SAR EVALUATION REPORT

FCC 47 CFR § 2.1093
IEEE Std 1528-2013

For
Dual-Band Wireless AX1800 USB Adapter

FCC ID: I88NWD7605
Model Name: NWD7605

Report Number: 4790327573-US-S0-V0
Issue Date: 2022/7/1

Prepared for
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REVISION HISTORY

Rev.	Date	Revisions	Revised By
V0	2022/7/1	Initial Issue	Cindy Hsin

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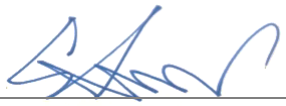
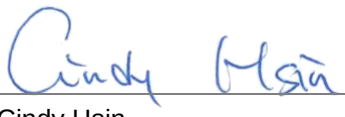
1. Attestation of Test Results

Applicant Name	Zyxel Communications Corporation	
FCC ID	I88NWD7605	
Model Name	NWD7605	
Exposure Category	General Population/Uncontrolled Exposure	
Applicable Standards	FCC 47 CFR § 2.1093 Published RF exposure KDB procedures IEEE Std 1528-2013	
Exposure Category	SAR Limits (W/Kg)	
	Peak spatial-average(1g of tissue)	
General population/Uncontrolled exposure	1.6	
RF Exposure Conditions	Equipment Class - Highest Reported SAR (W/kg)	
	DTS	NII
Body	0.830	0.546
Simultaneous TX	1.503	
Date Tested	2022/4/30 ~ 2022/5/5	
Test Results	Pass	

Underwriters Laboratories Taiwan Co., Ltd. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by Underwriters Laboratories Taiwan Co., Ltd. based on interpretations and/or observations of test results. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by Underwriters Laboratories Taiwan Co., Ltd. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by Underwriters Laboratories Taiwan Co., Ltd. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by TAF or any agency of any government. This report is written to support regulatory compliance of the applicable standards stated above.

Approved and Authorized By:	Prepared By:
	
Eric Lee Senior Laboratory Engineer Underwriters Laboratories Taiwan Co., Ltd.	Cindy Hsin Project Handler Underwriters Laboratories Taiwan Co., Ltd.

2. Test Specification, Methods and Procedures

The tests documented in this report were performed in accordance with FCC 47 CFR § 2.1093, IEEE STD 1528-2013, the following FCC Published RF exposure KDB procedures:

- 447498 D01 General RF Exposure Guidance v06
- 447498 D02 SAR Procedures for Dongle Xmtr v02r01
- 447498 D04 Interim General RF Exposure Guidance v01
- 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04
- 865664 D02 RF Exposure Reporting v01r02

3. Facilities and Accreditation

The test sites and measurement facilities used to collect data are located at

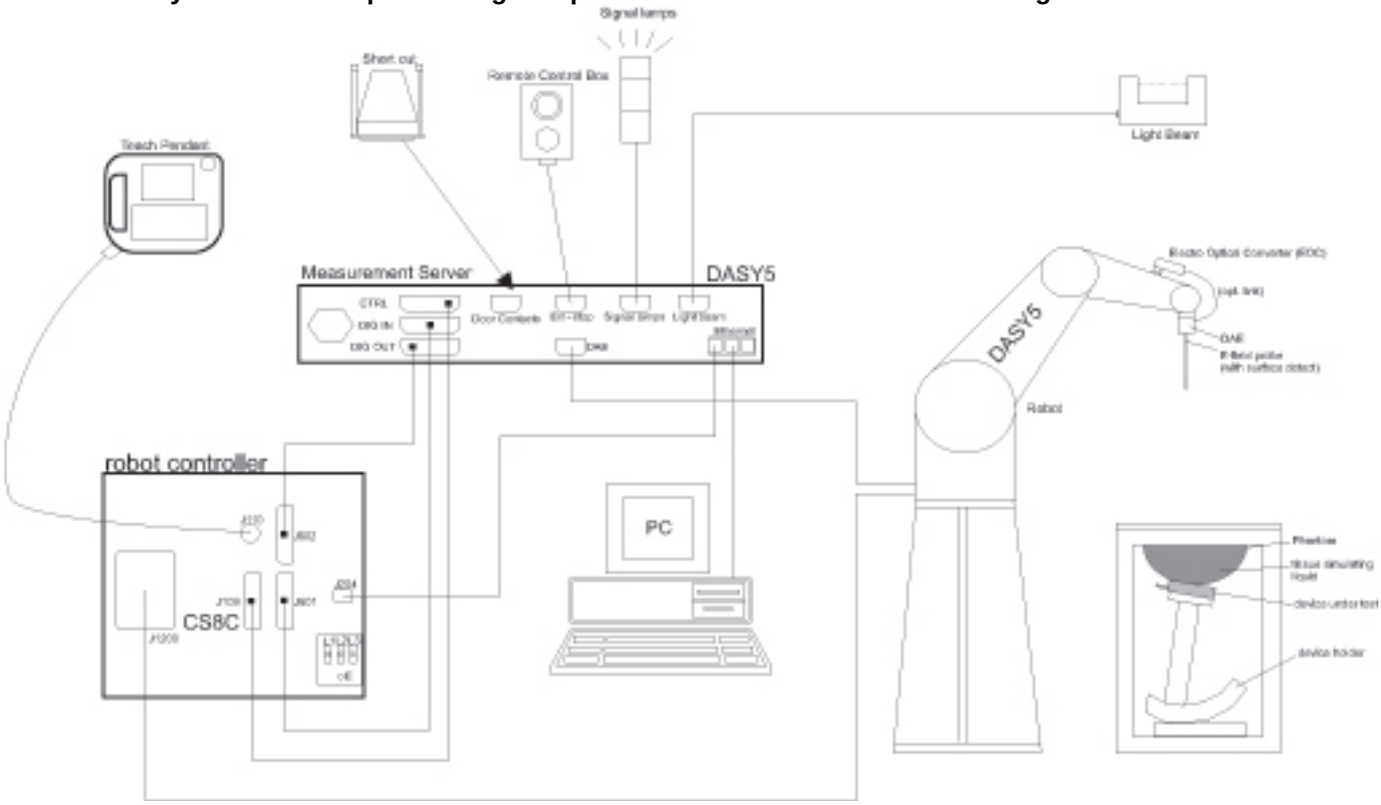
Underwriters Laboratories Taiwan Co., Ltd.,
SAR Room

Underwriters Laboratories Taiwan Co., Ltd. is accredited by TAF, Laboratory Code 3398.

4. SAR Measurement System & Test Equipment

4.1. SAR Measurement System

The DASY5 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 Win7 or Win10 and the DASY5 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 SAR Measurement 100 MHz to 6 GHz

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

Step 3: Zoom Scan

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

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

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

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

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

Step 4: Power drift measurement

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

4.3. Test Equipment

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

Dielectric Property Measurements

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Network Analyzer	Anritsu	MS46322B	1740002	2023/2/10
Dielectric Assessment Kit	SPEAG	DAK-3.5	1250	2022/9/23
Humidity/Temp meter	TECPEL	DTM-20	17020736	2022/5/24

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
EXG-B RF Vector Signal Generator	Keysight Technologies	N5172B	MY56200315	2022/5/26
Power Meter	Keysight Technologies	N1914A	MY56360007	2022/12/20
Power Sensor	Keysight Technologies	N8481H	MY56350009	2022/12/20
Power Meter	Anritsu	ML2495A	1645002	2022/12/21
Power Sensor	Anritsu	MA2411B	1531202	2022/12/21
Dosimetric E-Field Probe	SPEAG	EX3DV4	3901	2022/12/27
Data Acquisition Electronice	SPEAG	DAE4	1360	2022/10/7
System Validation Dipole	SPEAG	D2450V2	988	2022/11/9
System Validation Dipole	SPEAG	D5GHzV2	1244	2022/11/9
Humidity/Temp meter	TECPEL	DTM-20	17020735	2023/4/11

UL Software

Software Version
DASY NEO52 D10.4 S14.6.14
SEMCAD-X-PostPro

5. Measurement Uncertainty

Measurement uncertainty for 300 MHz to 3 GHz

Source of Uncertainty	Tolerance (± %)	Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (± %, 1g)	Standard Uncertainty (± %, 10g)
Measurement System							
Probe Calibration	6.00	Normal	1	1	1	6.00	6.00
Axial Isotropy	4.70	Rectangular	1.732	0.7	0.7	1.90	1.90
Hemispherical Isotropy	9.60	Rectangular	1.732	0.7	0.7	3.88	3.88
Boundary Effect	1.00	Rectangular	1.732	1	1	0.58	0.58
Probe Linearity	4.70	Rectangular	1.732	1	1	2.71	2.71
System Detection Limits	0.25	Rectangular	1.732	1	1	0.14	0.14
Readout Electronics	0.30	Normal	1	1	1	0.30	0.30
Probe Modulation Response	2.40	Rectangular	1.732	1	1	1.39	1.39
Response Time	0.00	Rectangular	1.732	1	1	0.00	0.00
Integration Time	2.60	Rectangular	1.732	1	1	1.50	1.50
RF Ambient Conditions – Noise	3.00	Rectangular	1.732	1	1	1.73	1.73
RF Ambient Conditions – Reflections	3.00	Rectangular	1.732	1	1	1.73	1.73
Probe Positioner Mechanical Restrictions	0.40	Rectangular	1.732	1	1	0.23	0.23
Probe Positioning with Respect to Phantom Shell	2.90	Rectangular	1.732	1	1	1.67	1.67
Interpolation, Extrapolation and Averaged SAR calculation algorithms of the Postprocessor	2.00	Rectangular	1.732	1	1	1.15	1.15
Test Sample Related							
Device Positioning	2.90	Normal	1	1	1	2.90	2.90
Device Holder Disturbance	3.60	Normal	1	1	1	3.60	3.60
DUT Power Drift of Measured SAR	5.00	Rectangular	1.732	1	1	2.89	2.89
SAR Scaling	0.00	Rectangular	1.732	1	1	0.00	0.00
Phantom and Setup							
Phantom Uncertainty - Shape,Thickness and Permittivity	7.20	Rectangular	1.732	1	1	4.16	4.16
SAR Correction for Deviations in Permittivity and Conductivity	1.90	Normal	1	1	0.84	1.90	1.60
Liquid Conductivity - measurement(DAK)	2.50	Normal	1	0.78	0.71	1.95	1.78
Liquid Permittivity - measurement(DAK)	2.50	Normal	1	0.23	0.26	0.58	0.65
Liquid Conductivity – Temperature Uncertainty	3.40	Rectangular	1.732	0.78	0.71	1.53	1.39
Liquid Permittivity – Temperature Uncertainty	0.40	Rectangular	1.732	0.23	0.26	0.05	0.06
Combined Standard Uncertainty (K=1)						11.57	11.48
Expanded Uncertainty U (K=2)						**23.14**	**22.97**

Measurement uncertainty for 3 GHz to 6 GHz

Source of Uncertainty	Tolerance (± %)	Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (± %, 1g)	Standard Uncertainty (± %, 10g)
Measurement System							
Probe Calibration	6.55	Normal	1	1	1	6.55	6.55
Axial Isotropy	4.70	Rectangular	1.732	0.7	0.7	1.90	1.90
Hemispherical Isotropy	9.60	Rectangular	1.732	0.7	0.7	3.88	3.88
Boundary Effect	2.00	Rectangular	1.732	1	1	1.15	1.15
Probe Linearity	4.70	Rectangular	1.732	1	1	2.71	2.71
System Detection Limits	0.25	Rectangular	1.732	1	1	0.14	0.14
Readout Electronics	0.30	Normal	1	1	1	0.30	0.30
Probe Modulation Response	2.40	Rectangular	1.732	1	1	1.39	1.39
Response Time	0.00	Rectangular	1.732	1	1	0.00	0.00
Integration Time	2.60	Rectangular	1.732	1	1	1.50	1.50
RF Ambient Conditions – Noise	3.00	Rectangular	1.732	1	1	1.73	1.73
RF Ambient Conditions – Reflections	3.00	Rectangular	1.732	1	1	1.73	1.73
Probe Positioner Mechanical Restrictions	0.40	Rectangular	1.732	1	1	0.23	0.23
Probe Positioning with Respect to Phantom Shell	6.70	Rectangular	1.732	1	1	3.87	3.87
Interpolation, Extrapolation and Averaged SAR calculation algorithms of the Postprocessor	4.00	Rectangular	1.732	1	1	2.31	2.31
Test Sample Related							
Device Positioning	2.90	Normal	1	1	1	2.90	2.90
Device Holder Disturbance	3.60	Normal	1	1	1	3.60	3.60
DUT Power Drift of Measured SAR	5.00	Rectangular	1.732	1	1	2.89	2.89
SAR Scaling	0.00	Rectangular	1.732	1	1	0.00	0.00
Phantom and Setup							
Phantom Uncertainty - Shape,Thickness and Permittivity	7.60	Rectangular	1.732	1	1	4.39	4.39
SAR Correction for Deviations in Permittivity and Conductivity	1.90	Normal	1	1	0.84	1.90	1.60
Liquid Conductivity - measurement(DAK)	2.50	Normal	1	0.78	0.71	1.95	1.78
Liquid Permittivity - measurement(DAK)	2.50	Normal	1	0.23	0.26	0.58	0.65
Liquid Conductivity – Temperature Uncertainty	3.40	Rectangular	1.732	0.78	0.71	1.53	1.39
Liquid Permittivity – Temperature Uncertainty	0.40	Rectangular	1.732	0.23	0.26	0.05	0.06
Combined Standard Uncertainty (K=1)						12.65	12.57
Expanded Uncertainty U (K=2)						**25.29**	**25.13**

6. Device Under Test (DUT) Information

6.1. DUT Description

Product	Dual-Band Wireless AX1800 USB Adapter
Brand Name	ZYXEL
Model Name	NWD7605
Operating Frequency	Wi-Fi 2.4GHz : 2412MHz ~ 2462MHz Wi-Fi 5GHz : 5180 ~ 5240 MHz, 5745 ~ 5825 MHz
Modulation	CCK, DQPSK, DBPSK for DSSS 1024QAM, 256QAM ,64QAM, 16QAM, QPSK, BPSK for OFDM
Transfer Rate	802.11a: up to 54 Mbps 802.11b: up to 11 Mbps 802.11g: up to 54 Mbps 802.11n: up to MCS15 802.11ac: up to MCS 9 802.11ax: up to HE11
Sample ID	4874101
Received Date	2022/03/16

Note :

1. This report is prepared for FCC permissive change. The difference compared with the original design is as the following:
   - Change product housing.
   - Reduce the 802.11b and 802.11g target power
   - Added the absorber tap on the PCB board

6.2. Wireless Technologies

Wireless technologies	Frequency bands	Operating mode	Duty Cycle used for SAR testing
Wi-Fi	2.4 GHz	802.11b 802.11g 802.11n (HT20) 802.11n (HT40) 802.11ac (VHT20) 802.11ac (VHT40) 802.11ax (HE20) 802.11ax (HE40)	99.21% (802.11b)
	5 GHz	802.11a 802.11n (HT20) 802.11n (HT40) 802.11ac (VHT20) 802.11ac (VHT40) 802.11ac (VHT80) 802.11ax (HE20) 802.11ax (HE40) 802.11ax (HE80)	96.32% (802.11a)
	Does this device support bands 5.60 ~ 5.65 GHz? ☐ Yes ☒ No		
	Does this device support straddle channel? ☐ Yes ☒ No		

7. RF Exposure Conditions (Test Configurations)

Refer to Appendix A for the specific details of the antenna-to-antenna and antenna-to-edge(s) distances.

Wireless technologies	RF Exposure Conditions	Test Position	Antenna to edge/surface		SAR Required
			Chain 0	Chain 1	
Wi-Fi	Body	Horizontal-Up	6mm	6mm	Yes
		Horizontal-Down	10mm	10mm	Yes
		Vertical-Front	20.5mm	6mm	Yes
		Vertical-Back	6mm	20.5mm	Yes
		Tip	16.5mm	16.5mm	Yes

8. Dielectric Property Measurements & System Check

8.1. Dielectric Property Measurements

The temperature of the tissue-equivalent medium used during measurement must also be within 18°C to 25°C and within ± 2°C of the temperature when the tissue parameters are characterized.
The dielectric parameters must be measured before the tissue-equivalent medium is used in a series of SAR measurements. The parameters should be re-measured after each 3 – 4 days of use; or earlier if the dielectric parameters can become out of tolerance; for example, when the parameters are marginal at the beginning of the measurement series.
Tissue dielectric parameters were measured at the low, middle and high frequency of each operating frequency range of the test device.
The dielectric constant (εr) and conductivity (σ) of typical tissue-equivalent media recipes are expected to be within ± 5% of the required target values; but for SAR measurement systems that have implemented the SAR error compensation algorithms documented in IEEE Std 1528-2013, to automatically compensate the measured SAR results for deviations between the measured and required tissue dielectric parameters, the tolerance for εr and σ may be relaxed to ± 10%. This is limited to frequencies ≤ 3 GHz.

Tissue Dielectric Parameters

FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz

Target Frequency (MHz)	Head	
	ε_r	σ (S/m)
150	52.3	0.76
300	45.3	0.87
450	43.5	0.87
835	41.5	0.90
900	41.5	0.97
915	41.5	0.98
1450	40.5	1.20
1610	40.3	1.29
1800 – 2000	40.0	1.40
2450	39.2	1.80
3000	38.5	2.40
5000	36.2	4.45
5100	36.1	4.55
5200	36.0	4.66
5300	35.9	4.76
5400	35.8	4.86
5500	35.6	4.96
5600	35.5	5.07
5700	35.4	5.17
5800	35.3	5.27

IEEE Std 1528-2013

Refer to Table 3 within the IEEE Std 1528-2013

Dielectric Property Measurements Results:

Date	Tissue Type	Frequency (MHz)	Relative Permittivity (εr)			Conductivity (σ)		
			Measured	Target	Delta (%)	Measured	Target	Delta (%)
2022/5/4	Head	5180	35.61	36.02	-1.13	4.51	4.64	-2.74
		5190	35.64	36.01	-1.02	4.52	4.65	-2.75
		5200	35.58	36.00	-1.15	4.53	4.66	-2.74
		5210	35.53	35.99	-1.27	4.54	4.67	-2.78
		5220	35.49	35.98	-1.36	4.55	4.68	-2.74
		5230	35.47	35.97	-1.38	4.57	4.69	-2.54
		5240	35.50	35.96	-1.29	4.59	4.70	-2.29
		5250	35.48	35.95	-1.30	4.59	4.71	-2.48
2022/5/5	Head	5745	34.49	35.36	-2.46	5.03	5.21	-3.48
		5755	34.50	35.35	-2.39	5.05	5.22	-3.26
		5775	34.55	35.33	-2.18	5.09	5.24	-2.98
		5785	34.50	35.32	-2.31	5.10	5.25	-2.93
		5795	34.50	35.31	-2.27	5.11	5.26	-2.99
		5800	34.51	35.30	-2.25	5.11	5.27	-3.04
		5825	34.40	35.28	-2.47	5.12	5.30	-3.39
2022/4/30	Head	2412	37.72	39.26	-3.92	1.75	1.76	-0.84
		2422	37.70	39.24	-3.93	1.77	1.77	-0.50
		2437	37.71	39.22	-3.85	1.78	1.79	-0.31
		2450	37.69	39.20	-3.86	1.79	1.80	-0.53
		2452	37.67	39.20	-3.90	1.79	1.80	-0.55
		2462	37.64	39.18	-3.93	1.80	1.81	-0.58

8.2. System Check

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

System 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.

Date	Tissue Type	Dipole S/N	Input Power (mW)	Measured 1g SAR (W/kg)	Targeted 1g SAR (W/kg)	Normalized 1g SAR (W/kg)	Delta 1g ±10 (%)	Measured 10g SAR (W/kg)	Targeted 10g SAR (W/kg)	Normalized 10g SAR (W/kg)	Delta 10g ±10 (%)	Plot No.
2022/4/30	Head	D2450V2-988	250	12.60	52.20	50.4	-3.45	5.86	23.90	23.44	-1.92	1
2022/5/4	Head	D5GHzV2-1244-5250	100	7.62	77.00	76.2	-1.04	2.07	22.00	20.7	-5.91	2
2022/5/5	Head	D5GHzV2-1244-5800	100	8.41	77.70	84.1	8.24	2.30	22.00	23	4.55	3

9. Conducted Output Power Measurements

9.1. Wi-Fi 2.4GHz (DTS Band)

Measured Results

Band	Mode	Data Rate	Ch #	Freq. (MHz)	Meas. Avg Pwr (dBm)		Duty cycle (%)		Tune up Power (dBm)		SAR Test (Yes/No)
					Chain 0	Chain 1	Chain 0	Chain 1	Chain 0	Chain 1	
2.4GHz (DTS)	802.11b	1 Mbps	1	2412	18.77	18.82	99.21	99.21	19.0	19.0	Yes
			6	2437	18.86	18.84			19.0	19.0	
			11	2462	16.58	16.78			17.0	17.0	
	802.11g	6 Mbps	1	2412	18.89	18.43	96.31	96.31	19.0	19.0	No
			6	2437	18.94	18.49			19.0	19.0	
			11	2462	16.53	16.63			17.0	17.0	
	802.11n (HT20)	MCS0	1	2412	18.46	17.36	94.98	94.98	19.0	18.0	No
			6	2437	18.56	17.35			19.0	18.0	
			11	2462	15.44	15.61			16.0	16.0	
	802.11n (HT40)	MCS0	3	2422	17.46	16.58	90.91	90.91	18.0	17.0	No
			6	2437	15.55	15.59			16.0	16.0	
			9	2452	14.00	14.02			14.5	14.5	
	802.11ax (HE20)	MCS0	1	2412	18.62	17.54	94.98	94.98	19.0	18.0	No
			6	2437	18.59	17.52			19.0	18.0	
			11	2462	15.58	15.75			16.0	16.0	
	802.11ax (HE40)	MCS0	3	2422	17.53	16.60	90.91	90.91	18.0	17.0	No
			6	2437	15.54	15.51			16.0	16.0	
			9	2452	14.04	14.14			14.5	14.5	

Note(s):

1. SAR is not required for 802.11g/n modes when the adjusted SAR for 802.11b is < 1.2 W/kg.
2. For “Not required”, SAR Test reduction was applied from KDB 248227 guidance, Sec. 2.1, b), 1) when the same maximum power is specified for multiple transmission modes in a frequency band, the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order 802.11a/g/n/ac mode is used for SAR measurement, on the highest measured output power channel in the initial test configuration, for each frequency band. Additional output power measurements were not deemed necessary.
3. Additionally, SAR is not required for Channels 12 and 13 because the tune-up limit and the measured output power for these two channels are no greater than those for the default test channels. Refer to §6.3.

9.2. Wi-Fi 5GHz (U-NII Bands)

Measured Results

Band	Mode	Data Rate	Ch #	Freq.	Meas. Avg Pwr (dBm)		Duty cycle		Tune up Power (dBm)		SAR Test
				(MHz)	Chain 0	Chain 1	Chain 0	Chain 1	Chain 0	Chain 1	(Yes/No)
5.2 GHz (U-NII 1)	802.11a	6 Mbps	36	5180	14	14.2	96.32	96.32	14.5	14.5	Yes
			40	5200	14.27	14.46			14.5	14.5	
			44	5220	14.23	14.1			14.5	14.5	
			48	5240	14.14	14.27			14.5	14.5	
	802.11n (HT20)	MCS0	36	5180	13.53	13.1	94.98	94.98	14	13.5	No
			40	5200	13.49	13.17			14	13.5	
			44	5220	13.03	12.86			13.5	13.5	
			48	5240	13.01	12.73			13.5	13.5	
	802.11n (HT40)	MCS0	38	5190	13.35	13.21	90.15	90.15	14	14	No
			46	5230	13.43	13.22			14	14	
	802.11ac (VHT20)	MCS0	36	5180	13.42	13.12	94.98	94.98	14	13.5	No
			40	5200	13.42	13.15			14	13.5	
			44	5220	12.92	12.8			13.5	13.5	
			48	5240	13.08	12.88			13.5	13.5	
	802.11ac (VHT40)	MCS0	38	5190	13.44	13.16	90.15	90.15	14	14	No
			46	5230	13.36	13.26			14	14	
	802.11ac (VHT80)	MCS0	42	5210	9.09	9.3	84.21	84.21	9.5	9.5	No
	802.11ax (HE20)	MCS0	36	5180	13.57	13.25	94.98	94.98	14	13.5	No
			40	5200	13.61	13.22			14	13.5	
			44	5220	13.11	12.87			13.5	13.5	
			48	5240	13.09	12.89			13.5	13.5	
	802.11ax (HE40)	MCS0	38	5190	13.54	13.23	90.15	90.15	14	14	No
			46	5230	13.55	13.27			14	14	
	802.11ax (HE80)	MCS0	42	5210	9.24	9.35	84.21	84.21	9.5	9.5	No

Band	Mode	Data Rate	Ch #	Freq.	Meas. Avg Pwr (dBm)		Duty cycle		Tune up Power (dBm)		SAR Test
				(MHz)	Chain 0	Chain 1	Chain 0	Chain 1	Chain 0	Chain 1	(Yes/No)
5.8 GHz (U-NII 3)	802.11a	6 Mbps	149	5745	12.26	11.19	96.32	96.32	12.5	11.5	Yes
			157	5785	12.23	11.15			12.5	11.5	
			165	5825	12.01	11.03			12.5	11.5	
	802.11n (HT20)	MCS0	149	5745	11.44	10.53	94.98	94.98	12	11	No
			157	5785	11.59	10.68			12	11	
			165	5825	11.5	10.2			12	11	
	802.11n (HT40)	MCS0	151	5755	11.27	10.42	90.15	90.15	12	11	No
			159	5795	11.26	10.45			12	11	
	802.11ac (VHT20)	MCS0	149	5745	11.37	10.64	94.98	94.98	12	11	No
			157	5785	11.63	10.6			12	11	
			165	5825	11.44	10.3			12	11	
	802.11ac (VHT40)	MCS0	151	5755	11.27	10.42	90.15	90.15	12	11	No
			159	5795	11.18	10.39			12	11	
	802.11ac (VHT80)	MCS0	155	5775	11.51	10.64	84.21	84.21	12	11	No
	802.11ax (HE20)	MCS0	149	5745	11.47	10.71	94.98	94.98	12	11	No
			157	5785	11.79	10.7			12	11	
			165	5825	11.54	10.34			12	11	
	802.11ax (HE40)	MCS0	151	5755	11.44	10.58	90.15	90.15	12	11	No
			159	5795	11.3	10.55			12	11	
	802.11ax (HE80)	MCS0	155	5775	11.69	10.78	84.21	84.21	12	11	No

Note(s):

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

10. Measured and Reported (Scaled) SAR Results

SAR Test Reduction criteria are as follows:

KDB 447498 D01 General RF Exposure Guidance:

Testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:

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

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

10.1. Test Condition

Test Item	Test Site No.	Test Date	Tested by
SAR	SAR1	2022/4/30 ~ 2022/5/5	Edison Hu

10.2. Wi-Fi

RF Exposure Conditions	Mode	Test Position	Dist. (mm)	Ch #.	Freq. (MHz)	Duty Cycle	Tune-up Limit (dBm)	Meas Power (dBm)	Meas 1-g SAR (W/kg)	Scaled 1-g SAR (W/kg)	Meas 10-g SAR (W/kg)	Scaled 10-g SAR (W/kg)	Power Drift	Antenna	Plot No.
Body	802.11b(1Mbps)	Horizontal-Up	5	6	2437	99.21%	19.0	18.86	0.623	0.649	0.293	0.305	0.04	Chain 0	
Body	802.11b(1Mbps)	Horizontal-Down	5	6	2437	99.21%	19.0	18.86	0.646	0.672	0.290	0.302	0.08	Chain 0	1
Body	802.11b(1Mbps)	Vertical-Front	5	6	2437	99.21%	19.0	18.86	0.249	0.259	0.118	0.123	0.16	Chain 0	
Body	802.11b(1Mbps)	Vertical-Back	5	6	2437	99.21%	19.0	18.86	0.059	0.061	0.033	0.034	0.16	Chain 0	
Body	802.11b(1Mbps)	Tip	5	6	2437	99.21%	19.0	18.86	0.167	0.174	0.083	0.086	0.11	Chain 0	

RF Exposure Conditions	Mode	Test Position	Dist. (mm)	Ch #.	Freq. (MHz)	Duty Cycle	Tune-up Limit (dBm)	Meas Power (dBm)	Meas 1-g SAR (W/kg)	Scaled 1-g SAR (W/kg)	Meas 10-g SAR (W/kg)	Scaled 10-g SAR (W/kg)	Power Drift	Antenna	Plot No.
Body	802.11b(1Mbps)	Horizontal-Up	5	6	2437	99.21%	19.0	18.84	0.658	0.688	0.297	0.311	0.20	Chain 1	
Body	802.11b(1Mbps)	Horizontal-Down	5	6	2437	99.21%	19.0	18.84	0.794	0.830	0.360	0.376	0.13	Chain 1	2
Body	802.11b(1Mbps)	Horizontal-Down	5	1	2412	99.21%	19.0	18.82	0.543	0.570	0.250	0.263	0.18	Chain 1	
Body	802.11b(1Mbps)	Horizontal-Down	5	11	2462	99.21%	19.0	18.78	0.467	0.495	0.212	0.225	0.20	Chain 1	
Body	802.11b(1Mbps)	Vertical-Front	5	6	2437	99.21%	19.0	18.84	0.050	0.053	0.028	0.029	0.08	Chain 1	
Body	802.11b(1Mbps)	Vertical-Back	5	6	2437	99.21%	19.0	18.84	0.284	0.297	0.134	0.140	0.20	Chain 1	
Body	802.11b(1Mbps)	Tip	5	6	2437	99.21%	19.0	18.84	0.195	0.204	0.098	0.102	0.10	Chain 1	

RF Exposure Conditions	Mode	Test Position	Dist. (mm)	Ch #.	Freq. (MHz)	Duty Cycle	Tune-up Limit (dBm)	Meas Power (dBm)	Meas 1-g SAR (W/kg)	Scaled 1-g SAR (W/kg)	Meas 10-g SAR (W/kg)	Scaled 10-g SAR (W/kg)	Power Drift	Antenna	Plot No.
Body	802.11a(6Mbps)	Horizontal-Up	5	40	5200	96.32%	14.5	14.3	0.495	0.542	0.117	0.128	0.18	Chain 0	3
Body	802.11a(6Mbps)	Horizontal-Down	5	40	5200	96.32%	14.5	14.3	0.265	0.290	0.094	0.103	-0.12	Chain 0	
Body	802.11a(6Mbps)	Vertical-Front	5	40	5200	96.32%	14.5	14.3	0.358	0.392	0.106	0.116	0.16	Chain 0	
Body	802.11a(6Mbps)	Vertical-Back	5	40	5200	96.32%	14.5	14.3	0.071	0.078	0.028	0.030	-0.03	Chain 0	
Body	802.11a(6Mbps)	Tip	5	40	5200	96.32%	14.5	14.3	0.120	0.131	0.044	0.048	0.15	Chain 0	

RF Exposure Conditions	Mode	Test Position	Dist. (mm)	Ch #.	Freq. (MHz)	Duty Cycle	Tune-up Limit (dBm)	Meas Power (dBm)	Meas 1-g SAR (W/kg)	Scaled 1-g SAR (W/kg)	Meas 10-g SAR (W/kg)	Scaled 10-g SAR (W/kg)	Power Drift	Antenna	Plot No.
Body	802.11a(6Mbps)	Horizontal-Up	5	40	5200	96.32%	14.5	14.46	0.228	0.239	0.075	0.079	0.02	Chain 1	
Body	802.11a(6Mbps)	Horizontal-Down	5	40	5200	96.32%	14.5	14.46	0.303	0.317	0.103	0.108	0.20	Chain 1	
Body	802.11a(6Mbps)	Vertical-Front	5	40	5200	96.32%	14.5	14.46	0.027	0.029	0.007	0.008	-0.15	Chain 1	
Body	802.11a(6Mbps)	Vertical-Back	5	40	5200	96.32%	14.5	14.46	0.521	0.546	0.175	0.183	0.12	Chain 1	4
Body	802.11a(6Mbps)	Tip	5	40	5200	96.32%	14.5	14.46	0.087	0.091	0.032	0.033	0.14	Chain 1	

RF Exposure Conditions	Mode	Test Position	Dist. (mm)	Ch #.	Freq. (MHz)	Duty Cycle	Tune-up Limit (dBm)	Meas Power (dBm)	Meas 1-g SAR (W/kg)	Scaled 1-g SAR (W/kg)	Meas 10-g SAR (W/kg)	Scaled 10-g SAR (W/kg)	Power Drift	Antenna	Plot No.
Body	802.11a(6Mbps)	Horizontal-Up	5	149	5745	96.32%	12.5	12.26	0.135	0.148	0.030	0.032	0.07	Chain 0	
Body	802.11a(6Mbps)	Horizontal-Down	5	149	5745	96.32%	12.5	12.26	0.291	0.319	0.092	0.101	-0.19	Chain 0	
Body	802.11a(6Mbps)	Vertical-Front	5	149	5745	96.32%	12.5	12.26	0.369	0.405	0.109	0.120	0.11	Chain 0	5
Body	802.11a(6Mbps)	Vertical-Back	5	149	5745	96.32%	12.5	12.26	0.050	0.055	0.017	0.019	0.03	Chain 0	
Body	802.11a(6Mbps)	Tip	5	149	5745	96.32%	12.5	12.26	0.056	0.062	0.022	0.024	0.04	Chain 0	

RF Exposure Conditions	Mode	Test Position	Dist. (mm)	Ch #.	Freq. (MHz)	Duty Cycle	Tune-up Limit (dBm)	Meas Power (dBm)	Meas 1-g SAR (W/kg)	Scaled 1-g SAR (W/kg)	Meas 10-g SAR (W/kg)	Scaled 10-g SAR (W/kg)	Power Drift	Antenna	Plot No.
Body	802.11a(6Mbps)	Horizontal-Up	5	149	5745	96.32%	11.5	11.19	0.230	0.256	0.067	0.075	-0.18	Chain 1	
Body	802.11a(6Mbps)	Horizontal-Down	5	149	5745	96.32%	11.5	11.19	0.265	0.295	0.086	0.095	-0.04	Chain 1	
Body	802.11a(6Mbps)	Vertical-Front	5	149	5745	96.32%	11.5	11.19	0.038	0.042	0.014	0.016	-0.17	Chain 1	
Body	802.11a(6Mbps)	Vertical-Back	5	149	5745	96.32%	11.5	11.19	0.473	0.527	0.153	0.171	0.05	Chain 1	6
Body	802.11a(6Mbps)	Tip	5	149	5745	96.32%	11.5	11.19	0.040	0.045	0.016	0.018	-0.17	Chain 1	

11. Simultaneous Transmission SAR Analysis

KDB 447498 D01 General RF Exposure Guidance explains how to calculate the SAR to Peak Location Ratio (SPLSR) between pairs of simultaneously transmitting antennas:

$$SPLSR = (SAR_1 + SAR_2)^{1.5} / Ri$$

Where:

SAR_1 is the highest measured or estimated SAR for the first of a pair of simultaneous transmitting antennas, in a specific test operating mode and exposure condition

SAR_2 is the highest measured or estimated SAR for the second of a pair of simultaneous transmitting antennas, in the same test operating mode and exposure condition as the first

Ri is the separation distance between the pair of simultaneous transmitting antennas. When the SAR is measured, for both antennas in the pair, it is determined by the actual x, y and z coordinates in the 1-g SAR for each SAR peak location, based on the extrapolated and interpolated result in the zoom scan measurement, using the formula of $[(x_1-x_2)^2 + (y_1-y_2)^2 + (z_1-z_2)^2]$

In order for a pair of simultaneous transmitting antennas with the sum of 1-g SAR > 1.6 W/kg to qualify for exemption from Simultaneous Transmission SAR measurements, it has to satisfy the condition of:

$$(SAR_1 + SAR_2)^{1.5} / Ri \leq 0.04$$

Simultaneous Transmission Condition

RF Exposure Condition	Item	Capable Transmit Configurations
Standalone	1	DTS Chain 0 + DTS Chain 1
	2	U-NII Chain 0 + U-NII Chain 1
	3	
	4	

Notes:
1. DTS Radio can transmit simultaneously with DTS Radio
2. U-NII Radio can transmit simultaneously with U-NII Radio.

11.1. Sum of the SAR for Wi-Fi

Test Position	Standalone SAR (W/kg)				∑ 1-g SAR (W/kg)	
	① WLAN 2.4 GHz Chain 0	② WLAN 2.4 GHz Chain 1	③ WLAN 5 GHz Chain 0	④ WLAN 5 GHz Chain 1	①+②	③+④
Horizontal-Up	0.649	0.688	0.542	0.256	1.337	0.798
Horizontal-Down	0.672	0.830	0.319	0.317	1.503	0.637
Vertical-Front	0.259	0.053	0.405	0.042	0.312	0.447
Vertical-Back	0.061	0.297	0.078	0.546	0.358	0.623
Tip	0.174	0.204	0.131	0.091	0.378	0.222

Appendixes

Refer to separated files for the following appendixes.

4790327573-US-S0-V0_Appendix A: SAR Setup Photos

4790327573-US-S0-V0_Appendix B: Antenna Dimensions and Separation Distances

4790327573-US-S0-V0_Appendix C: SAR System Check Plots

4790327573-US-S0-V0_Appendix D: Highest SAR Test Plots

4790327573-US-S0-V0_Appendix E: SAR Probe and Dipole Calibration Certificates

END OF REPORT