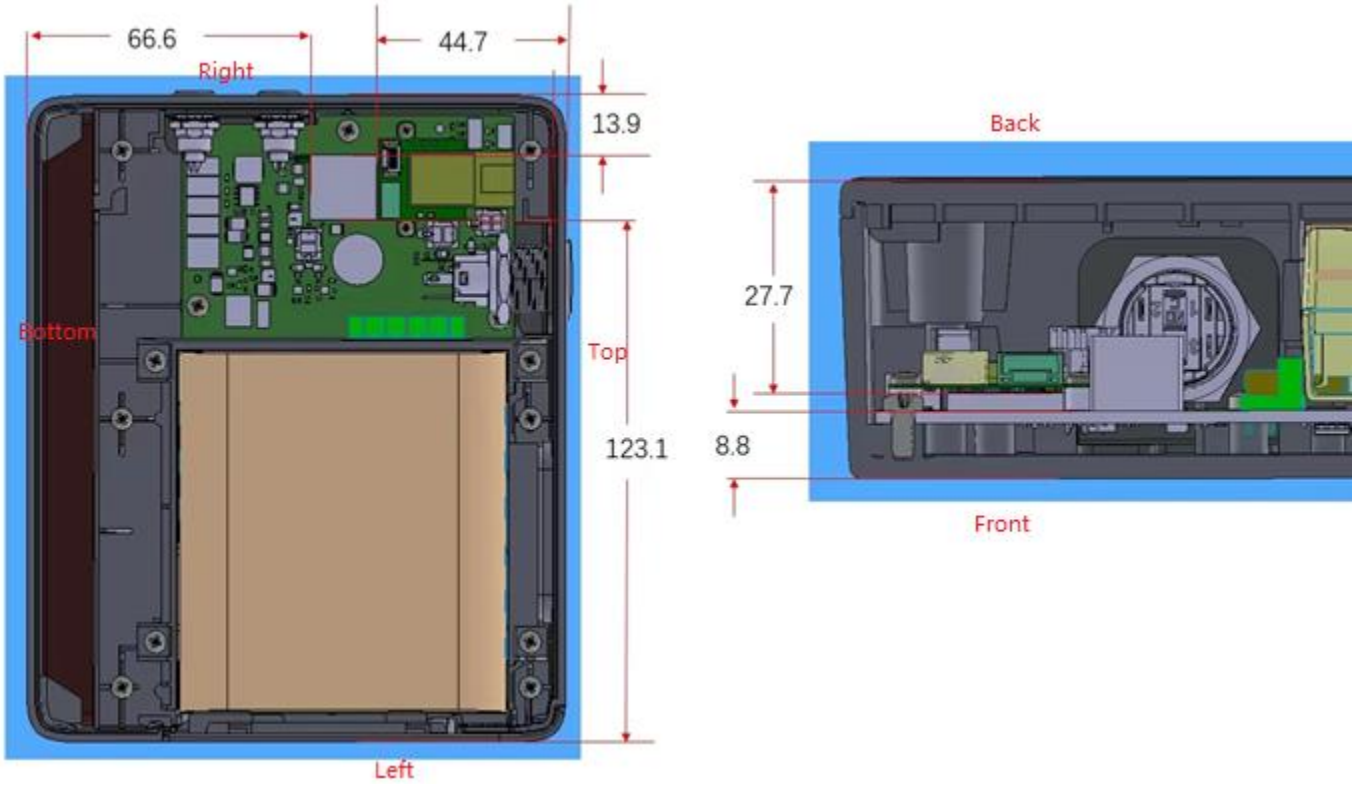
When the highest reported SAR for the initial test configuration, according to the initial test position or fixed exposure position requirements, is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for that subsequent test configuration.

9. RF Exposure Conditions

9.1. Antenna location map

Refer to the diagram inside the device which attached below for the specific details of the antenna-to-edges distances. As per KDB 941225 D06, when the antenna to-edge-distance is greater than 2.5 cm, SAR evaluation is not required for the corresponding position.

Antenna location map



Ant	Test Position	antenna to-edge-distance	Test required
	Front Surface	<25mm	Yes
	Back Surface	>25mm	No
	Left Edge	>25mm	No
	Right Edge	<25mm	Yes
	Top Edge	>25mm	No
	Bottom Edge	>25mm	No

9.2. Evaluation FCC

***SAR Test Exclusion Thresholds* for 100 MHz – 6 GHz and ≤ 50 mm**

Approximate SAR Test Exclusion Power Thresholds at Selected Frequencies and Test Separation Distances are illustrated in the following Table. The equation and threshold in 4.3.1 must be applied to determine SAR test exclusion.

MHz	5	10	15	20	25	mm
150	39	77	116	155	194	*SAR Test Exclusion Threshold* (mW)
300	27	55	82	110	137	
450	22	45	67	89	112	
835	16	33	49	66	82	
900	16	32	47	63	79	
1500	12	24	37	49	61	
1900	11	22	33	44	54	
2450	10	19	29	38	48	
3600	8	16	24	32	40	
5200	7	13	20	26	33	
5400	6	13	19	26	32	
5800	6	12	19	25	31	

For 100 MHz to 6 GHz and *test separation distances* ≤ 50 mm, the 1-g and 10-g *SAR test exclusion thresholds* are determined by the following:

[(*max. power of channel, including tune-up tolerance, mW*) / (*min. test separation distance, mm*)] · [$\sqrt{f_{(GHz)}}$] ≤ 3.0 for 1-g SAR, and ≤ 7.5 for 10-g extremity SAR,[30] where

For 5GHz Wi-Fi 1-g SAR

Frequency (MHz)	Power (dBm)	Power (mW)	Separation Distance (mm)	Calculation Result	Threshold	SAR Test
5250	13.00	19.95	5.00	9.1	3.0	Required

For SRD 1-g SAR

Frequency (MHz)	Power (dBm)	Power (mW)	Separation Distance (mm)	Calculation Result	Threshold	SAR Test
915	3.50	2.24	5.00	0.4	3.0	Excluded
0.125	-8.00	0.16	5.00	0.0	3.0	Excluded

For UWB 1-g SAR

Frequency (MHz)	Power (dBm)	Power (mW)	Separation Distance (mm)	Calculation Result	Threshold	SAR Test
6489.6	-7.50	0.18	5.00	0.1	3.0	Excluded

9.3. Evaluation ISED

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of ≤5 mm	At separation distance of 10 mm	At separation distance of 15 mm	At separation distance of 20 mm	At separation distance of 25 mm
≤300	71 mW	101 mW	132 mW	162 mW	193 mW
450	52 mW	70 mW	88 mW	106 mW	123 mW
835	17 mW	30 mW	42 mW	55 mW	67 mW
1900	7 mW	10 mW	18 mW	34 mW	60 mW
2450	4 mW	7 mW	15 mW	30 mW	52 mW
3500	2 mW	6 mW	16 mW	32 mW	55 mW
5800	1 mW	6 mW	15 mW	27 mW	41 mW

Frequency (MHz)	Exemption Limits (mW)				
	At separation distance of 30 mm	At separation distance of 35 mm	At separation distance of 40 mm	At separation distance of 45 mm	At separation distance of ≥50 mm
≤300	223 mW	254 mW	284 mW	315 mW	345 mW
450	141 mW	159 mW	177 mW	195 mW	213 mW
835	80 mW	92 mW	105 mW	117 mW	130 mW
1900	99 mW	153 mW	225 mW	316 mW	431 mW
2450	83 mW	123 mW	173 mW	235 mW	309 mW
3500	86 mW	124 mW	170 mW	225 mW	290 mW
5800	56 mW	71 mW	85 mW	97 mW	106 mW

For 5GHz Wi-Fi 1-g SAR

Test Mode	Frequency (MHz)	Power (dBm)	Power (mW)	Separation Distance (mm)	Threshold (mW)	SAR Test
WiFi	5250	13.00	19.95	5.00	1.24	Required

For SRD 1-g SAR

Test Mode	Frequency (MHz)	Power (dBm)	Power (mW)	Separation Distance (mm)	Threshold (mW)	SAR Test
SRD	915	3.50	2.24	5.00	16.25	Excluded
SRD	0.125	-8.00	0.16	5.00	71	Excluded

For UWB 1-g SAR

Test Mode	Frequency (MHz)	Power (dBm)	Power (mW)	Separation Distance (mm)	Threshold (mW)	SAR Test
UWB	6489.6	-7.50	0.18	5	1.12	Excluded

10. SAR Test Configuration

The EUT is a Vest Personnel Terminal that is worn with a vest, so consider a 1g body SAR (5mm) evaluation.

Actual work diagram


11. Dielectric Property Measurements & System Check

11.1. Dielectric Property Measurements

The temperature of the tissue-equivalent medium used during measurement must also be within 18°C to 25°C and within ± 2°C of the temperature when the tissue parameters are characterized.
The dielectric parameters must be measured before the tissue-equivalent medium is used in a series of SAR measurements. The parameters should be re-measured after each 3 – 4 days of use; or earlier if the dielectric parameters can become out of tolerance; for example, when the parameters are marginal at the beginning of the measurement series.
Tissue dielectric parameters were measured at the low, middle and high frequency of each operating frequency range of the test device.

Tissue Dielectric Parameters

FCC KDB 865664 D01 v01r04 SAR Measurement 100 MHz to 6 GHz

Target Frequency (MHz)	Head		Body	
	ε_r	σ (S/m)	ε_r	σ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800 – 2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5000	36.2	4.45	49.3	5.07
5100	36.1	4.55	49.1	5.18
5200	36.0	4.66	49.0	5.30
5300	35.9	4.76	48.9	5.42
5400	35.8	4.86	48.7	5.53
5500	35.6	4.96	48.6	5.65
5600	35.5	5.07	48.5	5.77
5700	35.4	5.17	48.3	5.88
5800	35.3	5.27	48.2	6.00

IEEE Std 1528-2013
Refer to Table 3 within the IEEE Std 1528-2013

Dielectric Property Measurements Results:

Liquid	Freq.	Liquid Parameters				Deviation(%)		Limit (%)	Temp. (℃)	Test Date
		Measured		Target						
		ε_r	σ	ε_r	σ	ε_r	σ			
Head 5250	5160	35.70	4.46	36.03	4.61	-0.92	-3.25	±5	22.5	2023.11.21
	5250	35.50	4.55	35.93	4.71	-1.20	-3.40			
	5340	35.50	4.66	35.83	4.80	-0.92	-2.92			
Head 5600	5500	35.00	4.80	35.64	4.96	-1.80	-3.23	±5	22.5	2023.11.21
	5600	34.80	4.93	35.53	5.07	-2.05	-2.76			
	5700	34.70	5.03	35.41	5.17	-2.01	-2.71			
Head 5750	5660	34.60	4.97	35.46	5.13	-2.43	-3.12	±5	22.5	2023.11.21
	5750	34.50	5.10	35.36	5.22	-2.43	-2.30			
	5840	34.30	5.21	35.27	5.30	-2.75	-1.70			

11.2. System Check

SAR system verification is required to confirm measurement accuracy, according to the tissue dielectric media, probe calibration points and other system operating parameters required for measuring the SAR of a test device. The system verification must be performed for each frequency band and within the valid range of each probe calibration point required for testing the device. The same SAR probe(s) and tissue-equivalent media combinations used with each specific SAR system for system verification must be used for device testing. When multiple probe calibration points are required to cover substantially large transmission bands, independent system verifications are required for each probe calibration point. A system verification must be performed before each series of SAR measurements using the same probe calibration point and tissue-equivalent medium. Additional system verification should be considered according to the conditions of the tissue-equivalent medium and measured tissue dielectric parameters, typically every three to four days when the liquid parameters are re-measured or sooner when marginal liquid parameters are used at the beginning of a series of measurements.

System Performance Check Measurement Conditions:

- The measurements were performed in the flat section of the TWIN SAM or ELI phantom, shell thickness: 2.0 ±0.2 mm (bottom plate) filled with Body or Head simulating liquid of the following parameters.
- The depth of tissue-equivalent liquid in a phantom must be ≥ 15.0 cm for SAR measurements ≤ 3 GHz and ≥ 10.0 cm for measurements > 3 GHz.
- The DASY system with an E-Field Probe was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10mm (above 1GHZ) and 15mm (below 1GHz) from dipole center to the simulating liquid surface.
- For area scan, standard grid spacing for head measurements is 15 mm in x- and y- dimension(≤2GHz), 12 mm in x- and y-dimension (2-4 GHz) and 10mm in x- and y- dimension(4-6GHz).
- For zoom scan, Δ x_{zoom}, Δ y_{zoom}≤ 2GHz - ≤8mm, 2-4GHz - ≤5 mm and 4-6 GHz-≤4 mm; Δ z_{zoom} ≤3GHz - ≤5 mm, 3-4 GHz- ≤4 mm and 4-6 GHz-≤2 mm.
- Distance between probe sensors and phantom surface was set to 3 mm except for 5 GHz band. For 5GHz band, Distance between probe sensors and phantom surface was set to 2.5 mm
- The dipole input power (forward power) was set to 100 mW or 250 mW depend on the certificate of the dipoles.
- The results are normalized to 1 W input power.

System Check Results

The 1-g and 10-g SAR measured with a reference dipole, using the required tissue-equivalent medium at the test frequency, must be within 10% of the manufacturer calibrated dipole SAR target.

T.S. Liquid		Messured Results		Target (Ref. value)	Delta (%)	Limit (%)	Temp. (℃)	Test Date
		Zoom Scan (W/Kg)	Normalize to 1W (W/Kg)					
Head 5250	1-g	7.660	76.60	77.90	-1.67	±10	22.5	2023.11.21
	10-g	2.230	22.30	22.60	-1.33			
Head 5600	1-g	8.010	80.10	80.90	-0.99	±10	22.5	2023.11.21
	10-g	2.300	23.00	23.30	-1.29			
Head 5750	1-g	8.150	81.50	78.30	4.09	±10	22.5	2023.11.21
	10-g	2.350	23.50	22.40	4.91			

12. Measured and Reported (Scaled) SAR Results

As per KDB 447498 D01 v06 sec.4.1.e), When SAR or MPE is measured at or scaled to the maximum tune-up tolerance limit, the results are referred to as reported.

Scaled SAR calculation formula:

Scaled SAR = Tune-up in mW / Conducted power in mW * Duty cycle (if available) * SAR value

SAR Test Reduction criteria are as follows:

KDB 447498 D01 v06 General RF Exposure Guidance:
A）Per KDB447498 D01 v06, all SAR measurement results are scaled to the maximum tune-up tolerance limit to demonstrate SAR compliance.
B）Testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:

- ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz.
- ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz.
- ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz.

Per KDB865664 D01 v01r04:
For each frequency band, repeated SAR measurement is required only when the measured SAR is ≥0.8W/Kg; if the deviation among the repeated measurement is ≤ 20%, and the measured SAR <1.45W/Kg, only one repeated measurement is required.

When the highest reported SAR for the initial test configuration, according to the initial test position or fixed exposure position requirements, is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for that subsequent test configuration.

13. Measured SAR Results

13.1. 5GHz Wi-Fi Band

Scenario and Distance (Body 5mm)	Test Mode	Channel/ Frequency	Power (dBm)		SAR Value	Power Drift	Duty Factor (%)	Scaled (W/Kg)
			Tune-up	Meas.	1-g (W/Kg)			
5.3GHz								
Front Surface	11a	52/5260	13.0	12.31	0.407	-0.11	100.00	0.477
Right Edge	11a	52/5260	13.0	12.31	0.096	-0.01	100.00	0.113
Front Surface	11a	60/5300	13.0	11.93	0.352	-0.01	100.00	0.450
Front Surface	11a	64/5320	13.0	11.81	0.458	-0.07	100.00	0.602
5.6GHz								
Front Surface	11a	116/5580	13.5	13.18	0.388	0.15	100.00	0.418
Right Edge	11a	116/5580	13.5	13.18	0.040	-0.02	100.00	0.043
Front Surface	11a	100/5500	13.5	13.08	0.337	-0.02	100.00	0.371
Front Surface	11a	140/5700	10.5	10.02	0.370	-0.02	100.00	0.413
5.8GHz								
Front Surface	11a	165/5825	14.5	13.98	0.386	-0.01	100.00	0.435
Right Edge	11a	157/5785	14.5	13.98	0.035	-0.04	100.00	0.039
Front Surface	11a	149/5745	14.5	13.71	0.377	-0.03	100.00	0.452
Front Surface	11a	157/5785	14.5	13.65	0.451	-0.03	100.00	0.548

Note:
The SAR testing was set to transmit at maximum power for all tests.

Subsequent test configuration SAR evaluation exclusion analysis for 5.3GHz band

Mode	Tune-up (dBm)	Tune-up (mW)	Highest Reported SAR (W/Kg)	Adjusted SAR (W/Kg)	SAR Test
802.11a	13	19.95	0.602	\	\
802.11n 20M	13	19.95	\	0.602	Excluded
802.11n 40M	10	10.00	\	0.302	Excluded
802.11ac 20M	13	19.95	\	0.602	Excluded
802.11ac 40M	10	10.00	\	0.302	Excluded

Note:
1) The 802.11a mode is selected as Initial Test Configuration for SAR test according to the specified maximum output power. As the highest reported SAR for the initial test configuration is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR test for the other 802.11 modes is not required.

Subsequent test configuration SAR evaluation exclusion analysis for 5.6GHz band

Mode	Tune-up (dBm)	Tune-up (mW)	Highest Reported SAR (W/Kg)	Adjusted SAR (W/Kg)	SAR Test
802.11a	13.5	22.39	0.418	\	\
802.11n 20M	13.5	22.39	\	0.418	Excluded
802.11n 40M	12	15.85	\	0.296	Excluded
802.11ac 20M	13.5	22.39	\	0.418	Excluded
802.11ac 40M	12	15.85	\	0.296	Excluded

Note:

1) The 802.11a mode is selected as Initial Test Configuration for SAR test according to the specified maximum output power. As the highest reported SAR for the initial test configuration is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR test for the other 802.11 modes is not required.

Subsequent test configuration SAR evaluation exclusion analysis for 5.8GHz band

Mode	Tune-up (dBm)	Tune-up (mW)	Highest Reported SAR (W/Kg)	Adjusted SAR (W/Kg)	SAR Test
802.11a	14.5	28.18	0.548	\	\
802.11n 20M	14.5	28.18	\	0.548	Excluded
802.11n 40M	12	15.85	\	0.308	Excluded
802.11ac 20M	14.5	28.18	\	0.548	Excluded
802.11ac 40M	12	15.85	\	0.308	Excluded

Note:

1) The 802.11a mode is selected as Initial Test Configuration for SAR test according to the specified maximum output power. As the highest reported SAR for the initial test configuration is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR test for the other 802.11 modes is not required.

14. Simultaneous Transmission SAR Analysis

The EUT Simultaneous Transmission combination as below:

NO	Combination
1	Wi-Fi + SRD+UWB
2	Wi-Fi + SRD
3	SRD+UWB

As per KDB 447498 D01 v06

b) When an antenna qualifies for the standalone SAR test exclusion of 4.3.1 and also transmits simultaneously with other antennas, the standalone SAR value must be estimated according to the following to determine the simultaneous transmission SAR test exclusion criteria:36

1) [(*max. power of channel, including tune-up tolerance, mW*) / (*min. test separation distance, mm*)]·[√f(GHz)/*x*] W/kg, for *test separation distances* ≤ 50 mm;
where *x* = 7.5 for 1-g SAR and *x* = 18.75 for 10-g SAR.
2) 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the *test separation distance* is > 50 mm.37

This SAR estimation formula has been considered in conjunction with the *SAR Test Exclusion Thresholds* to result in substantially conservative SAR values of ≤ 0.4 W/kg. When SAR is estimated, the peak SAR location is assumed to be at the feed-point or geometric center of the antenna, whichever provides a smaller antenna separation distance, and this location must be clearly identified in test reports. The estimated SAR is used only to determine simultaneous transmission SAR test exclusion; it should not be reported as the standalone SAR. When SAR is estimated, it must be applied to determine the sum of 1-g SAR test exclusion. When SAR to peak location separation ratio test exclusion is applied, the highest reported SAR for simultaneous transmission can be an estimated standalone SAR if the estimated SAR is the highest among the simultaneously transmitting antennas (see also KDB Publication 690783 D01). For situations where the estimated SAR is overly conservative for certain conditions, the test lab may choose to perform standalone SAR measurements, then use the measured SAR to determine simultaneous transmission SAR test exclusion. Estimated SAR values at selected frequencies, distances, and power levels are illustrated in Appendix D.

c) When the sum of SAR is larger than the limit, SAR test exclusion is determined by the SAR to peak location separation ratio. The simultaneously transmitting antennas in each operating mode and exposure condition combination must be considered one pair at a time to determine the SAR to peak location separation ratio to qualify for test exclusion. The ratio is determined by (SAR1 + SAR2)1.5/Ri, rounded to two decimal digits, and must be ≤ 0.04 for all antenna pairs in the configuration to qualify for 1-g SAR test exclusion. When 10-g SAR applies, the ratio must be ≤ 0.10. SAR1 and SAR2 are the highest *reported* or estimated SAR values for each antenna in the pair, and Ri is the separation distance in mm between the peak SAR locations for the antenna pair. The antennas in all antenna pairs that do not qualify for simultaneous transmission SAR test exclusion must be tested for SAR compliance, according to the enlarged zoom scan and volume scan post-processing procedures in KDB Publication 865664 D01.

For SRD/UWB 1-g SAR

Test separation distances ≤ 50 mm(1g-SAR)				
Frequency (GHz)	Power (dBm)	Power (mW)	Separation Distance (mm)	Estimate 1g SAR (W/Kg)
0.915	-15.00	0.03	5	0.001
0.000125	3.50	2.24	5	0.001
6.4896	-7.50	0.18	5	0.012

Simultaneous Tx Antenna Combination		∑SAR 1g (W/kg)	Limit (W/kg)
5GHz Wi-Fi$_{MAX}$	SRD		
0.602	0.001	0.603	1.6

Simultaneous Tx Antenna Combination		∑SAR 1g (W/kg)	Limit (W/kg)
5GHz Wi-Fi$_{MAX}$	UWB		
0.602	0.012	0.614	1.6

Simultaneous Tx Antenna Combination		∑SAR 1g (W/kg)	Limit (W/kg)
SRD	UWB		
0.001	0.012	0.013	1.6

Simultaneous Tx Antenna Combination			∑SAR 1g (W/kg)	Limit (W/kg)
5GHz Wi-Fi$_{MAX}$	SRD	UWB		
0.602	0.001	0.012	0.615	1.6

Appendixes

Refer to separated files for the following appendixes.

4791107348-SAR-1_App A Photo

4791107348-SAR-1_App B System Check Plots

4791107348-SAR-1_App C Highest Test Plots

4791107348-SAR-1_App D Cal. Certificates

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