FCC 47 CFR § 2.1093
IEEE Std 1528-2013

SAR EVALUATION REPORT
(RSDB for WLAN 2.4GHz/5GHz)

FOR

BT/BLE Tablet + DTS/UNII a/b/g/n/ac/ax and WPT

MODEL NUMBER: SM-X710

FCC ID: A3LSMX710

REPORT NUMBER: 4790872599-S1V2

ISSUE DATE: 6/16/2023

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TL-637

Revision History

Rev.	Date	Revisions	Revised By
V1	6/5/2023	Initial Issue	--
V2	6/16/2023	Added description in Sec.1	Jeongyeon.Won

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1. Attestation of Test Results

Applicant Name	SAMSUNG ELECTRONICS CO.,LTD.		
FCC ID	A3LSMX710		
Model Number	SM-X710		
Applicable Standards	FCC 47 CFR § 2.1093 IEEE Std 1528-2013 Published RF exposure KDB procedures		
Exposure Category	SAR Limits (W/Kg)		
	Peak spatial-average (1g of tissue)		
General population / Uncontrolled exposure	1.6		
RF Exposure Conditions	Equipment Class - The Highest Reported SAR (W/kg)		
	DTS	NII	DSS
Body	0.43	1.18	0.29
Simultaneous TX	1.46	1.46	1.40
Date Tested	5/30/2023 to 5/31/2023		
Test Results	Pass		

This supplemental report is an assessment for RSDB for dual band WLAN 2.4GHz/5GHz transmissions not covered in test report R14720543-S1 v3 (R14720543-S1 v3 is the test report for the other modes).

UL Korea, 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 UL Korea, Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. 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 UL Korea, Ltd. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Korea, 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 IAS, any agency of the Federal Government, or any agency of any government.

Approved & Released By:	Prepared By:
	
Justin Park Operations Leader UL Korea, Ltd. Suwon Laboratory	Jeongyeon Won Laboratory Engineer UL Korea, Ltd. Suwon Laboratory

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, ANSI C63.26-2015 the following FCC Published RF exposure KDB procedures:

- 248227 D01 802.11 Wi-Fi SAR v02r02
- 447498 D01 General RF Exposure Guidance v06
- 616217 D04 SAR for laptop and tablets v01r02
- 690783 D01 SAR Listings on Grants v01r03
- 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04
- 865664 D02 RF Exposure Reporting v01r02

In addition to the above, the following information was used:

- TCB workshop October, 2016; RF Exposure Procedures (DUT Holder Perturbations)
- TCB workshop April, 2019; RF Exposure Procedures (Tissue Simulating Liquids (TSL))
- TCB workshop April, 2022; RF Exposure Procedures (Sum-Peak Location Separation Ratio)
- TCB workshop October, 2020; 5G RFX Policies (Intra-band and Inter-band NSA-EN-DC evaluation)

3. Facilities and Accreditation

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

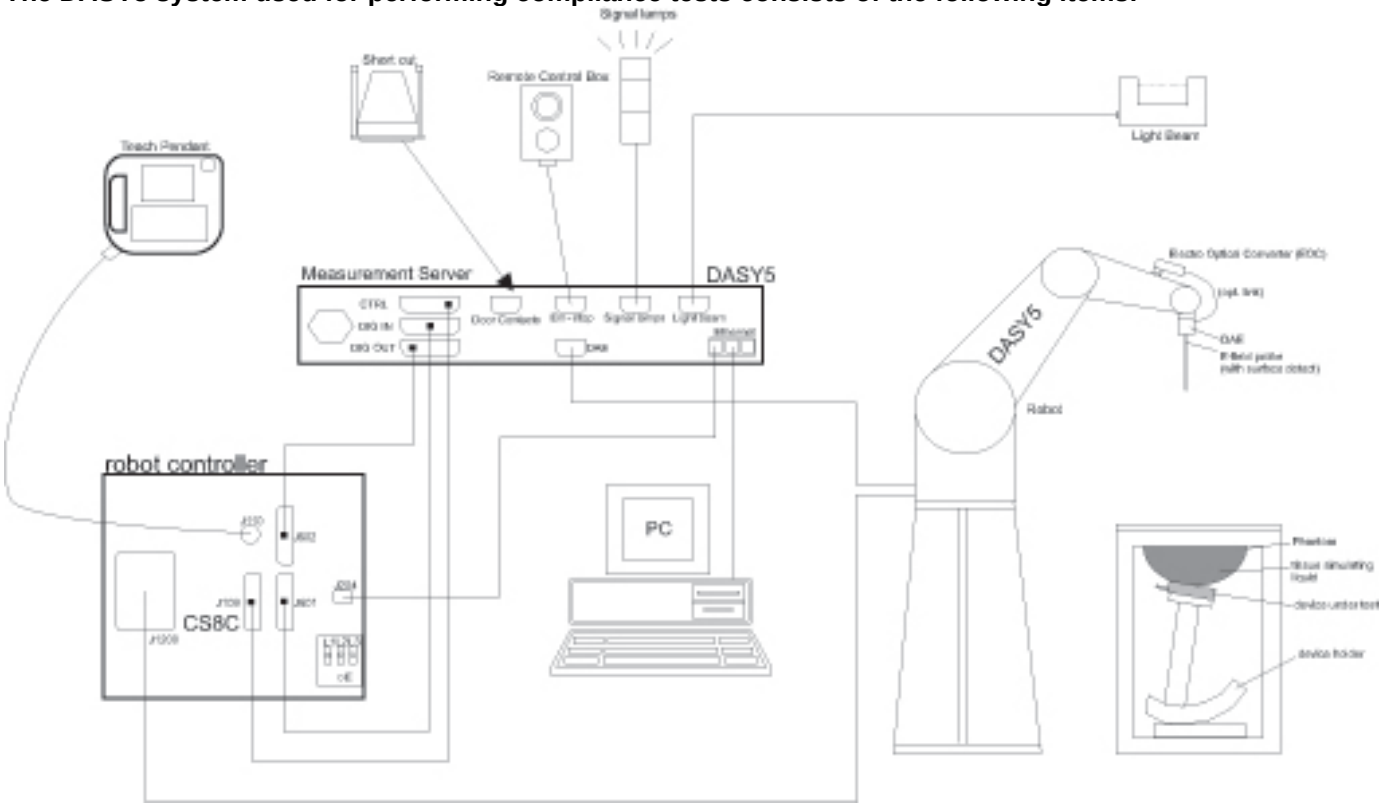
Suwon
SAR 5 Room

UL Korea, Ltd. is accredited by IAS, Laboratory Code TL-637.
The full scope of accreditation can be viewed at https://www.iasonline.org/wp-content/uploads/2017/05/TL-637-cert-New.pdf.

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 WinXP or Win7 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	≤ 1.5·$\Delta z_{Zoom}(n-1)$	
Minimum zoom scan volume	x, y, z		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm

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

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

Step 4: Power drift measurement

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

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 larger 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.

Dielectric Property Measurements

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Network Analyzer	Agilent	E5071C	MY46522054	8-5-2023
Network Analyzer	ROHDE & SCHWARZ	ZNB 20	102256	8-5-2023
Dielectric Assessment Kit	SPEAG	DAK-3.5	1196	7-25-2023
Shorting block	SPEAG	DAK-3.5 Short	SM DAK 200 BA	N/A
Thermometer	LKM	DTM3000	3851	8-3-2023

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
MXG Analog Signal Generator	Aglient	N5181A	MY50145882	8-4-2023
Power Sensor	KEYSIGHT	U2000A	MY60490008	8-3-2023
Power Sensor	KEYSIGHT	U2000A	MY60160004	8-3-2023
Power Amplifier	EXODUS	AMP2027	1410025-AMP2027-10003	11-2-2023
Directional Coupler	Aglient	772D	MY52180193	8-3-2023
Low Pass Filter	FILTRON	L140012FL	1410003S	8-3-2023
Attenuator	KEYSIGHT	8491B/003	MY39272277	8-2-2023
Attenuator	KEYSIGHT	8491B/010	MY39271981	8-3-2023
Attenuator	KEYSIGHT	8491B/020	MY39272301	8-3-2023
E-Field Probe	SPEAG	EX3DV4	7545	8-19-2023
E-Field Probe	SPEAG	EX3DV4	7646	3-23-2024
Data Acquisition Electronics	SPEAG	DAE4	1591	3-22-2024
Data Acquisition Electronics	SPEAG	DAE4	912	11-16-2023
System Validation Dipole	SPEAG	D2450V2	939	7-21-2023

Note(s):

1. All equipments were used until Cal.Due date.

5. Measurement Uncertainty

Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg and the measured 10-g SAR within a frequency band is < 3.75 W/kg. The expanded SAR measurement uncertainty must be ≤ 30%, for a confidence interval of k = 2. If these conditions are met, extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval.

5.1. DECISION RULE

Decision rule for statement(s) of conformity is based on Procedure 2, Clause 4.4.3 in IEC Guide 115:2021.

6. Device Under Test (DUT) Information

6.1. DUT Description

Device Dimension	Refer to Appendix A.
Back Cover	☒ The Back Cover is not removable.
Battery Options	☒ The rechargeable battery is not user accessible
Accessory	Keyboard
Wi-Fi Direct	Wi-Fi Direct enabled devices transfer data directly between each other ☒ Wi-Fi Direct (Wi-Fi 2.4 GHz) ☒ Wi-Fi Direct (Wi-Fi 5.2 GHz_UNII-1, Wi-Fi 5.8 GHz_UNII-3)
Test Sample Information	**No.** **S/N** **Notes** 1 R32W2005BLK WLAN Conducted 2 R32W300HCDL SAR

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) 802.11ac (VHT20) 802.11ax (HE20)	98.8% (802.11b)
	5 GHz	802.11a 802.11n (HT20), 802.11n (HT40) 802.11ac (VHT20), 802.11ac (VHT40) 802.11ac (VHT80), 802.11ac (VHT160) 802.11ax (HE20), 802.11ax (HE40) 802.11ax (HE80), 802.11ax (HE160)	86.4% (802.11n 40MHz BW) 97.4% (802.11ac 80MHz BW) 97.4% (802.11ac 160MHz BW)
	Does this device support bands 5.60 ~ 5.65 GHz? ☒ Yes ☐ No		
	Does this device support Band gap channel(s)? ☒ Yes ☐ No		
	6 GHz	802.11a 802.11ax (HE20) 802.11ax (HE40) 802.11ax (HE80) 802.11ax (HE160)	99.7%(802.11ax 160MHz BW)
Bluetooth	2.4 GHz	Version 5.0 LE	76.5%

Notes:

1. The Bluetooth protocol is considered source-based averaging. Bluetooth GFSK (DH5) was verified to have the highest duty cycle of 76.5% and was considered and used for SAR Testing.
2. Measured Duty Cycle is not required due to SAR test exemption.

6.3. Nominal and Maximum Output Power

KDB 447498 sec.4.1. 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

2.4GHz WLAN RSDB output power

RF Air interface	Band	Ch.	RF Output Power (dBm)									
			802.11 mode									
			SISO : Antenna 2					MIMO : Antenna 1 + Antenna 2				
			b	g	n	ac	ax	b	g	n	ac	ax
WiFi 2.4 GHz	DTS	Ch.1 - 11	9.0	9.0	9.0	9.0	9.0	12.0	12.0	12.0	12.0	12.0

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.

7.1. Required Test Configurations

The tables below identify the standalone test configurations required for this device according to the findings in Section 7.1:

Antenna	Test Configurations	Rear	Edge Top	Edge Right	Edge Bottom	Edge Left	Front
BT/WIFI1 Antenna	Wi-Fi 2.4 GHz	Yes	Yes	Yes	No	No	No
	Wi-Fi 5.2 GHz	Yes	Yes	Yes	No	No	No
	Wi-Fi 5.3 GHz	Yes	Yes	Yes	No	No	No
	Wi-Fi 5.5 GHz	Yes	Yes	Yes	No	No	No
	Wi-Fi 5.8 GHz	Yes	Yes	Yes	No	No	No
	Wi-Fi 5.9 GHz	Yes	Yes	Yes	No	No	No
	Wi-Fi 6 GHz	Yes	Yes	Yes	No	No	No
	Bluetooth	Yes	Yes	Yes	No	No	No
BT/WIFI2 Antenna	Wi-Fi 2.4 GHz	Yes	Yes	No	No	Yes	No
	Wi-Fi 5.2 GHz	Yes	Yes	No	No	Yes	No
	Wi-Fi 5.3 GHz	Yes	Yes	No	No	Yes	No
	Wi-Fi 5.5 GHz	Yes	Yes	No	No	Yes	No
	Wi-Fi 5.8 GHz	Yes	Yes	No	No	Yes	No
	Wi-Fi 5.9 GHz	Yes	Yes	No	No	Yes	No
	Wi-Fi 6 GHz	Yes	Yes	No	No	Yes	No
	Bluetooth	Yes	Yes	No	No	Yes	No

Note(s):

1. Yes = Testing is required. No = Testing is not required.
2. Some additional configurations were tested to support simultaneous transmission considerations.
3. The laptop configuration with the accessory keyboard connected was not evaluated as this was considered to be covered by the edge left tests.

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.

Tissue Dielectric Parameters
FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz

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

SAR test were performed in All RF exposure conditions using Head tissue according to TCB workshop note of April. 2019.

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

Dielectric Property Measurements Results:
SAR 5 Room

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
2023-05-30	Head 2450	e'	38.5000	Relative Permittivity (ϵ_r):	38.50	39.20	-1.79	5
		e"	13.4800	Conductivity (σ):	1.84	1.80	2.02	5
	Head 2400	e'	38.3900	Relative Permittivity (ϵ_r):	38.39	39.30	-2.31	5
		e"	13.1500	Conductivity (σ):	1.75	1.75	0.18	5
	Head 2480	e'	38.7800	Relative Permittivity (ϵ_r):	38.78	39.16	-0.98	5
		e"	13.7000	Conductivity (σ):	1.89	1.83	3.10	5

8.2. System Check

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

System Performance Check Measurement Conditions:

- The measurements were performed in the flat section of the TWIN SAM or ELI phantom, shell thickness: 2.0 ±0.2 mm (bottom plate) filled with Body or Head simulating liquid of the following parameters.
- The depth of tissue-equivalent liquid in a phantom must be ≥ 15.0 cm for SAR measurements ≤ 3 GHz and ≥ 10.0 cm for measurements > 3 GHz.
- The DASY system with an E-Field Probe was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10 mm (above 1 GHz) and 15 mm (below 1 GHz) from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 15 mm was aligned with the dipole.
  For 5 GHz band - The coarse grid with a grid spacing of 10 mm was aligned with the dipole.
- Special 7x7x7 (below 3 GHz) and/or 8x8x7 (above 3 GHz) fine cube was chosen for the cube.
- Distance between probe sensors and phantom surface was set to 2.5 mm.
  For 5 GHz band - Distance between probe sensors and phantom surface was set to 1.4 mm
- The dipole input power (forward power) was 100 mW.
- The results are normalized to 1 W input power.

Reference Target SAR Values

The reference SAR values can be obtained from the calibration certificate of system validation dipoles.

System Dipole	Serial No.	Cal. Date	Cal. Due Date	Target SAR Values (W/kg)	
				1g/10g	Head
D2450V2	939	7-21-2021	7-21-2023	1g	53.00
				10g	24.70

Note(s):

1. For System Validation Dipole, Calibration interval applied every 2 years according to referencing KDB 865664 guidance.

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.

SAR 5 Room

Date Tested	System Dipole		T.S. Liquid		Measured Results		Target (Ref. Value)	Delta ±10 %	Plot No.
	Type	Serial #			Zoom Scan to 100 mW	Normalize to 1 W			
5-30-2023	D2450V2	939	Head	1g	5.24	52.4	53.00	-1.13	
				10g	2.30	23.0	24.70	-6.88	

9. Conducted Output Power Measurements

9.1 Wi-Fi 2.4 GHz RSDB (DTS Band)

WLAN output power results

Antenna	Mode	Data Rate	Ch #	Freq. (MHz)	Average Power (dBm)			
					[redacted]	SISO Ant. 2		
						Meas. Avg Pwr (dBm)	Max. Tune-up Limit (dBm)	SAR Test (Yes/No)
WiFi 2.4G	802.11b	1 Mbps	1	2412.0		8.80	9.0	Yes
			6	2437.0		9.00		
			11	2462.0		8.70		

Antenna	Mode	Data Rate	Ch #	Freq. (MHz)	Average Power (dBm)					
					MIMO Ant. 1			MIMO Ant. 2		
					Meas. Avg Pwr	Max. Tune-up Limit	SAR Test (Yes/No)	Meas. Avg Pwr (dBm)	Max. Tune-up Limit (dBm)	SAR Test (Yes/No)
WiFi 2.4G	802.11b	1 Mbps	1	2412.0	8.96	9.0	Yes	8.75	9.0	Yes
			6	2437.0	8.88			8.99		
			11	2462.0	8.68			8.78		

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. 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.

10. Measured and Reported (Scaled) SAR Results

SAR Test Reduction criteria are as follows:

- Reported SAR(W/kg) for WWAN= Measured SAR *Tune-up Scaling Factor
- Reported SAR(W/kg) for Wi-Fi and Bluetooth= Measured SAR * Tune-up scaling factor * Duty Cycle scaling factor
- Duty Cycle scaling factor = 1 / Duty cycle (%)

KDB 447498 D01 General RF Exposure Guidance:

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

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

KDB 248227 D01 SAR meas for 802.11:

SAR test reduction for 802.11 Wi-Fi transmission mode configurations are considered separately for DSSS and OFDM. An initial test position is determined to reduce the number of tests required for certain exposure configurations with multiple test positions. An initial test configuration is determined for each frequency band and aggregated band according to maximum output power, channel bandwidth, wireless mode configurations and other operating parameters to streamline the measurement requirements. For 2.4 GHz DSSS, either the initial test position or DSSS procedure is applied to reduce the number of SAR tests; these are mutually exclusive. For OFDM, an initial test position is only applicable to next to the ear, UMPC mini-tablet and hotspot mode configurations, which is tested using the initial test configuration to facilitate test reduction. For other exposure conditions with a fixed test position, SAR test reduction is determined using only the initial test configuration.

The multiple test positions require SAR measurements in head, hotspot mode or UMPC mini-tablet configurations may be reduced according to the highest reported SAR determined using the *initial test position(s)* by applying the DSSS or OFDM SAR measurement procedures in the required wireless mode test configuration(s). The *initial test position(s)* is measured using the highest measured maximum output power channel in the required wireless mode test configuration(s). When the *reported* SAR for the *initial test position* is:

- ≤ 0.4 W/kg, further SAR measurement is not required for the other test positions in that exposure configuration and wireless mode combination within the frequency band or aggregated band. DSSS and OFDM configurations are considered separately according to the required SAR procedures.
- > 0.4 W/kg, SAR is repeated using the same wireless mode test configuration tested in the *initial test position* to measure the subsequent next closet/smallest test separation distance and maximum coupling test position, on the highest maximum output power channel, until the *reported* SAR is ≤ 0.8 W/kg or all required test positions are tested.
  - For subsequent test positions with equivalent test separation distance or when exposure is dominated by coupling conditions, the position for maximum coupling condition should be tested.
  - When it is unclear, all equivalent conditions must be tested.
- For all positions/configurations tested using the *initial test position* and subsequent test positions, when the *reported* SAR is > 0.8 W/kg, measure the SAR for these positions/configurations on the subsequent next highest measured output power channel(s) until the *reported* SAR is ≤ 1.2 W/kg or all required test channels are considered.
  - The additional power measurements required for this step should be limited to those necessary for identifying subsequent highest output power channels to apply the test reduction.
- When the specified maximum output power is the same for both UNII 1 and UNII 2A, begin SAR measurements in UNII 2A with the channel with the highest measured output power. If the reported SAR for UNII 2A is ≤ 1.2 W/kg, SAR is not required for UNII 1; otherwise treat the remaining bands separately and test them independently for SAR.
- When the specified maximum output power is different between UNII 1 and UNII 2A, begin SAR with the band that has the higher specified maximum output. If the highest reported SAR for the band with the highest specified power is ≤ 1.2 W/kg, testing for the band with the lower specified output power is not required; otherwise test the remaining bands independently for SAR.

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

10.1. Wi-Fi RSDB (DTS Band)

RF Exposure Conditions	Mode	Antenna	Power State	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Area Scan Max. SAR (W/kg)	Duty Cycle	Power (dBm)		1-g SAR (W/kg)		Plot No.
										Tune-up Limit	Meas.	Meas.	Scaled	
Body	802.11b MIMO	BT/WIFI1	RSDB	0	Edge Right	6	2437	0.232	98.8%	9.0	8.9	0.120	0.125	1
RF Exposure Conditions	Mode	Antenna	Power State	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Area Scan Max. SAR (W/kg)	Duty Cycle	Power (dBm)		1-g SAR (W/kg)		Plot No.
										Tune-up Limit	Meas.	Meas.	Scaled	
Body	802.11b SISO Ant 2	BT/WIFI1	RSDB	0	Edge Right	6	2437	0.001	98.8%	9.0	9.0	<0.001	<0.001	
RF Exposure Conditions	Mode	Antenna	Power State	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Area Scan Max. SAR (W/kg)	Duty Cycle	Power (dBm)		1-g SAR (W/kg)		Plot No.
										Tune-up Limit	Meas.	Meas.	Scaled	
Body	802.11b MIMO	BT/WIFI2	RSDB	0	Edge Right	6	2437	0.232	98.8%	9.0	9.0			

Note(s):

1. When the Highest reported SAR is ≤ 0.4 or 1.0 W/kg (1-g or 10-g respectively). Therefore, further SAR measurements within this exposure condition are not required.
2. Highest reported SAR is > 0.4 or 1.0 W/kg (1-g or 10-g respectively). Due to the highest reported SAR for this test position, other test positions in this exposure condition were evaluated until a SAR ≤ 0.8 or 2.0 W/kg (1-g or 10-g respectively) was reported.
3. Testing for a second channel was required because the reported SAR for this test position was > 0.8 or 2.0 W/kg (1-g or 10-g respectively).
4. In the case of RSDB, since it is equal to or lower than the original target, only the problematic part in simultaneous combination is measured.

11. SAR Measurement Variability

In accordance with published RF Exposure KDB 865664 D01 SAR measurement 100 MHz to 6 GHz. These additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

1) Repeated measurement is not required when the original highest measured SAR is <0.8 or 2 W/kg (1-g or 10-g respectively); steps 2) through 4) do not apply.
2) When the original highest measured SAR is ≥ 0.8 or 2 W/kg (1-g or 10-g respectively), repeat that measurement once.
3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ≥ 1.45 or 3.6 W/kg (~ 10% from the 1-g or 10-g respective SAR limit).
4) Perform a third repeated measurement only if the original, first, or second repeated measurement is ≥ 1.5 or 3.75 W/kg (1-g or 10-g respectively) and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

Peak spatial-average (1g of tissue)

Frequency Band (MHz)	Air Interface	RF Exposure Conditions	Test Position	Repeated SAR (Yes/No)	Highest Measured SAR (W/kg)	Repeated Measured SAR (W/kg)	Largest to Smallest SAR Ratio
2450	WiFi 2.4GHz	Body	Edge Right	No	0.120	N/A	N/A

Note(s):

Second Repeated Measurement is not required since the ratio of the largest to smallest SAR for the original and first repeated measurement is not > 1.20.

12. Simultaneous Transmission SAR Analysis

Simultaneous Transmission Condition

RF Exposure Condition	Item	Capable Transmit Configurations					RSDB Scenarios
Body	1	DTS MIMO	+	UNII MIMO			
	2	DTS Ant. 2	+	UNII MIMO	+	BT Ant.1	

Notes:

1. DTS supports Wi-Fi Direct and VoIP.
2. U-NII supports Wi-Fi Direct and VoIP.
3. U-NII only supports MIMO mode.
4. U-NII Radio can transmit simultaneously with Bluetooth Radio.
5. DTS Radio can transmit simultaneously with U-NII Radio in only RSDB Scenarios
6. BT tethering is considered about each RF exposure conditions.

Simultaneous transmission SAR test exclusion considerations

KDB 447498 D01 General RF Exposure Guidance provides two procedures for determining simultaneous transmission SAR test exclusion: Sum of SAR and SAR to Peak Location Ratio (SPLSR)

Sum of SAR

To qualify for simultaneous transmission SAR test exclusion based upon Sum of SAR the sum of the reported standalone SARs for all simultaneously transmitting antennas shall be below the applicable standalone SAR limit. If the sum of the SARs is above the applicable limit then simultaneous transmission SAR test exclusion may still apply if the requirements of the SAR to Peak Location Ratio (SPLSR) evaluation are met.

SAR to Peak Location Ratio (SPLSR)

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 reported 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 reported 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:

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

When an individual antenna transmits at on two bands simultaneously, the sum of the highest *reported* SAR for the frequency bands should be used to determine SAR_1.or SAR_2. When SPLSR is necessary, the smallest distance between the peak SAR locations for the antenna pair with respect to the peaks from each antenna should be used.

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

The antennas for the unlicensed transmitters are closely situated. As a result, the associated SAR hotspots are also closely situated. Some of the sum of SAR calculations yielded results over 1.6 W/kg. The SPSLR calculations for these situations were performed by treating the unlicensed SAR values as a single transmitter. The most conservative distance between all the unlicensed hotspots to the licensed hotspot was used for the value of *d* in the SPSLR calculation.

Simultaneous transmission SAR measurement

When simultaneous transmission SAR measurements are required in different frequency bands not covered by a single probe calibration point then separate tests for each frequency band are performed. The tests are performed using enlarged zoom scans which are processed, by means of superposition, using the DASY5 volume scan postprocessing procedures to determine the 1-g SAR for the aggregate SAR distribution.

The spatial resolution used for all enlarged zoom scans is the same as used for the most stringent zoom scans. I.E. the scan parameters required for the highest frequency assessed are used for all enlarged zoom scans. The scans cover the complete area of the device to ensure all transmitting antennas and radiating structures are assessed.

DASY5 provides the ability to perform Multiband Evaluations according to the latest standards using the Volume Scan job as well as appropriate routines for the Post-processing.

In order to extract and process measurements within different frequency bands, the SEMCAD X Post-processor performs the combination and subsequent superposition of these measurement data via DASY5= Combined MultiBand Averaged SAR.

Combined Multi Band Averaged SAR allows - in addition to the data extraction - an evaluation of the 1 g, 10 g and/or arbitrary averaged mass SAR.
Power Scaling Factor is used to allow the volume scans to be scaled by a value other than "1", this is important when the results need to be scaled to different maximum power levels. The Power Scaling Factor is applied to each individual point of the scan. When power scaling is used in multi-band combinations the scaling factor is applied to each individual point of the first scan, the second factor is then applied to each individual point of the second scan and so on. The scans are then combined.

SPLSR Hotspot Combination

Per November 2019 TCB Workshop Notes, SPLSR Hotspot Combination procedure can be applied to evaluate to simultaneous transmission SAR analysis.
Hybrid SPLSR and enlarged zoom scan (Volume scan) can be applied when Simultaneous transmission SAR is over 1.6 or 4.0 W/kg (1-g or 10-g respectively), it does not meet SPLSR criteria, and antenna pair is co-located. Antenna co-location means that SAR distributions overlap because the antennas are not significantly spatially separated.

Test procedure

Step.1 Perform enlarged zoom scan (Volume scan) on the co-located antenna pair to determine 1g/10g aggregate SAR.

Step.2 Apply SPLSR procedure for the spatially separated antenna and aggregate SAR distribution of the co-located antenna pair.

Sum to Peak Location Separation Ratio

Instead of doing a small volume scan over a co-located antenna pair (Hybrid SPLSR guide), Simultaneous transmission SAR test exclusion may algebraically sum the SAR values of the co-located pair and use that value in SPLSR calculation;

-In the calculation Separation distance must use the minimum distance between the spatially separated antenna and the closest antenna of the co-located antenna pair to be conservative.

12.1. Simultaneous transmission analysis

12.1.1. RSDB Body exposure condition

SAR (DTS & BT & UNII)

RF Exposure	Test Position	DTS SISO Ant. 2	DTS MIMO Ant. 1	DTS MIMO Ant. 2	UNII MIMO Ant. 1	UNII MIMO Ant. 2	BT Ant. 1
		1	2	3	4	5	6
Body (1-g SAR)	Rear	0.202	**0.432**	0.387	0.629	**1.182**	0.279
	Edge Top	0.216	0.288	0.387	0.218	0.081	0.110
	Edge Right	0.001	0.125	0.001	1.100	0.001	**0.293**
	Edge Left	0.216	0.629	0.216	0.001	0.614	0.001

Test Position	SAR (W/kg)			
	DTS MIMO Ant. 1 + UNII MIMO Ant 1	DTS MIMO Ant. 2 + UNII MIMO Ant 2	UNII MIMO Ant. 1 + BT Ant 1	DTS SISO Ant. 2 + UNII MIMO Ant 2
	2 + 4	3 + 5	4 + 6	1 + 5
Rear	1.061	1.569	0.908	1.384
Edge Top	0.506	0.468	0.328	0.297
Edge Right	1.225	0.002	1.393	0.002
Edge Left	0.630	0.830	0.002	0.830

Simultaneous Transmission Analysis

RF Exposure	Test Position	Highest SAR (W/kg)		Sum SAR (W/kg)
		DTS MIMO Ant. 1 + UNII MIMO Ant 1	DTS MIMO Ant. 2 + UNII MIMO Ant 2	DTS MIMO Ant 1 + DTS MIMO Ant 2 + UNII MIMO Ant 1 + UNII Ant MIMO 2
Body (1-g SAR)	Rear	1.061	1.569	2.630
	Edge Top	0.506	0.468	0.974
	Edge Right	1.225	0.002	1.227
	Edge Left	0.630	0.830	**1.460**

RF Exposure	Test Position	Highest SAR (W/kg)		Sum SAR (W/kg)
		UNII MIMO Ant. 1 + BT Ant 1	DTS SISO Ant. 2 + UNII MIMO Ant 2	DTS SISO Ant 2 + BT Ant 1 + UNII MIMO Ant 1 + UNII MIMO Ant 2
Body (1-g SAR)	Rear	0.908	1.384	2.292
	Edge Top	0.328	0.297	0.625
	Edge Right	1.393	0.002	**1.395**
	Edge Left	0.002	0.830	0.832

WLAN & BT Rear peak SAR locations

WLAN & BT

WLAN/BT/NFC Standalone	Reported SAR (W/kg)	SAR location (mm)		WLAN/BT/NFC combinations	SUM SAR (W/kg)	SAR location (mm)	
		X-axis	Y-axis			X-axis	Y-axis
DTS SISO Ant.2	0.202	-80.2	-118.8	DTS MIMO Ant 1 + UNII MIMO Ant 1	1.061	75.0	-117.5
DTS MIMO Ant 1	0.432	76.5	-123.0	DTS MIMO Ant 2 + UNII MIMO Ant 2	1.569	-77.0	-113.6
DTS MIMO Ant 2	0.387	-79.5	-116.5	UNII MIMO Ant 1 + BT Ant 1	0.908	75.0	-117.5
UNII MIMO Ant 1	0.629	75.0	-117.5	DTS SISO Ant 2 + UNII MIMO Ant 2	1.384	-77.0	-113.6
UNII MIMO Ant 2	1.182	-77.0	-113.6				
BT Ant 1	0.279	77.5	-124.5				

Sum-Peak Location Separation Ratio

RF Exposure	Test Position	Highest SAR (W/kg)				Sum SAR (W/kg) (1-g or 10-g)		Calculated Distance (mm)	1-g SPLSR (=<0.04) or 10-g SPLSR (=<0.10)	Volume Scan (Yes/No)	Figure
		DTS MIMO Ant 1	UNII MIMO Ant 1	DTS MIMO Ant 2	UNII MIMO Ant 2						
Body (1-g SAR)	Rear	0.432	0.629	0.387	1.182	DTS+UNII	2.630				1
		1.061		1.569		DTS+UNII	2.630	152.10	0.03	No	
Sum-Peak Location Separation Note 2		1.061		1.569		DTS+UNII					
RF Exposure	Test Position	Highest SAR (W/kg)				Sum SAR (W/kg) (1-g or 10-g)		Calculated Distance (mm)	1-g SPLSR (=<0.04) or 10-g SPLSR (=<0.10)	Volume Scan (Yes/No)	Figure
		UNII MIMO Ant 1	BT Ant 1	DTS SISO Ant 2	UNII MIMO Ant 2						
Body (1-g SAR)	Rear	0.629	0.279	0.202	1.182	BT+DTS+UNII	2.292				2
		0.908		1.384		BT+DTS+UNII	2.292	152.10	0.02	No	
Sum-Peak Location Separation Note 2		0.908		1.384		BT+DTS+UNII					

Note(s):

1. WiFi&BT data refer to Original model(R14720543-S1 FCC Report).
2. SPLSR Hotspot Combination Step.1) Perform enlarged zoom scan (Volume scan) on the co-located antenna pair to determine 1g/10g aggregate SAR. Refer to Original model(R14720543-S1 FCC Report) for detailed Volume Scan Result.
3. SPLSR Hotspot Combination Step.2) Apply SPLSR procedure for the spatially separated antenna and aggregate SAR distribution of the co-located antenna pair. Hybrid SPLSR procedure was applied for the spatially separated main bands and unlicensed bands for Multi-band Combined results.

Figure (1)

Mode		SAR	X	Y	Z	d: Calculated distance (mm)	
		W/kg	m	m	m		
DTS MIMO Ant 1 + UNII MIMO Ant 1	1	1.061	0.0750	-0.1175	-0.1770	1 + 2	152.1
DTS MIMO Ant 2 + UNII MIMO Ant 2	2	1.569	-0.0770	-0.1136	-0.1770		

The Peak Location Separation Distance is computed by using the formula below:

SQRT((X1-X2)^2+(Y1-Y2)^2+(Z1-Z2)^2)

Figure (2)

Mode		SAR W/kg	X m	Y m	Z m	d: Calculated distance (mm)	
BT Ant 1 + UNII MIMO Ant 1	1	0.908	0.0750	-0.1175	-0.1770	1 + 2	152.1
DTS SISO Ant 2 + UNII MIMO Ant 2	2	1.384	-0.0770	-0.1136	-0.1770		

The Peak Location Separation Distance is computed by using the formula below:

SQRT((X1-X2)^2+(Y1-Y2)^2+(Z1-Z2)^2)

Conclusion:

Simultaneous Transmission SAR analysis results is satisfied the FCC Limit requirement according to follow procedures with “Sum of SAR” or “SPLSR” or “SPLSR Hotspot combination(including Volume Scan)”.

Appendixes

Refer to separated files for the following appendixes.

4790872599-S1 FCC Report SAR_App A_Photos & Ant. Locations

4790872599-S1 FCC Report SAR_App B_Highest SAR Test Plots

4790872599-S1 FCC Report SAR_App C_System Check Plots

4790872599-S1 FCC Report SAR_App D_SAR Tissue Ingredients

4790872599-S1 FCC Report SAR_App E_Probe Cal. Certificates

4790872599-S1 FCC Report SAR_App F_Dipole Cal. Certificates

END OF REPORT