SAR EVALUATION REPORT

FCC 47 CFR § 2.1093
IEEE Std 1528-2013

For
Wi-Fi 2.4GHz + Bluetooth Smart Watch

Model: LG-W110, W110, LGW110
FCC ID: ZNFW110

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Prepared for
LG ELECTRONICS MOBILECOMM U.S.A., INC.
1000 SYLVAN AVE.
ENGLEWOOD CLIFFS, NJ 07632

Prepared by
UL Verification Services Inc.
47173 BENICIA STREET
FREMONT, CA 94538, U.S.A.
TEL: (510) 771-1000
FAX: (510) 661-0888

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--	8/12/2014	Initial Issue	--
A	8/13/2014	1. Updated Section 1 with the correct Highest Extremity SAR 2. Updated Sections 6.3.; 8.2.; and 11.2.1. with appropriate Bluetooth Power	Nathan Sousa

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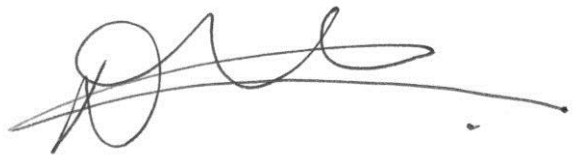
1. Attestation of Test Results

Applicant Name	LG ELECTRONICS MOBILECOMM U.S.A., INC.	
Application Purpose	☒ Original Grant ☐ Class II Permissive Change	
FCC ID	ZNFW110	
DUT Description	Wi-Fi 2.4GHz + Bluetooth Smart Watch	
Exposure Category	General Population/Uncontrolled Exposure (1g / 10g SAR limit: 1.6 / 4 W/kg, respectively)	
The Highest Reported SAR	RF Exposure Conditions	Equipment Class DTS
	Extremity (hand/wrist/ankle)	0.552 W/kg (10g)
	Next-to-Mouth	0.108 W/kg (1g)
Applicable Standards	FCC 47 CFR § 2.1093 KDB publication IEEE Std 1528-2013	
Test Results	Pass	
Dates tested	07/30/2014 – 08/01/2014; 8/08/2014	

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.

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.

Approved & Released By:	Prepared By:
	
Dave Weaver Program Manager UL Verification Services Inc.	Tony M Soares Laboratory Technician 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 1528-2003 & 2013, the following FCC Published RF exposure KDB procedures, and TCB workshop updates:

- 447498 D01 General RF Exposure Guidance v05r02
- 248227 D01 SAR Meas for 802 11abg v01r02
- 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r03
- 865664 D02 SAR Reporting v01r01
- 690783 D01 SAR Listings on Grants v01r03

3. Facilities and Accreditation

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

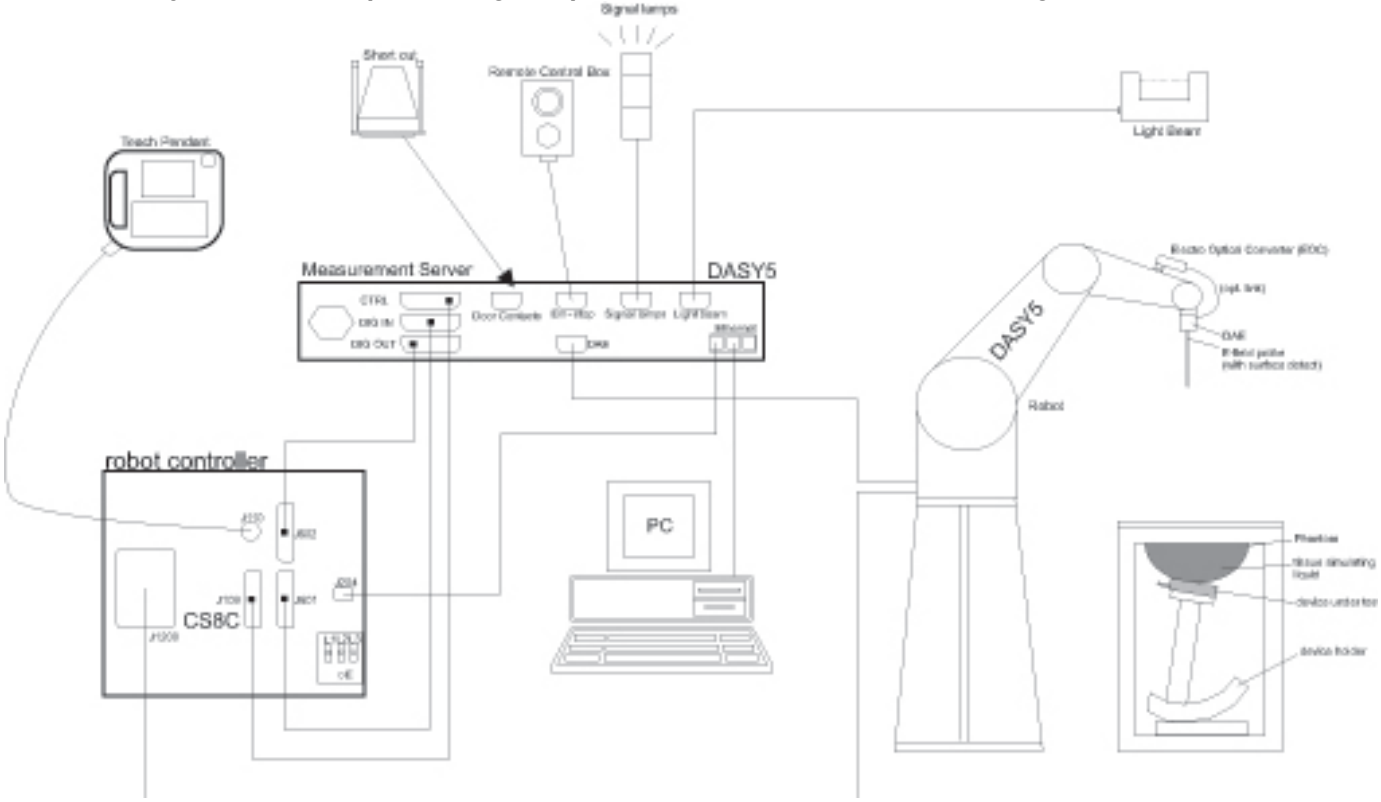
47173 Benicia Street	47266 Benicia Street
SAR Lab A	SAR Lab 1
SAR Lab B	SAR Lab 2
SAR Lab C	SAR Lab 3
SAR Lab D	SAR Lab 4
SAR Lab E	SAR Lab 5
SAR Lab F	
SAR Lab G	
SAR Lab H	

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at http://ts.nist.gov/standards/scopes/2000650.htm.

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. 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	ENA Series/E5071B	MY42100131	2/24/2015
Dielectronic Probe kit	SPEAG	DAK-3.5	1087	11/13/2014
Dielectronic Probe kit	SPEAG	DAK-3.5 Short	SM DAK 200 BA	N/A
Thermometer	Control Company	4242	122529163	9/19/2014
Thermometer	EXTECH	445703	CCS-200	3/24/2015

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Agilent Signal Generator	Agilent	8665B	3438A0063	7/10/2015
Power Meter	HP	438A	2822A05684	10/10/2014
Power Sensor	Agilent	8481A	2237A31744	10/2/2014
Power Sensor	Agilent	8481A	2349A36506	9/30/2014
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1808939	N/A
Bi-directional coupler	Werlatone, Inc.	C8060-102	2710	N/A
DC Power Supply	Sorensen Ametek	XT15-4	1319A02778	N/A
HP Signal Generator	HP	8665B	3546A00784	6/23/2015
Power Meter	HP	438A	3513U04320	10/2/2014
Power Sensor	Agilent	8481A	2702A66876	9/30/2014
Power Sensor	Agilent	8481A	3318A95392	9/30/2014
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1622052	N/A
Bi-directional coupler	Werlatone, Inc.	C8060-102	2711	N/A
DC Power Supply	HP	6296A	2841A-05955	N/A
E-Field Probe (SAR 1)	SPEAG	EX3DV4	3909	5/19/2015
E-Field Probe (SAR 5)	SPEAG	EX3DV4	3991	5/14/2015
Data Acquisition Electronics (SAR 1)	SPEAG	DAE3	427	1/14/2015
Data Acquisition Electronics (SAR 5)	SPEAG	DAE4	1439	5/16/2015
System Validation Dipole	SPEAG	D2450V2	899	9/10/2014
Thermometer (SAR Lab 1)	EXTECH	445703	CCS-205	3/24/2015
Thermometer (SAR Lab 5)	EXTECH	445703	CCS-239	6/3/2015

Others

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Power Meter	Agilent	N1912A	MY53040015	7/10/2015
Power Sensor	Agilent	N1921A	MY52020011	5/6/2015
Bluetooth Tester	R & S	CBT	100900-ac	7/4/2014

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, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2003 & 2013 is not required in SAR reports submitted for equipment approval.

6. Device Under Test (DUT) Information

6.1. DUT Description

Model: LG-W110	
Intended Use	This device should be restricted to wrist-worn and no other operation configuration should be used
Device Dimension	Overall (Length x Width): 56 mm x 49 mm (excluding strap) Overall Diagonal: 60 mm Display Diagonal: 35 mm
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 GHz)

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)	100%
Bluetooth	2.4 GHz	Version 4.0 LE	N/A

6.3. Nominal and Maximum Output Power

Upper limit (dB): 1.0 ~ -1.5		RF Output Power (dBm)	
RF Air interface	Mode	Target	Max. tune-up tolerance limit
WiFi 2.4 GHz	802.11b	17.0	**18.0**
	802.11g	14.0	**15.0**
	802.11n HT20	13.0	**14.0**
Upper limit (dB): 1.5 ~ -0.5		RF Output Power (dBm)	
RF Air interface	Mode	Target	Max. tune-up tolerance limit
Bluetooth		8.5	**10.0**
Bluetooth LE		7.5	**9.0**

6.4. Simultaneous Transmission Condition

Simultaneous transmission is not supported

7. RF Exposure Conditions (Test Configurations)

Refer to Appendix 6.5.Photos and Antenna Locations for the specific details of the antenna-to-antenna and antenna-to-edge(s) distances.

7.1. Extremity (Hand/Wrist/Ankle)

Test Configurations	Antenna-to-edge/surface	SAR Required	Note
Rear	< 25 mm	Yes	

7.2. Next to the Mouth Exposure

Test Configurations	Antenna-to-edge/surface	SAR Required	Note
Rear	< 25 mm	Yes	
Front	< 25 mm	Yes	

8. Conducted Output Power Measurements

8.1. Wi-Fi (2.4 GHz Band)

Required Test Channels per KDB 248227 D01

Mode	Band	GHz	Channel	"Default Test Channels"	
				802.11b	802.11g
802.11b/g	2.4 GHz	**2.412**	1#	√	∇
		2.437	6	√	∇
		2.462	11#	√	∇

Notes:
√ = "default test channels"
∇ = possible 802.11g channels with maximum average output ¼ dB ≥ the "default test channels"
= when output power is reduced for channel 1 and /or 11 to meet restricted band requirements the highest output channels closest to each of these channels should be tested.

Measured Results

Band (GHz)	Mode	Data Rate	Ch #	Freq. (MHz)	Avg Pwr (dBm)	SAR Test (Yes/No)
2.4 (DTS)	802.11b	1 Mbps	1	2412	17.6	Yes
			6	2437	17.2	
			11	2462	17.5	
	802.11g	6 Mbps	1	2412	14.6	No
			6	2437	14.4	
			11	2462	14.7	
	802.11n (HT20)	MCS0	1	2412	13.5	No
			6	2437	13.3	
			11	2462	13.6	

Note(s):

1. Per KDB 248227 D01, SAR is not required for 802.11g/HT20 channels when the maximum average output power is less than 1/4 dB higher than that measured on the corresponding 802.11b channels.

Power measurements to determine worst-case data rates

Mode	Ch #	Freq. (MHz)	Data Rate	Avg Pwr (dBm)	SAR test (Yes/No)
802.11b	6	2437	1 Mbps	17.2	Yes
			2 Mbps	17.2	No
			5.5 Mbps	17.1	No
			11 Mbps	17.0	No

8.2. Bluetooth

Maximum tune-up tolerance limit is 10.0 dBm from the rated nominal maximum output power. This power level qualifies for exclusion of SAR testing. Refer to Standalone SAR Test Exclusion Considerations Section 9.2.

9. 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.

9.1. 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 in IEEE Std 1528-2013

9.2. Dielectric Property Measurements Results

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.

SAR Lab 1

	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
7/29/2014	Body 2450	e'	50.7900	Relative Permittivity (ϵ_r):	50.79	52.70	-3.62	5
		e"	14.3800	Conductivity (σ):	1.96	1.95	0.46	5
	Body 2410	e'	50.8900	Relative Permittivity (ϵ_r):	50.89	52.76	-3.54	5
		e"	14.3000	Conductivity (σ):	1.92	1.91	0.46	5
	Body 2475	e'	50.7300	Relative Permittivity (ϵ_r):	50.73	52.67	-3.68	5
		e"	14.4200	Conductivity (σ):	1.98	1.99	-0.03	5
8/7/2014	Head 2450	e'	38.0600	Relative Permittivity (ϵ_r):	38.06	39.20	-2.91	5
		e"	13.8600	Conductivity (σ):	1.89	1.80	4.90	5
	Head 2410	e'	38.2300	Relative Permittivity (ϵ_r):	38.23	39.28	-2.67	5
		e"	13.7000	Conductivity (σ):	1.84	1.76	4.28	5
	Head 2475	e'	37.9700	Relative Permittivity (ϵ_r):	37.97	39.17	-3.06	5
		e"	13.9300	Conductivity (σ):	1.92	1.83	4.93	5

SAR Lab 5

	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
8/1/2014	Body 2450	e'	51.3000	Relative Permittivity (ϵ_r):	51.30	52.70	-2.66	5
		e"	14.3900	Conductivity (σ):	1.96	1.95	0.53	5
	Body 2410	e'	51.4200	Relative Permittivity (ϵ_r):	51.42	52.76	-2.54	5
		e"	14.2800	Conductivity (σ):	1.91	1.91	0.32	5
	Body 2475	e'	51.2300	Relative Permittivity (ϵ_r):	51.23	52.67	-2.73	5
		e"	14.4400	Conductivity (σ):	1.99	1.99	0.10	5

10. 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 remeasured or sooner when marginal liquid parameters are used at the beginning of a series of measurements.

10.1. 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	Freq. (MHz)	Target SAR Values (W/kg)		
				1g/10g	Head	Body
D2450V2	899	9/10/2013	2450	1g	51.3	49.7
				10g	23.9	23.3

10.2. 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 Lab 1

Date Tested	System Dipole		T.S. Liquid		Measured Results			Target (Ref. Value)	Delta ±10 %	Est./Zoom Ratio	Plot No.
	Type	Serial #			Area Scan	Zoom Scan	Normalize to 1 W				
7/29/2014	D2450V2	899	Body	1g	5.23	5.21	52.1	49.70	4.83	0.38	
				10g	2.250	2.400	24.0	23.30	3.00		
8/7/2014	D2450V2	899	Head	1g	5.71	5.55	55.5	51.30	**8.19**	2.80	1,2
				10g	2.490	2.490	24.9	23.9	4.18		

SAR Lab 5

Date Tested	System Dipole		T.S. Liquid		Measured Results			Target (Ref. Value)	Delta ±10 %	Est./Zoom Ratio	Plot No.
	Type	Serial #			Area Scan	Zoom Scan	Normalize to 1 W				
8/1/2014	D2450V2	899	Body	1g	5.43	5.45	54.5	49.70	**9.66**	-0.37	3,4
				10g	2.370	2.530	25.3	23.3	8.58		

11. 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 Measurements Procedures for 802.11 a/b/g Transmitters v01r02 (pg.6):
Each channel should be tested at the lowest data rate in each a-b/g mode or 4.9 GHz channel BW configuration.
When the extrapolated maximum peak SAR for the maximum output channel is ≤ 1.6 W/kg and the 1-g averaged SAR is ≤ 0.8 W/kg, testing of other channels in the “default test channels” or “required test channels” configuration is optional.

11.1. Wi-Fi (DTS Band)

Frequency Band	RF Exposure Conditions	Mode	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Power (dBm)		10-g SAR (W/kg)		Plot No.
							Tune-up limit	Meas.	Meas.	Scaled	
2.4 GHz	Extremity	802.11b 1 Mbps	0	Rear	6	2437.0	18.0	17.2	0.459	0.552	1
2.4 GHz	Extremity	802.11n MCS0	0	Rear	6	2437.0	14.0	13.3	0.230	0.270	2
Frequency Band	RF Exposure Conditions	Mode	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		Plot No.
							Tune-up limit	Meas.	Meas.	Scaled	
2.4 GHz	Next-to-Mouth	802.11b 1 Mbps	10	Front	6	2437.0	18.0	17.2	0.090	0.108	3
2.4 GHz	Next-to-Mouth	802.11n MCS0	10	Front	6	2437.0	14.0	13.3	0.031	0.036	4

11.2. Bluetooth

11.2.1. Standalone SAR Test Exclusion Considerations

The 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at test separation distances ≤ 50 mm are determined by:

[(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)]·[√f(GHz)] ≤ 3.0, for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- $f_{(GHz)}$ is the RF channel transmit frequency in GHz
- Power and distance are rounded to the nearest mW and mm before calculation
- The result is rounded to one decimal place for comparison

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

Extremity Exposure Conditions

Max. tune-up tolerance limit		Min. test separation distance (mm)	Frequency (GHz)	Result
(dBm)	(mW)			
10.0	10	5	2.480	3.1

Next-to-Mouth Exposure Conditions

Max. tune-up tolerance limit		Min. test separation distance (mm)	Frequency (GHz)	Result
(dBm)	(mW)			
10.0	10	10	2.480	1.6

Conclusion:

- The computed extremity value is < 7.5; therefore, Bluetooth qualifies for Standalone SAR test exclusion for the extremity condition.
- The computed next-to-mouth value is < 3; therefore, Bluetooth qualifies for Standalone SAR test exclusion. for the next-to-mouth condition.

12. SAR Measurement Variability

In accordance with published RF Exposure KDB procedure 865664 D01 SAR measurement 100 MHz to 6 GHz v01. 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 < 2 W/kg; steps 2) through 4) do not apply.
2) When the original highest measured SAR is ≥ 2 W/kg, 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 > 3 or when the original or repeated measurement is ≥ 3.625 W/kg (~ 10% from the 10-g SAR limit).
4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥3.75 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 3.

12.1. The Highest Measured SAR Configuration in Each Frequency Band

Frequency Band (MHz)	Air Interface	Wrist Worn (W/kg)	Repeated SAR (Yes/No)
2400	Wi-Fi 802.11b/g/n	0.465	No

13. Simultaneous Transmission SAR Analysis

Simultaneous transmission is not supported.

14. Appendixes

Refer to separated files for the following appendixes.

14.1. Photos and Antenna Locations

14.2. System Performance Check Plots

14.3. Highest SAR Test Plots

14.4. Calibration Certificate for E-Field Probe EX3DV4 - SN 3902

14.5. Calibration Certificate for E-Field Probe EX3DV4 - SN 3991

14.6. Calibration Certificate for D2450V2 - SN 899

END OF REPORT