SAR EVALUATION REPORT

FCC 47 CFR § 2.1093
IEEE Std 1528-2013

For
GSM Phone + Bluetooth & WLAN 2.4GHz b/g/n

FCC ID: A3LSMG361H
Model Name: SM-G361H/DS and SM-G361H

Report Number: 15K20822-S1A
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ACCREDITED

TL-637

Revision History

Rev.	Date	Revisions	Revised By
--	5/20/2015	Initial Issue	Justin Park
A	5/26/2015	1. Sec 6.1., 6.2., 6.3. : Updated Table 2. Updated Section 8.2. D835V2 Cal. Date 3. Updated Section 9.1., 9.3. with the correct data 4. Removed Section 10. KDB 941225 D05 SAR for LTE devices 5. Updated Section 10.2., 10.3. with the correct data 6. Updated Section 12.with the correct data	Justin Park
B	5/29/2015	1. Sec 6.1., 6.3. : Updated Table	Justin Park

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1. Attestation of Test Results

Applicant Name		SAMSUNG ELECTRONICS CO.,LTD.			
FCC ID		A3LSMG361H			
Model Name		SM-G361H/DS and SM-G361H			
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		0.549	0.283	N/A	N/A
Body-worn*		0.846	0.146		
Hotspot/Wi-Fi Direct					
Simultaneous TX	Head	0.832			
	Body-worn*	0.992			
	Hotspot/ Wi-Fi Direct				
Note: 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.					
Date Tested		5/14/2015 to 5/18/2015			
Test Results		Pass			

UL Korea, Ltd. tested the above equipment in accordance with the requirements set forth in the above standards. All indications of Pass/Fail in this report are opinions expressed by UL Korea, Ltd. based on interpretations and/or observations of test results. Measurement Uncertainties were not taken into account and are published for informational purposes only. The test results show that the equipment tested is capable of demonstrating compliance with the requirements as documented in this report.

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Korea, Ltd. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Korea, Ltd. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by IAS, any agency of the Federal Government, or any agency of any government.

Approved & Released By:	Prepared By:
	
JiHo Choi Operations Manager UL Korea, Ltd Suwon Laboratory	Justin Park Engineer UL Korea, Ltd Suwon Laboratory

2. Test Specification, Methods and Procedures

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

- 248227 D01 802.11 Wi-Fi SAR v02
- 447498 D01 General RF Exposure Guidance v05r02
- 447498 D03 Supplement C Cross-Reference v01
- 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 D01 3G SAR Procedures v03
- 941225 D06 Hotspot Mode v02

3. Facilities and Accreditation

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

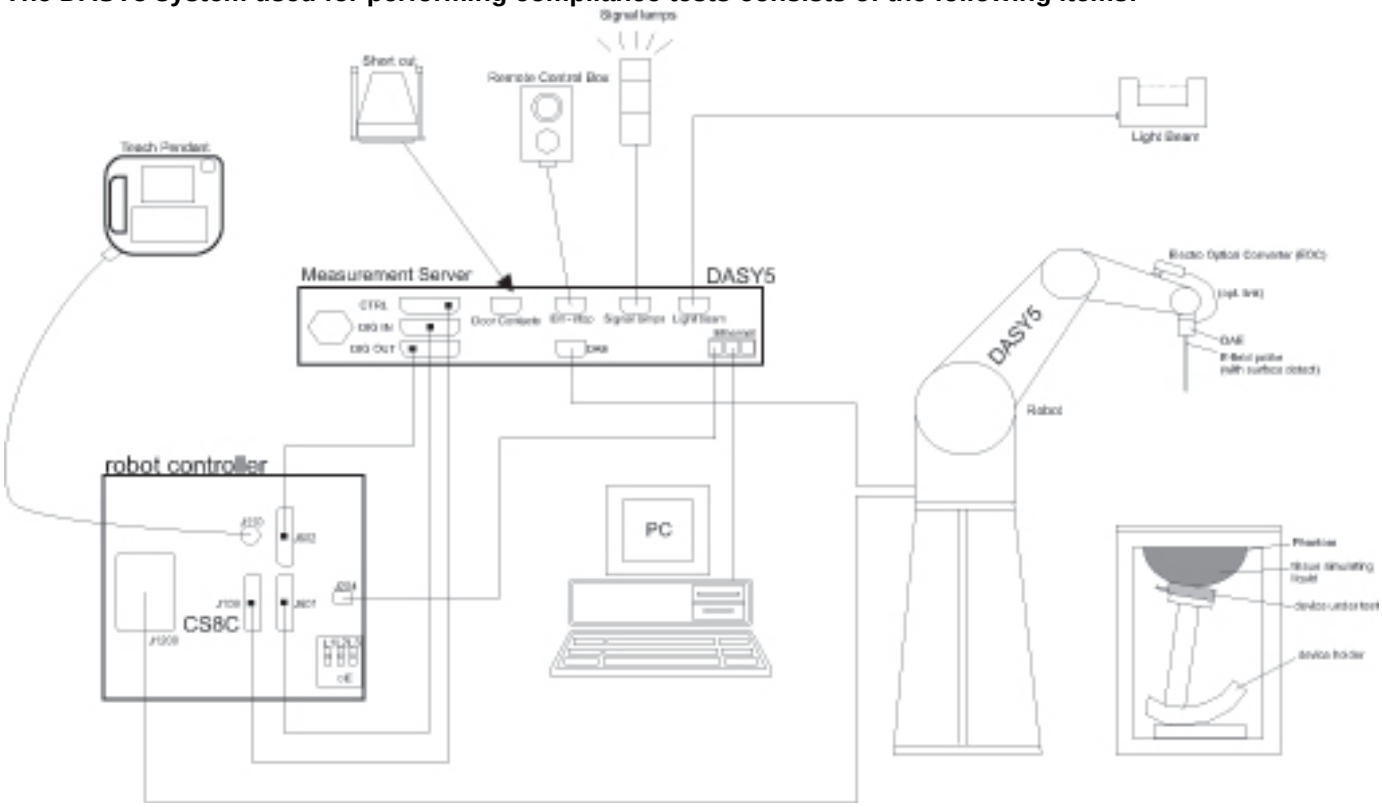
Suwon
SAR 1 Room
SAR 2 Room
SAR 3 Room

UL Korea, Ltd. is accredited by IAS, Laboratory Code TL-637.
The full scope of accreditation can be viewed at http://www.iasonline.org/PDF/TL/TL-637.pdf.

4. SAR Measurement System & Test Equipment

4.1. SAR Measurement System

The DASY5 system used for performing compliance tests consists of the following items:



- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (DAE) which performs the signal amplification, signal multiplexing, AD-conversion, offset measurements, mechanical surface detection, collision detection, etc. The unit is battery powered with standard or rechargeable batteries. The signal is optically transmitted to the EOC.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP or Win7 and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

4.2. SAR Scan Procedures

Step 1: Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. The minimum distance of probe sensors to surface is 2.1 mm. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

Step 2: Area Scan

The Area Scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum locations even in relatively coarse grids. When an Area Scan has measured all reachable points, it computes the field maximal found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE Standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan). If only one Zoom Scan follows the Area Scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of Zoom Scans has to be increased accordingly.

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

<table>
<tr><td></td><td>≤ 3 GHz</td><td>> 3 GHz</td></tr>
<tr><td>Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface</td><td>5 ± 1 mm</td><td>½·δ·ln(2) ± 0.5 mm</td></tr>
<tr><td>Maximum probe angle from probe axis to phantom surface normal at the measurement location</td><td>30° ± 1°</td><td>20° ± 1°</td></tr>
<tr><td rowspan="2">Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}</td><td>≤ 2 GHz: ≤ 15 mm
2 – 3 GHz: ≤ 12 mm</td><td>3 – 4 GHz: ≤ 12 mm
4 – 6 GHz: ≤ 10 mm</td></tr>
<tr><td colspan="2">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.</td></tr>
</table>

Step 3: Zoom Scan

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

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

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

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

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

Step 4: Power drift measurement

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

Step 5: Z-Scan (FCC only)

The Z Scan measures points along a vertical straight line. The line runs along the Z-axis of a one-dimensional grid. In order to get a reasonable extrapolation the extrapolated distance should not be larger than the step size in Z-direction.

4.3. Test Equipment

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

Dielectric Property Measurements

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Network Analyzer	Agilent	E5071C	MY46522054	9-23-2015
Dielectronic Probe kit	SPEAG	DAK-3.5	1196	8-5-2015
Dielectronic Probe kit	SPEAG	DAK-3.5 Short	SM DAK 200 BA	N/A
Thermometer	LKM	DTM3000	3424	11-13-2015

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
MXG Analog Signal Generator	Agilent	N5181A	MY50145882	9-23-2015
Power Sensor	Agilent	U2000A	MY54260010	9-23-2015
Power Sensor	Agilent	U2000A	MY54260007	9-23-2015
Power Amplifier	EXODUS	1410025-AMP2027-10003	10003	11-7-2015
Directional Coupler	Agilent	772D	MY52180193	9-22-2015
Directional Coupler	Agilent	778D	MY52180432	9-22-2015
Low Pass Filter	MICROLAB	LA-15N	03943	11-4-2015
Low Pass Filter	FILTRON	L14012FL	1410003S	11-4-2015
Low Pass Filter	MICROLAB	LA-60N	03942	11-5-2015
Attenuator	Agilent	8491B/003	MY39269292	9-22-2015
Attenuator	Agilent	8491B/010	MY39269315	9-22-2015
Attenuator	Agilent	8491B/020	MY39269298	9-22-2015
E-Field Probe (SAR 2)	SPEAG	EX3DV4	7313	8-27-2015
E-Field Probe (SAR 3)	SPEAG	EX3DV4	7314	8-27-2015
E-Field Probe (SAR 3)	SPEAG	EX3DV4	7323	12-5-2015
Data Acquisition Electronics (SAR 2)	SPEAG	DAE4	1447	8-25-2015
Data Acquisition Electronics (SAR 3)	SPEAG	DAE4	1446	8-27-2015
System Validation Dipole	SPEAG	D835V2	4d174	8-13-2015
System Validation Dipole	SPEAG	D1900V2	5d190	8-12-2015
System Validation Dipole	SPEAG	D1900V2	5d199	2-6-2016
System Validation Dipole	SPEAG	D2450V2	939	8-11-2015
Thermometer (SAR 2)	Lutron	MHB-382SD	AH.50215	11-18-2015
Thermometer (SAR 3)	Lutron	MHB-382SD	AH.50213	11-18-2015

Others

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Base Station Simulator	R & S	CMW500	150313	8-13-2015
Base Station Simulator	R & S	CMW500	150314	8-13-2015

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): 130 mm x 68 mm Overall Diagonal: 140 mm Display Diagonal: 115.7 mm
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 3.85Vdc, 7.70Wh ☐ 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 GHz)
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**
GSM	850 1900	Voice (GMSK) GPRS (GMSK) EGPRS (Rx Only)	GPRS Multi-Slot Class: ☐ Class 8 - 1 Up, 4 Down ☐ Class 10 - 2 Up, 4 Down ☒ Class 12 - 4 Up, 4 Down ☐ Class 33 - 4 Up, 5 Down	GSM Voice: 12.5% (E)GPRS: 1 Slot: 12.5% 2 Slots: 25% 3 Slots: 37.5% 4 Slots: 50%
	Does this device support DTM (Dual Transfer Mode)? ☐ Yes ☒ No			
Wi-Fi	2.4 GHz	802.11b 802.11g 802.11n (HT20)		100%
Bluetooth	2.4 GHz	Version 4.1 LE		N/A

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

RF Air interface	Mode	Target	Max. tune-up tolerance limit
GSM850	Voice (1 slot)	32.5	**33.0**
	GPRS 1 slot	32.5	**33.0**
	GPRS 2 slots	30.0	**30.5**
	GPRS 3 slots	28.0	**28.5**
	GPRS 4 slots	26.0	**26.5**
GSM1900	Voice (1 slot)	29.5	**30.0**
	GPRS 1 slot	29.5	**30.0**
	GPRS 2 slots	28.0	**28.5**
	GPRS 3 slots	26.0	**26.5**
	GPRS 4 slots	24.0	**24.5**

Upper limit (dB): -1.5 ~ 0.5		Max. RF Output Power (dBm)	
RF Air interface	Mode	Target	Max. tune-up tolerance limit
WiFi 2.4 GHz	802.11b	17.5	**18.0**
	802.11g	15.0	**15.5**
	802.11n HT20	13.5	**14.0**
Bluetooth		10.5	**11.0**
Bluetooth LE		9.0	**9.5**

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	Yes	
			Edge 3 (Bottom)	< 25 mm	Yes	
			Edge 4 (Left)	< 25 mm	Yes	
WLAN	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 / Wi-Fi Direct	10 mm	Rear	< 25 mm	Yes	
			Front	< 25 mm	Yes	
			Edge 1 (Top)	< 25 mm	Yes	
			Edge 2 (Right)	< 25 mm	Yes	
			Edge 3 (Bottom)	> 25 mm	No	1
			Edge 4 (Left)	> 25 mm	No	1

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 2 Room

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
5-14-2015	Head 835	e'	42.0200	Relative Permittivity (ε_r):	42.02	41.50	1.25	5
		e''	19.0000	Conductivity (σ):	0.88	0.90	-1.98	5
	Head 820	e'	42.1700	Relative Permittivity (ε_r):	42.17	41.60	1.36	5
		e''	19.0200	Conductivity (σ):	0.87	0.90	-3.48	5
	Head 850	e'	41.8600	Relative Permittivity (ε_r):	41.86	41.50	0.87	5
		e''	18.9500	Conductivity (σ):	0.90	0.92	-2.12	5
5-15-2015	Body 1900	e'	52.0300	Relative Permittivity (ε_r):	52.03	53.30	-2.38	5
		e''	14.9800	Conductivity (σ):	1.58	1.52	4.12	5
	Body 1850	e'	52.1700	Relative Permittivity (ε_r):	52.17	53.30	-2.12	5
		e''	14.9700	Conductivity (σ):	1.54	1.52	1.31	5
	Body 1910	e'	52.0000	Relative Permittivity (ε_r):	52.00	53.30	-2.44	5
		e''	14.9800	Conductivity (σ):	1.59	1.52	4.66	5
5-17-2015	Body 835	e'	53.0000	Relative Permittivity (ε_r):	53.00	55.20	-3.99	5
		e''	20.4600	Conductivity (σ):	0.95	0.97	-2.07	5
	Body 820	e'	53.1300	Relative Permittivity (ε_r):	53.13	55.28	-3.88	5
		e''	20.5200	Conductivity (σ):	0.94	0.97	-3.39	5
	Body 850	e'	52.8700	Relative Permittivity (ε_r):	52.87	55.16	-4.15	5
		e''	20.3900	Conductivity (σ):	0.96	0.99	-2.38	5
5-17-2015	Head 1900	e'	38.6400	Relative Permittivity (ε_r):	38.64	40.00	-3.40	5
		e''	13.6300	Conductivity (σ):	1.44	1.40	2.85	5
	Head 1850	e'	38.8500	Relative Permittivity (ε_r):	38.85	40.00	-2.88	5
		e''	13.5800	Conductivity (σ):	1.40	1.40	-0.22	5
	Head 1910	e'	38.6000	Relative Permittivity (ε_r):	38.60	40.00	-3.50	5
		e''	13.6400	Conductivity (σ):	1.45	1.40	3.47	5

SAR 3 Room

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
5-16-2015	Body 2450	e'	51.6100	Relative Permittivity (ε_r):	51.61	52.70	-2.07	5
		e''	15.0100	Conductivity (σ):	2.04	1.95	4.86	5
	Body 2410	e'	51.6900	Relative Permittivity (ε_r):	51.69	52.76	-2.03	5
		e''	14.9300	Conductivity (σ):	2.00	1.91	4.89	5
	Body 2475	e'	51.5500	Relative Permittivity (ε_r):	51.55	52.67	-2.12	5
		e''	15.0600	Conductivity (σ):	2.07	1.99	4.40	5
5-16-2015	Head 2450	e'	38.5100	Relative Permittivity (ε_r):	38.51	39.20	-1.76	5
		e''	13.7900	Conductivity (σ):	1.88	1.80	4.37	5
	Head 2410	e'	38.6200	Relative Permittivity (ε_r):	38.62	39.28	-1.68	5
		e''	13.7200	Conductivity (σ):	1.84	1.76	4.44	5
	Head 2475	e'	38.4100	Relative Permittivity (ε_r):	38.41	39.17	-1.94	5
		e''	13.8300	Conductivity (σ):	1.90	1.83	4.17	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
D835V2	4d174	8-13-2014	835	1g	9.32	9.62
				10g	6.09	6.37
D1900V2	5d190	8-12-2014	1900	1g	40.2	40.4
				10g	21.0	21.3
D1900V2	5d199	2-6-2015	1900	1g	41	40.6
				10g	21.4	21.6
D2450V2	939	8-11-2014	2450	1g	52.1	51.4
				10g	24.2	24

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 2 Room

Date Tested	System Dipole		T.S. Liquid		Measured Results		Target (Ref. Value)	Delta ±10 %	Plot No.
	Type	Serial #			Zoom Scan to 100 mW	Normalize to 1 W			
5-14-2015	D835V2	4d174	Head	1g	0.97	9.73	9.32	4.40	
				10g	0.64	6.39	6.09	4.93	
5-15-2015	D1900V2	5d199	Body	1g	4.12	41.20	40.6	1.48	
				10g	2.11	21.10	21.60	-2.31	
5-17-2015	D835V2	4d174	Body	1g	0.96	9.61	9.62	-0.10	1, 2
				10g	0.63	6.33	6.37	-0.63	
5-17-2015	D1900V2	5d199	Head	1g	4.07	40.70	41.00	-0.73	3, 4
				10g	2.08	20.80	21.40	-2.80	

SAR 3 Room

Date Tested	System Dipole		T.S. Liquid		Measured Results		Target (Ref. Value)	Delta ±10 %	Plot No.
	Type	Serial #			Zoom Scan to 100 mW	Normalize to 1 W			
5-16-2015	D2450V2	939	Body	1g	5.44	54.40	51.40	5.84	
				10g	2.49	24.90	24.00	3.75	
5-16-2015	D2450V2	939	Head	1g	5.43	54.30	52.10	4.22	5,6
				10g	2.48	24.80	24.20	2.48	

9. Conducted Output Power Measurements

9.1. GSM

Per KDB 941225 D01 3G SAR Procedures:

SAR test reduction for GPRS and EDGE modes is determined by the source-based time-averaged output power specified for production units, including tune-up tolerance. The data mode with highest specified time-averaged output power should be tested for SAR compliance in the applicable exposure conditions. For modes with the same specified maximum output power and tolerance, the higher number time-slot configuration should be tested.

GSM850 Measured Results

Band	Mode	Coding Scheme	Time Slots	Ch No.	Freq. (MHz)	Max. Pwr	
						Burst (dBm)	Frame (dBm)
850	GSM (Voice)	CS1	1	128	824.2	32.7	23.6
				190	836.6	32.6	23.5
				251	848.8	32.7	23.6
	GPRS (GMSK)	CS1	1	128	824.2	32.7	23.6
				190	836.6	32.6	23.5
				251	848.8	32.7	23.6
			2	128	824.2	30.1	24.1
				190	836.6	30.1	24.1
				251	848.8	30.2	24.2
			3	128	824.2	28.1	23.8
				190	836.6	28.1	23.8
				251	848.8	28.1	23.9
			4	128	824.2	26.1	23.1
				190	836.6	26.1	23.0
				251	848.8	26.1	23.1

EGPRS(8PSK) is Rx only

Notes:

The worst-case configuration and mode for SAR testing is determined to be as follows:

- Head & Body-worn: GMSK Voice Mode
- Hotspot mode: GMSK (GPRS) mode with 2 time slots based on the output power measurements above.

GSM1900 Measured Results

Band	Mode	Coding Scheme	Time Slots	Ch No.	Freq. (MHz)	Max. Pwr	
						Burst (dBm)	Frame (dBm)
1900	GSM (Voice)	CS1	1	512	1850.2	29.2	20.2
				661	1880.0	29.1	20.1
				810	1909.8	29.1	20.1
	GPRS (GMSK)	CS1	1	512	1850.2	29.2	20.2
				661	1880.0	29.1	20.1
				810	1909.8	29.1	20.1
			2	512	1850.2	28.1	22.1
				661	1880.0	28.0	22.0
				810	1909.8	27.7	21.7
			3	512	1850.2	26.4	22.2
				661	1880.0	26.2	22.0
				810	1909.8	25.9	21.7
			4	512	1850.2	24.5	21.4
				661	1880.0	24.2	21.2
				810	1909.8	23.9	20.9

EGPRS(8PSK) is Rx only

Notes:

The worst-case configuration and mode for SAR testing is determined to be as follows:

- Head & Body-worn: GMSK Voice Mode
- Hotspot mode: GMSK (GPRS) mode with 3 time slots based on the output power measurements above.

9.2. Wi-Fi 2.4GHz (DTS Band)

Measured Results

Band (GHz)	Mode	Data Rate	Ch #	Freq. (MHz)	Avg Pwr (dBm)	Max Output Power (dBm)	SAR Test (Yes/No)	Note(s)
2.4	802.11b	1 Mbps	1	2412	17.1	18	Yes	
			6	2437	17.1			
			11	2462	17.1			
	802.11g	6 Mbps	1	2412	Not PWR Meas. require	15.5	No	1
			6	2437				
			11	2462				
	802.11n (HT20)	6.5 Mbps	1	2412	Not PWR Meas. require	14.0	No	1
			6	2437				
			11	2462				

Note(s):

1. Output Power and SAR is not required for 802.11g/n HT20 channels 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 ≤ 1.2 W/kg.

9.3. Bluetooth

Maximum tune-up tolerance limit is 11.0 dBm from the rated nominal maximum output power. This power level qualifies for exclusion of SAR testing.

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 D01 SAR test for 3G devices:
When the maximum output power and tune-up tolerance specified for production units in a secondary mode is ≤ ¼ dB higher than the primary mode or when the highest reported SAR of the primary mode is scaled by the ratio of specified maximum output power and tune-up tolerance of secondary to primary mode and the adjusted SAR is ≤ 1.2 W/kg, SAR measurement is not required for the secondary mode

KDB 248227 D01 SAR meas for 802.11 v02:
SAR test reduction for 802.11 Wi-Fi transmission mode configurations are considered separately for DSSS and OFDM. An initial test position is determined to reduce the number of tests required for certain exposure configurations with multiple test positions. An initial test configuration is determined for each frequency band and aggregated band according to maximum output power, channel bandwidth, wireless mode configurations and other operating parameters to streamline the measurement requirements. For 2.4 GHz DSSS, either the initial test position or DSSS procedure is applied to reduce the number of SAR tests; these are mutually exclusive. For OFDM, an initial test position is only applicable to next to the ear, UMPC mini-tablet and hotspot mode configurations, which is tested using the initial test configuration to facilitate test reduction. For other exposure conditions with a fixed test position, SAR test reduction is determined using only the initial test configuration.

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

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

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

10.1. GSM850

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	
Head	Voice	0	Left Touch	190	836.6	33.0	32.6	0.147	0.161	
			Left Tilt	190	836.6	33.0	32.6	0.087	0.095	
			Right Touch	190	836.6	33.0	32.6	0.141	0.155	
			Right Tilt	190	836.6	33.0	32.6	0.121	0.133	
Head VoIP	GPRS 2 Slots	0	Left Touch	190	836.6	30.5	30.1	0.301	0.330	1
			Left Tilt	190	836.6	30.5	30.1	0.173	0.190	
			Right Touch	190	836.6	30.5	30.1	0.290	0.318	
			Right Tilt	190	836.6	30.5	30.1	0.252	0.276	
Body-worn	Voice	10	Rear	190	836.6	33.0	32.6	0.683	0.749	
			Front	190	836.6	33.0	32.6	0.426	0.467	
Body-worn(VoIP) & Hotspot	GPRS 2 Slots	10	Rear	128	824.2	30.5	30.1	0.757	0.830	
				190	836.6	30.5	30.1	0.772	0.846	2
				251	848.8	30.5	30.2	0.779	0.835	
			Front	190	836.6	30.5	30.1	0.538	0.590	
Hotspot			Edge 2	190	836.6	30.5	30.1	0.601	0.659	
			Edge 3	190	836.6	30.5	30.1	0.065	0.071	
			Edge 4	190	836.6	30.5	30.1	0.611	0.670	

10.2. GSM1900

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	
Head	Voice	0	Left Touch	661	1880.0	30.0	29.1	0.385	0.474	
			Left Tilt	661	1880.0	30.0	29.1	0.143	0.176	
			Right Touch	661	1880.0	30.0	29.1	0.214	0.263	
			Right Tilt	661	1880.0	30.0	29.1	0.126	0.155	
Head VoIP	GPRS 3 Slots	0	Left Touch	661	1880.0	26.5	26.2	0.512	0.549	3
			Left Tilt	661	1880.0	26.5	26.2	0.192	0.206	
			Right Touch	661	1880.0	26.5	26.2	0.235	0.252	
			Right Tilt	661	1880.0	26.5	26.2	0.170	0.182	
Body-worn	Voice	10	Rear	661	1880.0	30.0	29.1	0.458	0.563	
			Front	661	1880.0	30.0	29.1	0.357	0.439	
Body-worn(VoIP) & Hotspot	GPRS 3 Slots	10	Rear	661	1880.0	26.5	26.2	0.664	0.711	4
			Front	661	1880.0	26.5	26.2	0.514	0.551	
Hotspot			Edge 2	661	1880.0	26.5	26.2	0.108	0.116	
			Edge 3	661	1880.0	26.5	26.2	0.146	0.156	
			Edge 4	661	1880.0	26.5	26.2	0.393	0.421	

10.3. Wi-Fi (DTS Band)

Frequency Band	Mode	RF Exposure Conditions	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Area Scan Max. SAR (W/kg)	Power (dBm)		1-g SAR (W/kg)		Notes	Plot No.
								Tune-up limit	Meas.	Meas.	Scaled		
2.4GHz	802.11b 1 Mbps	Head	0	Left Touch	6	2437.0	0.299	18.0	17.1	0.230	0.283	1	5
				Left Tilt	6	2437.0	0.311	18.0	17.1	0.215	0.265		
				Right Touch	6	2437.0	0.200						
				Right Tilt	6	2437.0	0.220						
		Body-worn & Hotspot & Wi-Fi Direct	10	Rear	6	2437.0	0.158	18.0	17.1	0.119	0.146	1	6
				Front	6	2437.0	0.070						
				Edge 1	6	2437.0	0.109						
				Edge 2	6	2437.0	0.028						

Note(s):

1. Highest *reported* SAR is ≤ 0.4 W/kg. Therefore, further SAR measurements within this exposure condition are not required.
2. Highest *reported* SAR is > 0.4 W/kg. Due to the highest *reported* SAR for this test position, other test positions in Head exposure condition were evaluated until a SAR ≤ 0.8 W/kg was *reported*.
3. Testing for a second channel was required because the *reported* SAR for this test position was >0.8 W/kg.
4. Additional testing required in order satisfying FCC simultaneous transmission limit criteria.

10.4. Bluetooth

Standalone SAR Test Exclusion Considerations & Estimated SAR

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.

When the standalone SAR test exclusion is applied to an antenna that transmits simultaneously with other antennas, the standalone SAR must be estimated according to following to determine simultaneous transmission SAR test exclusion:

- *(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)]·[√$f_{(GHz)}$/x]* W/kg for test separation distances ≤ 50 mm;
  where x = 7.5 for 1-g SAR, and x = 18.75 for 10-g SAR.
- 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distances is > 50 mm.

Body-worn Accessory Exposure Conditions

Max. tune-up tolerance limit		Min. test separation distance (mm)	Frequency (GHz)	SAR test exclusion Result*	Test Configuration	Estimated 1-g SAR (W/kg)
(dBm)	(mW)					
11.0	13	10	2.480	2.0	Rear/Front	0.273

Conclusion:

*: The computed value is < 3; therefore, Bluetooth qualifies for Standalone SAR test exclusion.

11. SAR Measurement Variability

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

1) Repeated measurement is not required when the original highest measured SAR is < 0.80 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 (MHz)	Air Interface	RF Exposure Conditions	Test Position	Repeated SAR (Yes/No)	Highest Measured SAR (W/kg)	Repeated Measured SAR (W/kg)	Largest to Smallest SAR Ratio
850	GSM 850	Body & Hotspot	Rear	No	0.779	N/A	N/A
1900	GSM 1900	Body & Hotspot	Rear	No	0.664	N/A	N/A
2400	Wi-Fi 802.11b/g/n	Head	Left Touch	No	0.23	N/A	N/A

Note(s):

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

12. Simultaneous Transmission SAR Analysis

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	GSM(Voice)	+	DTS
	2	GSM(GPRS)	+	DTS
Body-worn	3	GSM(Voice)	+	DTS
	4	GSM(Voice)	+	BT
	5	GSM(GPRS)	+	DTS
	6	GSM(GPRS)	+	BT
Hotspot & Wi-Fi Direct	7	GSM(GPRS)	+	DTS

Notes:

1. DTS supports Hotspot and Wi-Fi Direct
2. GPRS support Hotspot.
3. VoIP is supported in GPRS.
4. DTS Radio cannot transmit simultaneously with Bluetooth Radio.

12.1. Sum of the SAR for GSM 850 & Wi-Fi & BT

RF Exposure conditions	Test Position	① WWAN	② DTS	③ BT	① + ② WWAN + DTS		① + ③ WWAN + BT	
					∑ 1-g SAR (mW/g)	SPLSR (Yes/ No)	∑ 1-g SAR (mW/g)	SPLSR (Yes/ No)
Head	Left Touch	0.330	0.283		0.613	No		
	Left Tilt	0.190	0.283		0.473	No		
	Right Touch	0.318	0.283		0.601	No		
	Right Tilt	0.276	0.283		0.559	No		
Body-worn & Hotspot	Rear	0.846	0.146	0.273	0.992	No	1.119	No
	Front	0.590	0.146	0.273	0.736	No	0.863	No
Hotspot	Edge 1		0.146					
	Edge 2	0.659	0.146		0.805	No		
	Edge 3	0.071	0.146		0.217	No		
	Edge 4	0.670	0.146		0.816	No		

12.2. Sum of the SAR for GSM 1900 & Wi-Fi & BT

RF Exposure conditions	Test Position	① WWAN	② DTS	③ BT	① + ② WWAN + DTS		① + ③ WWAN + BT	
					∑ 1-g SAR (mW/g)	SPLSR (Yes/ No)	∑ 1-g SAR (mW/g)	SPLSR (Yes/ No)
Head	Left Touch	0.549	0.283		0.832	No		
	Left Tilt	0.206	0.283		0.489	No		
	Right Touch	0.263	0.283		0.546	No		
	Right Tilt	0.182	0.283		0.465	No		
Body-worn & Hotspot	Rear	0.711	0.146	0.273	0.857	No	0.984	No
	Front	0.551	0.146	0.273	0.697	No	0.824	No
Hotspot	Edge 1		0.146					
	Edge 2	0.116	0.146		0.262	No		
	Edge 3	0.156	0.146		0.302	No		
	Edge 4	0.421	0.146		0.567	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_15K20822-S1 SAR Photos & Ant. Locations

B_15K20822-S1 SAR Highest Test Plots

C_15K20822-S1 SAR System Check Plots

D_15K20822-S1 SAR Tissue Ingredients

E_15K20822-S1 SAR Probe Cal. Certificates

F_15K20822-S1 SAR Dipole Cal. Certificates

END OF REPORT