SAR EVALUATION REPORT

(Class II Permissive Change)
Added 20/15 MHz Bandwidth to LTE Bands 2/4
Reference FCC Report 14U17493-S7A for Original and 14U18112-S7A for C2PC

FCC 47 CFR § 2.1093
IEEE Std 1528-2013

For
GSM/WCDMA/LTE Phone + Bluetooth, DTS/UNII a/b/g/n and NFC

FCC ID: ZNFD725
Model Name: LG-D725, LGD725, D725, LG-D727, LGD727 and D727

Report Number: 15I19863-S1
Issue Date: 2/5/2015

Prepared for
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NVLAP LAB CODE 200065-0

Revision History

Rev.	Date	Revisions	Revised By
--	2/5/2015	Initial Issue	--

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1. Attestation of Test Results

Applicant Name	LG ELECTRONICS MOBILECOMM U.S.A., INC.				
FCC ID	ZNFD725				
Model Name	LG-D725, LGD725, D725, LG-D727, LGD727 and D727				
Applicable Standards	FCC 47 CFR § 2.1093 Published RF exposure KDB procedures IEEE Std 1528-2013				
SAR Limits (W/Kg)					
Exposure Category	Peak spatial-average(1g of tissue)				
General population / Uncontrolled exposure	1.6				
The Highest Reported SAR (W/kg)					
RF Exposure Conditions	**Equipment Class**				
	Licensed	**DTS**	**U-NII**	**DSS (BT)**	
Head	1.074*	0.229*	0.221*	N/A	
Body-worn	1.070*	0.209*	0.270*		
Hotspot/Wi-Fi Direct	1.070*	0.209*	N/A		
Simultaneous TX	1.269	1.208	1.269		
*Highest reported SAR from 14U17493-S7A for Original and 14U18112-S7A for C2PC.					
Date Tested	1/22/2015 to 1/23/2015				
Test Results	Pass				

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:
	
Bobby Bayani Senior Engineer UL Verification Services Inc.	James Kim 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 1528-2013, the following FCC Published RF exposure KDB procedures:

- 447498 D01 General RF Exposure Guidance v05r02
- 447498 D03 Supplement C Cross-Reference
- 648474 D04 Handset SAR v01r02
- 690783 D01 SAR Listings on Grants v01r03
- 865664 D01 SAR measurement 100 MHz to 6 GHz v01r03
- 865664 D02 RF Exposure Reporting v01r01
- 941225 D05 SAR for LTE Devices v02r03
- 941225 D05A LTE Rel.10 KDB Inquiry Sheet v01r01
- 941225 D06 Hotspot Mode v02

3. Facilities and Accreditation

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

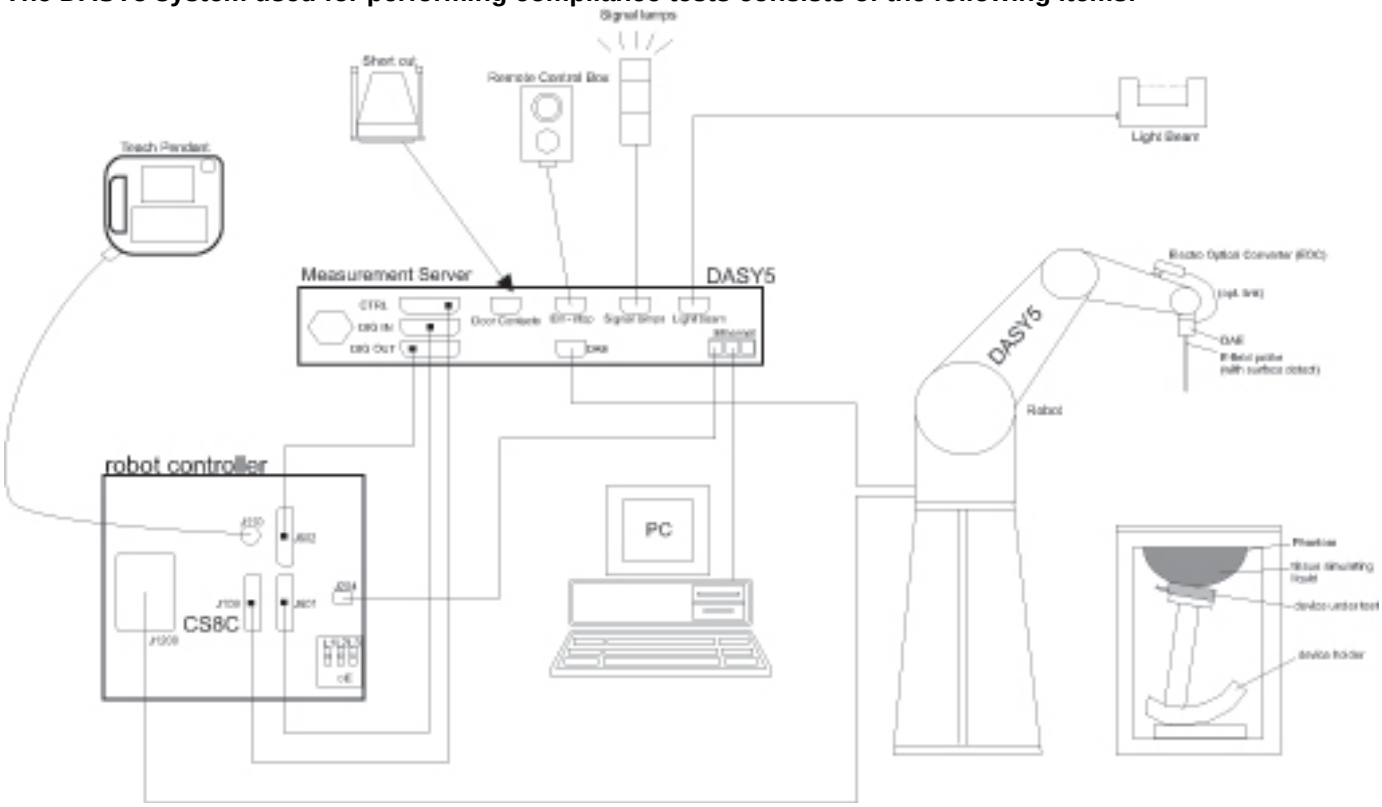
47173 Benicia Street	47266 Benicia Street
SAR Lab A	SAR Lab 1
SAR Lab B	SAR Lab 2
SAR Lab C	SAR Lab 3
SAR Lab D	SAR Lab 4
SAR Lab E	SAR Lab 5
SAR Lab F	
SAR Lab G	
SAR Lab H	

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

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	8753ES	MY40001647	7/17/2015
Dielectronic Probe kit	SPEAG	DAK-3.5	1103	2/18/2015
Dielectronic Probe kit	SPEAG	DAK-3.5 Short	SM DAK 200 BA	N/A
Thermometer	Traceable Calibration Control Co.	4242	122529162	10/8/2015

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Synthesized Signal Generator	HP	8665B	3744A01084	5/20/2015
Power Meter	Agilent	N1912A	MY53040016	5/5/2015
Power Sensor	Agilent	E9323A	MY53070005	5/1/2015
Power Sensor	Agilent	E9323A	MY53070009	5/28/2015
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1795093	N/A
Directional coupler	Werlatone	C8060-102	2149	N/A
DC Power Supply	AMETEK	XT 15-4	1319A02778	N/A
Directional coupler	Werlatone	C8060-102	2141	N/A
DC Power Supply	BK PRECISION	1611	215-02292	N/A
E-Field Probe (SAR Lab F)	SPEAG	EX3DV4	3936	7/24/2015
E-Field Probe (SAR Lab H)	SPEAG	EX3DV4	3686	3/18/2015
Data Acquisition Electronics (SAR Lab F)	SPEAG	DAE4	1239	4/15/2015
Data Acquisition Electronics (SAR Lab H)	SPEAG	DAE4	1258	5/15/2015
System Validation Dipole	SPEAG	D1750V2	1077	9/11/2015
System Validation Dipole	SPEAG	D1900V2	5d140	4/23/2015

Other

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Base Station Simulator	R & S	CMW500	132910-cp	4/25/2015

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 1528-2013 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): 136.95 mm x 69.4mm Overall Diagonal: 146mm Display Diagonal: 127.0mm
Battery Back Cover	☒ Normal Battery Cover ☐ Normal Battery Cover with NFC ☐ Wireless Charger Battery Cover ☐ Wireless Charger Battery Cover with NFC ☐ The rechargeable battery is not user accessible.
Battery Options	☒ Standard – Lithium-ion battery, Rating 3.8 Vdc, 9.7 Wh ☐ Extended (large capacity) ☐ The rechargeable battery is not user accessible.
Accessory	Headset
Wireless Router (Hotspot)	Wi-Fi Hotspot mode permits the device to share its cellular data connection with other Wi-Fi-enabled devices. ☒ Mobile Hotspot (Wi-Fi 2.4 GHz) ☒ Mobile Hotspot ((Wi-Fi 5.8 GHz only)
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 5.8 GHz only)

6.2. Wireless Technologies

Wireless technologies	Frequency bands	Operating mode	Duty Cycle used for SAR testing
LTE (FDD)	Band 2 Band 4	QPSK 16QAM (Rel. 10) ☐ Do not support Carrier Aggregation (CA). ☒ Rel. 10 Carrier Aggregation (1 Uplink and 2 Downlinks) ☐ Rel. 11 Carrier Aggregation (2 Uplink and 2 Downlinks)	100%
	Does this device SV-LTE (1xRTT-LTE)? ☐Yes ☒ No		

6.3. Nominal and Maximum Output Power

KDB 447498 sec.4.1.(3) 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

Upper limit (dB): -1.5 ~ 0.5		RF Output Power (dBm)	
RF Air interface	Mode	Target	Max. tune-up tolerance limit
LTE Band 2	QPSK	24.2	**24.7**
LTE Band 4	QPSK	24.2	**24.7**

6.4. General LTE SAR Test and Reporting Considerations

<table>
<tr><th>Item</th><th>Description</th></tr>
<tr><td>Frequency range, Channel Bandwidth, Numbers and Frequencies</td><td>
<table>
<tr><td rowspan="3">Band 2</td><td colspan="6">Frequency range: 1850 - 1910 MHz</td></tr>
<tr><td colspan="6">Channel Bandwidth</td></tr>
<tr><td>20 MHz</td><td>15 MHz</td><td>10 MHz</td><td>5 MHz</td><td>3 MHz</td><td>1.4 MHz</td></tr>
<tr><td>Low</td><td>18700/ 1860</td><td>18675/ 1857.5</td><td>18650/ 1855</td><td>18625/ 1852.5</td><td></td><td></td></tr>
<tr><td>Mid</td><td>18900/ 1880</td><td>18900/ 1880</td><td>18900/ 1880</td><td>18900/ 1880</td><td></td><td></td></tr>
<tr><td>High</td><td>19100/ 1900</td><td>19125/ 1902.5</td><td>19150/ 1905</td><td>19175/ 1907.5</td><td></td><td></td></tr>
<tr><td rowspan="3">Band 4</td><td colspan="6">Frequency range: 1710 - 1755 MHz</td></tr>
<tr><td colspan="6">Channel Bandwidth</td></tr>
<tr><td>20 MHz</td><td>15 MHz</td><td>10 MHz</td><td>5 MHz</td><td>3 MHz</td><td>1.4 MHz</td></tr>
<tr><td>Low</td><td>20050/ 1720</td><td>20025/ 1717.5</td><td>20000/ 1715</td><td>19975/ 1712.5</td><td></td><td></td></tr>
<tr><td>Mid</td><td>20175/ 1732.5</td><td>20175/ 1732.5</td><td>20175/ 1732.5</td><td>20175/ 1732.5</td><td></td><td></td></tr>
<tr><td>High</td><td>20300/ 1745</td><td>20325/ 1747.5</td><td>20350/ 1750</td><td>20375/ 1752.5</td><td></td><td></td></tr>
</table>
</td></tr>
<tr><td>Carrier Aggregation Combinations</td><td>
<table>
<tr><td rowspan="2">Band 2 Primary</td><td colspan="2">Channel Bandwidth</td><td rowspan="2">Band 17 Secondary</td><td colspan="2">Channel Bandwidth</td></tr>
<tr><td>20 MHz</td><td>15 MHz</td><td>10 MHz</td><td>5 MHz</td></tr>
<tr><td>Low</td><td>18700/ 1860</td><td>18675/ 1857.5</td><td colspan="3" rowspan="3">Secondary Cell is Downlink only</td></tr>
<tr><td>Mid</td><td>18900/ 1880</td><td>18900/ 1880</td></tr>
<tr><td>High</td><td>19100/ 1900</td><td>19125/ 1902.5</td></tr>
<tr><td rowspan="2">Band 4 Primary</td><td colspan="2">Channel Bandwidth</td><td rowspan="2">Band 17 Secondary</td><td colspan="2">Channel Bandwidth</td></tr>
<tr><td>20 MHz</td><td>15 MHz</td><td>10 MHz</td><td>5 MHz</td></tr>
<tr><td>Low</td><td>20050/ 1720</td><td>20025/ 1717.5</td><td colspan="3" rowspan="3">Secondary Cell is Downlink only</td></tr>
<tr><td>Mid</td><td>20175/ 1732.5</td><td>20175/ 1732.5</td></tr>
<tr><td>High</td><td>20300/ 1745</td><td>20325/ 1747.5</td></tr>
</table>
</td></tr>
<tr><td>LTE transmitter and antenna implementation</td><td>LTE has two (2) TX antennas and one (1) DRX MIMO antenna
TX/RX Antenna 4: LTE Band 17, 7, and 5
TX/RX Antenna 5: LTE Bands 2 and 4
Refer to Appendix A.</td></tr>
<tr><td>Maximum power reduction (MPR)</td><td>
Table 6.2.3-1: Maximum Power Reduction (MPR) for Power Class 3
<table>
<tr><th rowspan="2">Modulation</th><th colspan="6">Channel bandwidth / Transmission bandwidth (RB)</th><th rowspan="2">MPR (dB)</th></tr>
<tr><th>1.4 MHz</th><th>3.0 MHz</th><th>5 MHz</th><th>10 MHz</th><th>15 MHz</th><th>20 MHz</th></tr>
<tr><td>QPSK</td><td>> 5</td><td>> 4</td><td>> 8</td><td>> 12</td><td>> 16</td><td>> 18</td><td>≤ 1</td></tr>
<tr><td>16 QAM</td><td>≤ 5</td><td>≤ 4</td><td>≤ 8</td><td>≤ 12</td><td>≤ 16</td><td>≤ 18</td><td>≤ 1</td></tr>
<tr><td>16 QAM</td><td>> 5</td><td>> 4</td><td>> 8</td><td>> 12</td><td>> 16</td><td>> 18</td><td>≤ 2</td></tr>
</table>
MPR Built-in by design
A-MPR (additional MPR) was disabled during SAR testing
</td></tr>
<tr><td>Power reduction</td><td>No</td></tr>
<tr><td>Spectrum plots for RB configurations</td><td>A properly configured base station simulator was used for the SAR and power measurements; therefore, spectrum plots for each RB allocation and offset configuration are not included in the SAR report.</td></tr>
</table>

7. RF Exposure Conditions (Test Configurations)

Refer to “SAR Photos and Ant locations” Appendix for the specific details of the antenna-to-antenna and antenna-to-edge(s) distances.

Wireless technologies	RF Exposure Conditions	DUT-to-User Separation	Test Position	Antenna-to-edge/surface	SAR Required	Note
WWAN	Head	0 mm	Left Touch	N/A	Yes	
			Left Tilt (15°)	N/A	Yes	
			Right Touch	N/A	Yes	
			Right Tilt (15°)	N/A	Yes	
	Body	15 mm	Rear	N/A	Yes	2
			Front	N/A	Yes	2
	Hotspot	10 mm	Rear	< 25 mm	Yes	
			Front	< 25 mm	Yes	
			Edge 1 (Top)	> 25 mm	No	1
			Edge 2 (Right)	> 25 mm	No	1
			Edge 3 (Bottom)	< 25 mm	Yes	
			Edge 4 (Left)	< 25 mm	Yes	

Notes:

1. SAR is not required because the distance from the antenna to the edge is > 25 mm as per KDB 941225 D06 Hot Spot SAR.
2. The Body-worn minimum separation distance is 15 mm. To cover both body-worn and hotspot RF exposure conditions testing was performed at a separation distance of 10 mm.

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

IEEE Std 1528-2013

Refer to Table 3 within the IEEE Std 1528-2013

Dielectric Property Measurements Results:

SAR Lab F

	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
1/23/2015	Head 1750	e'	39.0100	Relative Permittivity (ϵ_r):	39.01	40.08	-2.68	5
		e''	13.9400	Conductivity (σ):	1.36	1.37	-0.92	5
	Head 1710	e'	39.2000	Relative Permittivity (ϵ_r):	39.20	40.15	-2.36	5
		e''	14.0200	Conductivity (σ):	1.33	1.35	-0.99	5
	Head 1755	e'	38.9900	Relative Permittivity (ϵ_r):	38.99	40.08	-2.71	5
		e''	13.9600	Conductivity (σ):	1.36	1.37	-0.69	5
1/23/2015	Body 1750	e'	51.9100	Relative Permittivity (ϵ_r):	51.91	53.44	-2.86	5
		e''	15.3900	Conductivity (σ):	1.50	1.49	0.77	5
	Body 1710	e'	52.0100	Relative Permittivity (ϵ_r):	52.01	53.54	-2.86	5
		e''	15.4700	Conductivity (σ):	1.47	1.46	0.64	5
	Body 1755	e'	51.8900	Relative Permittivity (ϵ_r):	51.89	53.43	-2.88	5
		e''	15.4100	Conductivity (σ):	1.50	1.49	0.98	5

SAR Lab H

	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
1/22/2015	Head 1900	e'	38.6500	Relative Permittivity (ϵ_r):	38.65	40.00	-3.38	5
		e''	13.6300	Conductivity (σ):	1.44	1.40	2.85	5
	Head 1850	e'	38.9000	Relative Permittivity (ϵ_r):	38.90	40.00	-2.75	5
		e''	13.5200	Conductivity (σ):	1.39	1.40	-0.66	5
	Head 1910	e'	38.6300	Relative Permittivity (ϵ_r):	38.63	40.00	-3.42	5
		e''	13.7000	Conductivity (σ):	1.45	1.40	3.93	5
1/22/2015	Body 1900	e'	51.1300	Relative Permittivity (ϵ_r):	51.13	53.30	-4.07	5
		e''	14.5400	Conductivity (σ):	1.54	1.52	1.06	5
	Body 1850	e'	51.3100	Relative Permittivity (ϵ_r):	51.31	53.30	-3.73	5
		e''	14.4300	Conductivity (σ):	1.48	1.52	-2.35	5
	Body 1910	e'	51.1400	Relative Permittivity (ϵ_r):	51.14	53.30	-4.05	5
		e''	14.5800	Conductivity (σ):	1.55	1.52	1.87	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 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.

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
D1750V2	1077	9/11/2014	1750	1g	36.5	36.9
				10g	19.4	19.8
D1900V2	5d140	4/23/2014	1900	1g	40.1	40.2
				10g	21.0	21.3

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 F

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			
1/23/2015	D1750V2	1077	Head	1g	3.74	37.40	36.5	2.47	1,2
				10g	1.98	19.80	19.4	2.06	
1/23/2015	D1750V2	1077	Body	1g	3.76	37.60	36.9	1.90	
				10g	1.99	19.90	19.8	0.51	

SAR Lab H

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			
1/22/2015	D1900V2	5d140	Head	1g	3.71	37.10	40.1	-7.48	3,4
				10g	1.92	19.20	21.0	-8.57	
1/22/2015	D1900V2	5d140	Body	1g	3.85	38.50	40.2	-4.23	
				10g	2.00	20.00	21.3	-6.10	

9. Conducted Output Power Measurements

9.1. LTE

The following tests were conducted according to the test requirements outlined in section 6.2 of the 3GPP TS36.101 specification.

UE Power Class: 3 (23 +/- 2dBm). The allowed Maximum Power Reduction (MPR) for the maximum output power due to higher order modulation and transmit bandwidth configuration (resource blocks) is specified in Table 6.2.3-1 of the 3GPP TS36.101.

Table 6.2.3-1: Maximum Power Reduction (MPR) for Power Class 3

Modulation	Channel bandwidth / Transmission bandwidth (RB)						MPR (dB)
	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz	
QPSK	> 5	> 4	> 8	> 12	> 16	> 18	≤ 1
16 QAM	≤ 5	≤ 4	≤ 8	≤ 12	≤ 16	≤ 18	≤ 1
16 QAM	> 5	> 4	> 8	> 12	> 16	> 18	≤ 2

The allowed A-MPR values specified below in Table 6.2.4.-1 of 3GPP TS36.101 are in addition to the allowed MPR requirements. All the measurements below were performed with A-MPR disabled, by using Network Signalling Value of “NS_01”.

Table 6.2.4-1: Additional Maximum Power Reduction (A-MPR)

Network Signalling value	Requirements (sub-clause)	E-UTRA Band	Channel bandwidth (MHz)	Resources Blocks (N_{RB})	A-MPR (dB)
NS_01	6.6.2.1.1	Table 5.5-1	1.4, 3, 5, 10, 15, 20	Table 5.6-1	NA
NS_03	6.6.2.2.1	2, 4,10, 23, 25, 35, 36	3	>5	≤ 1
			5	>6	≤ 1
			10	>6	≤ 1
			15	>8	≤ 1
			20	>10	≤ 1
NS_04	6.6.2.2.2	41	5	>6	≤ 1
			10, 15, 20	See Table 6.2.4-4	
NS_05	6.6.3.3.1	1	10,15,20	≥ 50	≤ 1
NS_06	6.6.2.2.3	12, 13, 14, 17	1.4, 3, 5, 10	Table 5.6-1	n/a
NS_07	6.6.2.2.3 6.6.3.3.2	13	10	Table 6.2.4-2	Table 6.2.4-2
NS_08	6.6.3.3.3	19	10, 15	> 44	≤ 3
NS_09	6.6.3.3.4	21	10, 15	> 40	≤ 1
				> 55	≤ 2
NS_10		20	15, 20	Table 6.2.4-3	Table 6.2.4-3
NS_11	6.6.2.2.1	23[1]	1.4, 3, 5, 10	Table 6.2.4-5	Table 6.2.4-5
..					
NS_32	-	-	-	-	-
Note 1: Applies to the lower block of Band 23, i.e. a carrier placed in the 2000-2010 MHz region.					

LTE Band 2 Measured Results

Band	BW (MHz)	Mode	RB Allocation	RB offset	Target MPR	Meas. MPR	Avg Pwr (dBm)		
							1860 MHz	1880 MHz	1900 MHz
LTE Band 2	20	QPSK	1	0	0	0	24.5	24.5	24.3
			1	50	0	0	24.4	24.5	24.2
			1	99	0	0	24.5	24.4	24.3
			50	0	1	1	23.5	23.5	23.5
			50	25	1	1	23.4	23.4	23.4
			50	50	1	1	23.4	23.5	23.4
			100	0	1	1	23.4	23.4	23.5
		16QAM	1	0	1	1	23.7	23.7	23.5
			1	50	1	1	23.3	23.6	23.3
			1	99	1	1	23.3	23.5	23.2
			50	0	2	2	22.5	22.5	22.4
			50	25	2	2	22.5	22.4	22.4
			50	50	2	2	22.5	22.4	22.3
			100	0	2	2	22.4	22.4	22.3
Band	BW (MHz)	Mode	RB Allocation	RB offset	Target MPR	Meas. MPR	Avg Pwr (dBm)		
							1857.5 MHz	1880 MHz	1902.5 MHz
LTE Band 2	15	QPSK	1	0	0	0	24.5	24.5	24.4
			1	36	0	0	24.4	24.4	24.5
			1	74	0	0	24.4	24.4	24.4
			36	0	1	1	23.4	23.4	23.4
			36	18	1	1	23.4	23.3	23.3
			36	37	1	1	23.3	23.3	23.4
			75	0	1	1	23.4	23.4	23.4
		16QAM	1	0	1	1	23.2	23.3	23.2
			1	36	1	1	23.2	23.2	23.2
			1	74	1	1	23.2	23.2	23.3
			36	0	2	2	22.4	22.4	22.4
			36	18	2	2	22.3	22.4	22.3
			36	37	2	2	22.2	22.3	22.4
			75	0	2	2	22.4	22.5	22.4

LTE Band 4 Measured Results

Band	BW (MHz)	Mode	RB Allocation	RB offset	Target MPR	Meas. MPR	Avg Pwr (dBm)		
							1720 MHz	1732.5 MHz	1745 MHz
LTE Band 4	20	QPSK	1	0	0	0	24.4	24.2	24.3
			1	49	0	0	24.4	24.2	24.3
			1	99	0	0	24.4	24.3	24.3
			50	0	1	1	23.4	23.4	23.5
			50	24	1	1	23.5	23.4	23.5
			50	50	1	1	23.5	23.5	23.5
			100	0	1	1	23.4	23.4	23.5
		16QAM	1	0	1	1	23.3	23.6	23.4
			1	49	1	1	23.2	23.6	23.4
			1	99	1	1	23.3	23.6	23.5
			50	0	2	2	22.5	22.5	22.5
			50	24	2	2	22.5	22.5	22.5
			50	50	2	2	22.5	22.5	22.5
			100	0	2	2	22.5	22.5	22.5
Band	BW (MHz)	Mode	RB Allocation	RB offset	Target MPR	Meas. MPR	Avg Pwr (dBm)		
							1717.5 MHz	1732.5 MHz	1747.5 MHz
LTE Band 4	15	QPSK	1	0	0	0	24.3	24.4	24.5
			1	37	0	0	24.3	24.4	24.5
			1	74	0	0	24.3	24.3	24.5
			36	0	1	1	23.5	23.5	23.5
			36	20	1	1	23.4	23.5	23.6
			36	39	1	1	23.5	23.5	23.6
			75	0	1	1	23.5	23.6	23.6
		16QAM	1	0	1	1	23.4	23.6	23.4
			1	37	1	1	23.4	23.6	23.4
			1	74	1	1	23.4	23.6	23.4
			36	0	2	2	22.5	22.5	22.6
			36	20	2	2	22.4	22.5	22.5
			36	39	2	2	22.4	22.5	22.5
			75	0	2	2	22.6	22.6	22.6

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 648474 D04 Handset SAR:

With headset attached, when the reported SAR for body-worn accessory, measured without a headset connected to the handset, is > 1.2 W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a headset attached to the handset.

KDB 941225 D05 SAR for LTE Devices:

SAR test reduction is applied using the following criteria:

- Start with the largest channel bandwidth and measure SAR for QPSK with 1 RB, and 50% RB allocation, using the RB offset and required test channel combination with the highest maximum output power among RB offsets at the upper edge, middle and lower edge of each required test channel.
- When the reported SAR is > 0.8 W/kg, testing for other Channels is performed at the highest output power level for 1RB, and 50% RB configuration for that channel.
- Testing for 100% RB configuration is performed at the highest output power level for 100% RB configuration across the Low, Mid and High Channel when the highest reported SAR for 1 RB and 50% RB are > 0.8 W/kg. Testing for the remaining required channels is not needed because the reported SAR for 100% RB Allocation < 1.45 W/kg.
- Testing for 16-QAM modulation is not required because the reported SAR for QPSK is < 1.45 W/Kg and its output power is not more than 0.5 dB higher than that of QPSK.
- Testing for the other channel bandwidths is not required because the reported SAR for the highest channel bandwidth is < 1.45 W/Kg and its output power is not more than 0.5 dB higher than that of the highest channel bandwidth.

10.1. LTE Band 2 (20MHz Bandwidth)

RF Exposure Conditions	Mode	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	RB Allocation	RB offest	Power (dBm)		1-g SAR (W/kg)		Plot No.
								Tune-up limit	Meas.	Meas.	Scaled	
Head	QPSK	0	Left Touch	18900	1880.0	1	49	24.7	24.5	0.685	0.717	1
						50	50	23.7	23.5	0.543	0.569	
			Left Tilt	18900	1880.0	1	49	24.7	24.5	0.278	0.291	
						50	50	23.7	23.5	0.220	0.230	
			Right Touch	18900	1880.0	1	49	24.7	24.5	0.472	0.494	
						50	50	23.7	23.5	0.380	0.398	
			Right Tilt	18900	1880.0	1	49	24.7	24.5	0.288	0.302	
						50	50	23.7	23.5	0.223	0.234	
Body-worn & Hotspot	QPSK	10	Rear	18700	1860.0	1	99	24.7	24.5	0.954	0.999	2
				18900	1880.0	1	49	24.7	24.5	0.830	0.869	
						50	50	23.7	23.5	0.654	0.685	
				19100	1900.0	1	0	24.7	24.3	0.604	0.662	
			Front	18900	1880.0	1	49	24.7	24.5	0.667	0.698	
						50	50	23.7	23.5	0.665	0.696	
Hotspot	QPSK	10	Edge 3	18900	1880.0	1	49	24.7	24.5	0.306	0.320	
						50	50	23.7	23.5	0.254	0.266	
			Edge 4	18900	1880.0	1	49	24.7	24.5	0.569	0.596	
						50	50	23.7	23.5	0.432	0.452	

10.2. LTE Band 4 (20MHz Bandwidth)

RF Exposure Conditions	Mode	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	RB Allocation	RB offest	Power (dBm)		1-g SAR (W/kg)		Plot No.
								Tune-up limit	Meas.	Meas.	Scaled	
Head	QPSK	0	Left Touch	20175	1732.5	1	99	24.7	24.3	0.596	0.654	3
						50	50	23.7	23.5	0.493	0.516	
			Left Tilt	20175	1732.5	1	99	24.7	24.3	0.179	0.196	
						50	50	23.7	23.5	0.145	0.152	
			Right Touch	20175	1732.5	1	99	24.7	24.3	0.404	0.443	
						50	50	23.7	23.5	0.162	0.170	
			Right Tilt	20175	1732.5	1	99	24.7	24.3	0.199	0.218	
						50	50	23.7	23.5	0.161	0.169	
Body-worn & Hotspot	QPSK	10	Rear	20050	1720.0	1	99	24.7	24.3	0.713	0.782	
				20175	1732.5	1	99	24.7	24.3	0.756	0.829	4
						50	50	23.7	23.5	0.628	0.658	
				20300	1745.0	1	99	24.7	24.3	0.699	0.766	
			Front	20175	1732.5	1	99	24.7	24.3	0.665	0.729	
						50	50	23.7	23.5	0.544	0.570	
Hotspot	QPSK	10	Edge 3	20175	1732.5	1	99	24.7	24.3	0.474	0.520	
						50	50	23.7	23.5	0.393	0.412	
			Edge 4	20175	1732.5	1	99	24.7	24.3	0.497	0.545	
						50	50	23.7	23.5	0.400	0.419	

10.3. 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 < 0.80 W/kg; steps 2) through 4) do not apply.
2) When the original highest measured SAR is ≥ 0.80 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 > 1.20 or when the original or repeated measurement is ≥ 1.45 W/kg (~ 10% from the 1-g SAR limit).
4) Perform a third repeated measurement only if the original, first or second repeated measurement is ≥1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

Frequency Band	Air Interface	RF Exposure Conditions	Test Position	Repeated SAR	Highest Measured SAR	Repeated Measured SAR	Largest to Smallest
1900	LTE Band 2	Body & Hotspot	Rear	Yes	0.954	0.951	1.00
1700	LTE Band 4	Body & Hotspot	Rear	No	0.756	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.

11. Simultaneous Transmission SAR Analysis

KDB 447498 D01 General RF Exposure Guidance introduces a new formula for calculating the SAR to Peak Location Ratio (SPLSR) between pairs of simultaneously transmitting antennas:

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

Where:

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

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

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

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

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

Simultaneous Transmission Condition

RF Exposure Condition	Item	Capable Transmit Configurations		
Head	1	LTE	+	DTS
	2	LTE	+	UNII
Body-worn	3	LTE	+	DTS
	4	LTE	+	UNII
	5	LTE	+	BT
Hotspot & Wi-Fi Direct	6	LTE	+	DTS

Notes:

1. LTE support Hotspot.
2. VoIP is supported in LTE.
3. Wi-Fi 2.4 GHz Radio cannot transmit simultaneously with Bluetooth Radio.
4. Wi-Fi 5 GHz Radio cannot transmit simultaneously with Bluetooth Radio.

11.2. Sum of the SAR for LTE Band 2 & Wi-Fi & BT

RF Exposure conditions	Test Position	① WWAN	② DTS	③ UNII	④ BT	①+② WWAN +DTS		①+③ WWAN + UNII		①+④ WWAN +BT	
						∑1-g SAR (mW/g)	SPLSR (Yes/ No)	∑1-g SAR (mW/g)	SPLSR (Yes/ No)	∑1-g SAR (mW/g)	SPLSR (Yes/ No)
Head	Left Touch	0.717	0.120	0.090		0.837	No	0.807	No		
	Left Tilt	0.291	0.142	0.072		0.433	No	0.363	No		
	Right Touch	0.494	0.229	0.221		0.723	No	0.715	No		
	Right Tilt	0.302	0.178	0.176		0.480	No	0.478	No		
Body-worn & Hotspot	Rear	0.999	0.209	0.270	0.210	1208	No	1269	No	1209	No
	Front	0.698	0.053	0.047	0.210	0.751	No	0.745	No	0.908	No
Hotspot	Edge 4	0.596	0.198			0.794	No	0.596	No		

11.3. Sum of the SAR for LTE Band 4 & Wi-Fi & BT

RF Exposure conditions	Test Position	① WWAN	② DTS	③ UNII	④ BT	①+② WWAN +DTS		①+③ WWAN + UNII		①+④ WWAN +BT	
						∑1-g SAR (mW/g)	SPLSR (Yes/ No)	∑1-g SAR (mW/g)	SPLSR (Yes/ No)	∑1-g SAR (mW/g)	SPLSR (Yes/ No)
Head	Left Touch	0.654	0.120	0.090		0.774	No	0.744	No		
	Left Tilt	0.196	0.142	0.072		0.338	No	0.268	No		
	Right Touch	0.443	0.229	0.221		0.672	No	0.664	No		
	Right Tilt	0.218	0.178	0.176		0.396	No	0.394	No		
Body-worn & Hotspot	Rear	0.829	0.209	0.270	0.210	1038	No	1099	No	1039	No
	Front	0.729	0.053	0.047	0.210	0.782	No	0.776	No	0.939	No
Hotspot	Edge 4	0.545	0.198			0.743	No	0.545	No		

Conclusion:

Simultaneous transmission SAR measurement (Volume Scan) is not required because the either sum of the 1-g SAR is < 1.6 W/kg or the SPLSR is < 0.04 for all circumstances that require SPLSR calculation.

Appendixes

Refer to separated files for the following appendixes.

A_15I19863v0 SAR Photos & Ant. Locations

B_15I19863v0 SAR Highest Test Plots

C_15I19863v0 SAR System Check Plots

D_15I19863v0 SAR Tissue Ingredients

E_15I19863v0 SAR Probe Cal. Certificates

F_15I19863v0 SAR Dipole Cal. Certificates

END OF REPORT