



SAR EVALUATION REPORT

**FCC 47 CFR § 2.1093
IEEE Std 1528-2013**

For
MOBILE FAP 60, 10-PRINT FINGERPRINT CAPTURE DEVICE

**FCC ID: Q9Y7680
Model Name: NOMAD 60 WIRELESS READER**

**Report Number: 12204358-S4V3
Issue Date: 7/25/2018**

Prepared for
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NVLAP LAB CODE 200065-0

Revision History



Rev.	Date	Revisions	Revised By
V1	7/13/2018	Initial Issue	--
V2	7/17/2018	Corrected Equipment Class	Dave Weaver
V3	7/25/2018	Section 6.2 – Corrected wireless technologies Updated note to Section 9.1	Dave Weaver

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1. Attestation of Test Results

Applicant Name	CROSS MATCH TECHNOLOGIES INC.			
FCC ID	Q9Y7680			
Model Name	NOMAD 60 WIRELESS READER			
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)		Extremities (hands, wrists, ankles, etc.) (10g of tissue)	
General population / Uncontrolled exposure	1.6		4	
RF Exposure Conditions	Equipment Class - Highest Reported SAR (W/kg)			
	PCT	DTS	NII	DSS
Extremity	N/A	0.525	N/A	N/A
Simultaneous TX	N/A	N/A	N/A	N/A
Date Tested	7/13/2018			
Test Results	Pass			
<p>UL Verification Services Inc. 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 Verification Services Inc. 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.</p> <p>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 Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. 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 NVLAP, NIST, any agency of the Federal Government, or any agency of any government (NIST Handbook 150, Annex A). This report is written to support regulatory compliance of the applicable standards stated above.</p>				
Approved & Released By:		Prepared By:		
				
Dave Weaver Operations Leader UL Verification Services Inc.		Tomohisa Nakagawa Test Engineer UL Verification Services Inc.		

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:

- 248227 D01 802.11 Wi-Fi SAR v02r02
- 447498 D01 General RF Exposure Guidance v06
- 447498 D03 Supplement C Cross-Reference 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

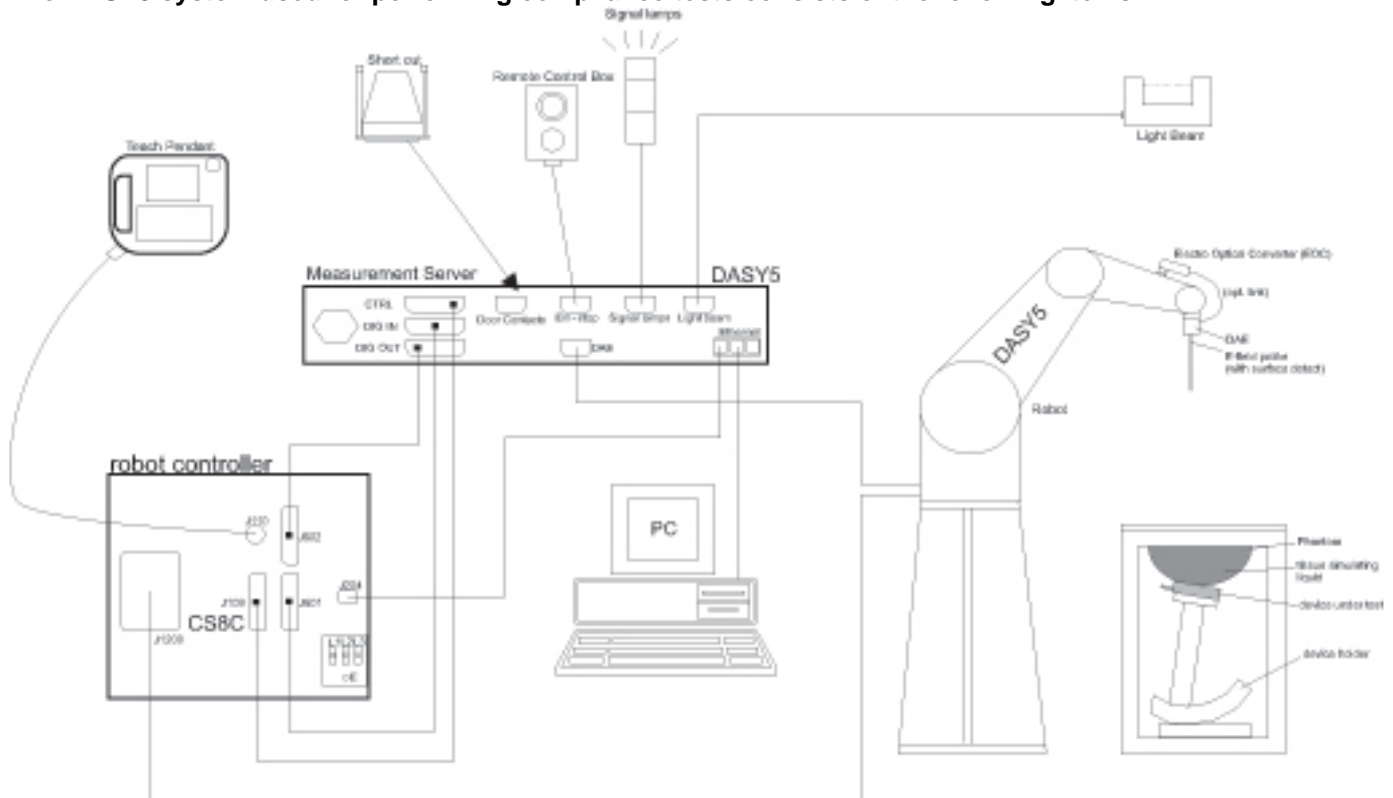
47173 Benicia Street	47266 Benicia Street
SAR Lab A	SAR Lab 1
SAR Lab B	SAR Lab 2
SAR Lab C	SAR Lab 3
SAR Lab D	SAR Lab 4
SAR Lab E	SAR Lab 5
SAR Lab F	SAR Lab 6
SAR Lab G	SAR Lab 7
SAR Lab H	SAR Lab 8

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0.

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	$\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5$ mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	$30^\circ \pm 1^\circ$	$20^\circ \pm 1^\circ$
Maximum area scan spatial resolution: $\Delta x_{\text{Area}}, \Delta y_{\text{Area}}$	≤ 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 \leq 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: $\Delta x_{\text{Zoom}}, \Delta y_{\text{Zoom}}$			≤ 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: $\Delta z_{\text{Zoom}}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{\text{Zoom}}(1)$: between 1 st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{\text{Zoom}}(n>1)$: between subsequent points	$\leq 1.5 \cdot \Delta z_{\text{Zoom}}(n-1)$	
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 <u>reported</u> SAR from the <i>area scan based 1-g SAR estimation</i> 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. Volume Scan Procedures

Step 1: Repeat Step 1-4 in Section 4.2

Step 2: Volume Scan

Volume Scans are used to assess peak SAR and averaged SAR measurements in largely extended 3-dimensional volumes within any phantom. This measurement does not need any previous area scan. The grid can be anchored to a user specific point or to the current probe location.

Step 3: 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.

4.4. 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
S-Parameter Network Analyzer	Agilent	8753ES	MY40000980	2019/5/14
Dielectric Probe kit	SPEAG	DAK-3.5	1082	2018/10/17
Shorting Block	SPEAG	DAK-3.5 Short	SM DAK 200 BA	2018/10/17
Thermometer	Fisher Scientific	Traceable	140562250	2018/11/7

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Synthesized Signal Generator	Agilent	N5181A	MY50140630	2019/5/25
Power Meter	HP	437B	3125U12345	2018/8/10
Power Sensor	HP	8481A	3318A92374	2018/8/15
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1795092	N/A
Bi-directional coupler	Werlatone, Inc.	C8060-102	2141	N/A
DC Power Supply	BK Precision	1611	215-02292	N/A

Lab Equipment

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
E-Field Probe (SAR Lab 6)	SPEAG	EX3DV4	3885	2018/10/24
Data Acquisition Electronics (SAR Lab 6)	SPEAG	DAE4	1545	2019/4/13
System Validation Dipole	SPEAG	D2450V2	706	2019/5/18
Thermometer (SAR Lab 5/6/7/8)	Fisher Scientific	Traceable	181062300	2019/2/26

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Power Meter	Keysight	N1912A	MY55196007	2018/7/17
Power Sensor	Agilent	N1921A	MY53260010	2018/10/17

Note(s):

*Equipment not used past calibration 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 $\leq 30\%$, 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.

6. Device Under Test (DUT) Information

6.1. DUT Description

Device Dimension	Overall (Length x Width x Height): 103 mm x 132 mm x 16 mm		
Back Cover	The Back Cover is not removable.		
Battery Options	The rechargeable battery is not user accessible.		
Test sample information	S/N	Model	Notes
	ENB003	NOMAD 60 WIRELESS READER	SAR Conducted
	ENB004	NOMAD 60 WIRELESS READER	SAR Radiated
Hardware Version	Beta		
Software Version	Mfg Tools-Nomad4_WIFI_Nightly_Image_04_02_2018.eng. QCA Radio Control Toolkit (QRCT) version 3.0.156.0		

6.2. Wireless Technologies

Wireless technologies	Frequency bands	Operating Mode	Duty Cycle used for SAR testing
Wi-Fi	2.4 GHz	802.11b	97.00% (802.11b)
		802.11g	81.45% (802.11g)
		802.11n (HT20)	81.01% (802.11n HT20)
		802.11n (HT40)	N/A
	5 GHz	802.11a	82.87% (802.11a)
		802.11n (HT20)	83.04% (802.11n HT20)
		802.11n (HT40)	72.00% (802.11n HT40)
802.11ac (VHT20)		83.27% (802.11ac VHT20)	
		802.11ac (VHT40)	71.80% (802.11ac VHT40)
		802.11ac (VHT80)	58.00% (802.11ac VHT80)
Does this device support bands 5.60 ~ 5.65 GHz? <input checked="" type="checkbox"/> Yes <input type="checkbox"/> No			
Does this device support Band gap channel? <input type="checkbox"/> Yes <input checked="" type="checkbox"/> No			
Bluetooth	2.4 GHz	Version 4.1	N/A

Notes:

- The DUT does not support LE mode

6.3. Test Rationale

The DUT is a handheld fingerprint reader. Data is only transmitted when a fingerprint is being read. Therefore only extremity SAR testing was performed.

6.4. Maximum Output Power from Tune-up Procedure

Mode	Channels	Max. RF Output Power (dBm)
802.11b	1	19.0
	2-10	19.5
	11	19.0
802.11g	1	14.5
	2-10	16.5
	11	13.5
802.11n	1	13.5
	2-10	16.5
	11	13.0
802.11n40	3	10.5
	4	11.0
	5-8	12.0
	9	11.0
802.11a	36	10.50
802.11a	40-48	11.50
802.11n HT20 / VHT20	36	10.50
802.11n HT20 / VHT20	40-48	10.00
802.11n HT40 / VHT40	38	9.00
802.11n HT40 / VHT40	46	11.50
802.11ac VHT80	All	9.00
802.11a	52-60	11.50
802.11a	64	10.00
802.11n HT20 / VHT20	52-60	12.50
802.11n HT20 / VHT20	64	10.00
802.11n HT40 / VHT40	54	11.50
802.11n HT40 / VHT40	62	10.00
802.11ac VHT80	All	9.50
802.11a	100-136	8.50
802.11a	140	10.00
802.11n HT20 / VHT20	100-136	8.50
802.11n HT20 / VHT20	140	10.00
802.11n HT40 / VHT40	102	8.00
802.11n HT40 / VHT40	110-134	10.00
802.11ac VHT80	106	9.50
802.11ac VHT80	122	10.50
802.11a	All	10.50
802.11n HT20 / VHT20	All	10.50
802.11n HT40 / VHT40	All	9.50
802.11ac VHT80	All	10.50
GFSK	All	2.0
EDR	All	1.5

Note(s):

- When the specified maximum output power is the same for both U-NII band 1 and U-NII band 2A, begin SAR measurement in U-NII band 2A; and if the highest reported SAR for U-NII band 2A is
 - ≤ 3.0 W/kg, SAR is not required for U-NII band 1
 - > 3.0 W/kg, both bands should be tested independently for SAR.

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. Standalone SAR Test Exclusion Considerations

Since the *Dedicated Host Approach* is applied, the standalone SAR test exclusion procedure in KDB 447498 § 4.3.1 is applied to determine the minimum test separation distance:

- When the separation distance from the antenna to an adjacent edge is ≤ 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.
- When the separation distance from the antenna to an adjacent edge is > 5 mm, the actual antenna-to-edge separation distance is applied to determine SAR test exclusion.
- SAR Test exclusion threshold determines SAR exclusion
 - a. SAR Test exclusion threshold is calculated using the procedure in KDB 447498 § 4.3.1.

SAR Test Exclusion Calculations for WLAN & Bluetooth

Antennas < 50mm to adjacent edges

Tx Interface	Frequency (MHz)	Output Power		Separation Distances (mm)						Calculated Threshold Value					
		dBm	mW	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front
Wi-Fi Main Antenna															
Wi-Fi 2.4 GHz	2462	19.50	89	6.34	6.2	11	76.8	118.25	6.66	23.3 -MEASURE-	23.3 -MEASURE-	12.7 -MEASURE-	> 50 mm	> 50 mm	19.9 -MEASURE-
Wi-Fi 5.2 GHz	5240	11.50	14	6.34	6.2	11	76.8	118.25	6.66	5.3 -EXEMPT-	5.3 -EXEMPT-	2.9 -EXEMPT-	> 50 mm	> 50 mm	4.6 -EXEMPT-
Wi-Fi 5.3 GHz	5320	12.50	18	6.34	6.2	11	76.8	118.25	6.66	6.9 -EXEMPT-	6.9 -EXEMPT-	3.8 -EXEMPT-	> 50 mm	> 50 mm	5.9 -EXEMPT-
Wi-Fi 5.6 GHz	5700	10.50	11	6.34	6.2	11	76.8	118.25	6.66	4.4 -EXEMPT-	4.4 -EXEMPT-	2.4 -EXEMPT-	> 50 mm	> 50 mm	3.8 -EXEMPT-
Wi-Fi 5.8 GHz	5825	10.50	11	6.34	6.2	11	76.8	118.25	6.66	4.4 -EXEMPT-	4.4 -EXEMPT-	2.4 -EXEMPT-	> 50 mm	> 50 mm	3.8 -EXEMPT-
Bluetooth	2480	2.00	2	6.34	6.2	11	76.8	118.25	6.66	0.5 -EXEMPT-	0.5 -EXEMPT-	0.3 -EXEMPT-	> 50 mm	> 50 mm	0.4 -EXEMPT-

Note(s):

- According to KDB 447498, if the calculated threshold value is > 7.5 , then SAR testing is required.

Tx Interface	Frequency (MHz)	Output Power		Separation Distances (mm)						Calculated Threshold Value					
		dBm	mW	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front
Wi-Fi Main Antenna															
Wi-Fi 2.4 GHz	2462	19.50	89	6.34	6.2	11	76.8	118.25	6.6	< 50 mm	< 50 mm	< 50 mm	507 mW -EXEMPT-	921.5 mW -EXEMPT-	< 50 mm
Wi-Fi 5.2 GHz	5240	11.50	14	6.34	6.2	11	76.8	118.25	6.6	< 50 mm	< 50 mm	< 50 mm	431.8 mW -EXEMPT-	846.3 mW -EXEMPT-	< 50 mm
Wi-Fi 5.3 GHz	5320	12.50	18	6.34	6.2	11	76.8	118.25	6.6	< 50 mm	< 50 mm	< 50 mm	430.6 mW -EXEMPT-	845.1 mW -EXEMPT-	< 50 mm
Wi-Fi 5.6 GHz	5700	10.50	11	6.34	6.2	11	76.8	118.25	6.6	< 50 mm	< 50 mm	< 50 mm	425.1 mW -EXEMPT-	839.6 mW -EXEMPT-	< 50 mm
Wi-Fi 5.8 GHz	5825	10.50	11	6.34	6.2	11	76.8	118.25	6.6	< 50 mm	< 50 mm	< 50 mm	423.4 mW -EXEMPT-	837.9 mW -EXEMPT-	< 50 mm
Bluetooth	2480	2.00	2	6.34	6.2	11	76.8	118.25	6.6	< 50 mm	< 50 mm	< 50 mm	506.1 mW -EXEMPT-	920.6 mW -EXEMPT-	< 50 mm

Note(s):

According to KDB 447498, if the calculated Power threshold is less than the output power then SAR testing is required.

7.2. Required Test Configurations

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

Test Configurations	Rear	Edge1	Edge2	Edge3	Edge4	Front
Wi-Fi 2.4 GHz	Yes	Yes	Yes	No	No	Yes
Wi-Fi 5.2 GHz	No	No	No	No	No	No
Wi-Fi 5.3 GHz	No	No	No	No	No	No
Wi-Fi 5.6 GHz	No	No	No	No	No	No
Wi-Fi 5.8 GHz	No	No	No	No	No	No
Bluetooth	No	No	No	No	No	No

Note(s):

- Yes = SAR Testing is required.
No = SAR Testing is not required.

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 $\pm 2^\circ\text{C}$ 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 (rounded to the nearest 10MHz).

The dielectric constant (ϵ_r) and conductivity (σ) of typical tissue-equivalent media recipes are expected to be within $\pm 5\%$ 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 ϵ_r and σ may be relaxed to $\pm 10\%$. This is limited to frequencies $\leq 3\text{ GHz}$.

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

IEEE Std 1528-2013

Refer to Table 3 within the IEEE Std 1528-2013

Dielectric Property Measurements Results

SAR Lab	Date	Band (MHz)	Tissue Type	Frequency (MHz)	Relative Permittivity (ϵ_r)			Conductivity (σ)		
					Measured	Target	Delta	Measured	Target	Delta
6	2018/7/12	2450	Body	2450	50.79	52.70	-3.62	2.01	1.95	3.18
				2400	50.84	52.77	-3.66	1.99	1.90	4.64
				2480	50.72	52.66	-3.69	2.04	1.99	2.45

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 \pm 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 \geq 15.0 cm for SAR measurements \leq 3 GHz and \geq 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 3 mm.
For 5 GHz band - Distance between probe sensors and phantom surface was set to 2.5 mm
- The dipole input power (forward power) was 100 mW.
- The results are normalized to 1 W input power.

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 Lab	Date	Tissue Type	Dipole Type_Serial #	Dipole Cal. Due Data	Measured Results for 1g SAR				Measured Results for 10g SAR				Plot No.
					Zoom Scan to 100 mW	Normalize to 1 W	Target (Ref. Value)	Delta \pm 10 %	Zoom Scan to 100 mW	Normalize to 1 W	Target (Ref. Value)	Delta \pm 10 %	
6	2018/7/12	Body	D2450V2 SN:706	2019/5/18	5.070	50.70	50.60	0.20	2.370	23.70	23.70	0.00	1,2

9. Conducted Output Power Measurements

9.1. Wi-Fi 2.4GHz (DTS Band)

9.1.1. Wi-Fi 2.4GHz Measured Output Power

Band (GHz)	Mode	Data Rate	Ch #	Freq. (MHz)	Meas. Avg Pwr (dBm)	Max Output Power (dBm)	SAR Test (Yes/No)
2.4 (DTS)	802.11b	1 Mbps	1	2412	Not Required	19.0	No
			2	2417	19.40	19.5	Yes
			6	2437	19.30	19.5	
			10	2457	19.22	19.5	
			11	2462	Not Required	19.0	No
	802.11g	6 Mbps	1	2412	Not Required	14.5	No
			2	2417	Not Required	16.5	
			6	2437	Not Required	16.5	
			10	2457	Not Required	16.5	
			11	2462	Not Required	13.5	
	802.11n (HT20)	6.5 Mbps	1	2412	Not Required	13.5	No
			2	2417	Not Required	16.5	
			6	2437	Not Required	16.5	
			10	2457	Not Required	16.5	
			11	2462	Not Required	13.0	

Note(s):

- For "Not required", SAR Test reduction was applied in accordance with KDB 248227.
- SAR Not Required for 802.11n HT20 mode when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 3.0 W/kg per KDB 248227.
As HT40 power is lower than the HT20 power HT40 SAR is not required for the same reason.

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

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 closest/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.

While 1-g SAR thresholds are specified in the procedures for SAR test reduction and exclusion, above thresholds should be multiplied by 2.5 when 10-g extremity SAR is considered since it is 1-g SAR

10.1. Wi-Fi (DTS Band)

RF Exposure Conditions	Mode	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Duty Cycle	Power (dBm)		10-g SAR (W/kg)		Plot No.
							Tune-up Limit	Meas.	Meas.	Scaled	
Extremity	802.11b	0	Rear	2	2417	97.0%	19.50	19.40	0.498	0.525	1
				6	2437	97.0%	19.50	19.30			
				10	2457	97.0%	19.50	19.22			
			Front	2	2417	97.0%	19.50	19.40			
				6	2437	97.0%	19.50	19.30			
				10	2457	97.0%	19.50	19.22			
			Edge 1	2	2417	97.0%	19.50	19.40			
				6	2437	97.0%	19.50	19.30			
				10	2457	97.0%	19.50	19.22			
			Edge 2	2	2417	97.0%	19.50	19.40			
				6	2437	97.0%	19.50	19.30			
				10	2457	97.0%	19.50	19.22			

11. Simultaneous Transmission Conditions

The DUT does not support simultaneous transmission.

12. 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 ($\sim 10\%$ 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 .

Frequency Band (MHz)	Air Interface	RF Exposure Conditions	Test Position	Repeated SAR (Yes/No)	Highest Measured SAR (W/kg)	First Repeated	
						Measured SAR (W/kg)	Largest to Smallest SAR Ratio
2400	Wi-Fi 802.11b/g/n	Extremity	Rear	No	0.498	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 < 1.20 .

13. Simultaneous Transmission Conditions

The DUT does not support simultaneous transmission.

Appendixes

Refer to separated files for the following appendixes.

12204358-S4V1 Appendix A: SAR Setup Photos

12204358-S4V1 Appendix B: SAR System Check Plots

12204358-S4V1 Appendix C: Highest SAR Test Plots

12204358-S4V1 Appendix D: SAR Liquid Tissue Ingredients

12204358-S4V1 Appendix E: SAR Probe Calibration Certificates

12204358-S4V1 Appendix F: SAR Dipole Calibration Certificates

END OF REPORT