1FCC 47 CFR Parts 1 & 2
Published RF Exposure KDB Procedures
IEEE Std 1528-2013

SAR EVALUATION REPORT

For

GSM Phone + Bluetooth & DTS/UNII a/b/g/n/ac + ANT

Model: SM-G9098
FCC ID: A3LSMG9098

Report Number: 14U16938-7
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Prepared for

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1. Attestation of Test Results

Applicant	Samsung Electronics Co., Ltd.			
DUT description	GSM Phone + Bluetooth & DTS/UNII a/b/g/n/ac + ANT			
Model	SM-G9098			
Test device is	An identical prototype			
Device category	Portable			
Exposure category	General Population/Uncontrolled Exposure			
Date tested	01/14/2014 – 01/25/2014			
The highest reported SAR values	RF exposure condition	Licensed	DTS	UNII
	Head(Flat Phantom)	0.519 W/kg	0.045 W/kg	0.099 W/kg
	Body-worn Accessory	0.635 W/kg	0.480 W/kg	0.509 W/kg
	Wireless Router (Hotspot)	0.635 W/kg	0.480 W/kg	N/A
	Simultaneous Transmission	1.144 W/kg	1.115 W/kg	1.144 W/kg
Applicable Standards	FCC 47 CFR Parts 1 & 2 Published RF Exposure KDB Procedures, and TCB workshop updates IEEE Std 1528-2013			
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.

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2. Test Methodology

The tests documented in this report were performed in accordance with FCC 47 CFR Parts 1 & 2, IEEE STD 1528-2013, the following FCC Published RF exposure KDB procedures, and TCB workshop updates:

- 447498 D01 General RF Exposure Guidance v05r01
- 648474 D04 Handset SAR v01r01
- 941225 D01 SAR test for 3G devices v02
- 941225 D03 SAR Test Reduction GSM GPRS EDGE v01
- 941225 D04 SAR for GSM E GPRS Dual Xfer Mode v01
- 941225 D06 Hot Spot SAR v01r01
- 248227 D01 SAR Meas for 802 11abg v01r02
- 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r01
- 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, Fremont, California, USA.

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 F	

UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0. The full scope of accreditation can be viewed at http://www.ccsemc.com.

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4. Calibration and Uncertainty

4.1. Measuring Instrument Calibration

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.

Tissue Dielectric Properties

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Network Analyzer	Agilent	8753ES	MY40000980	2/20/2014
Dielectronic Probe kit	SPEAG	DAK-3.5	1103	2/5/2014
Thermometer	Control Company	4242	122529163	9/19/2014

System Performance Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Synthesized Signal Generator	HP	8665B	3744A01155	3/6/2014
Power Meter	Agilent	N1911A	MY53060002	4/4/2014
Power Meter	Agilent	N1911A	MY53060016	8/3/2014
Power Sensor	Agilent	E9323A	MY53070003	4/3/2014
Power Sensor	Agilent	E9323A	MY53070007	9/30/2014
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1622052	N/A
Directional coupler	Werlatone	C8060-102	2149	N/A
DC Power Supply	KENWOOD	PA36-3A	7060074	N/A
Thermometer	TRACEABLE	4242	122529163	9/19/2014
E-Field Probe	SPEAG	EX3DV4	3929	6/24/2014
E-Field Probe	SPEAG	EX3DV4	3773	4/26/2014
E-Field Probe	SPEAG	EX3DV4	3902	7/12/2014
Data Acquisition Electronics	SPEAG	DAE4	1258	3/6/2014
Data Acquisition Electronics	SPEAG	DAE4	1259	2/7/2014
Data Acquisition Electronics	SPEAG	DAE4	1359	2/8/2014
Data Acquisition Electronics	SPEAG	DAE4	1377	7/15/2014
System Validation Dipole	SPEAG	D1900V2	5d140	4/18/2014
System Validation Dipole	SPEAG	D2450V2	706	5/29/2014
System Validation Dipole	SPEAG	D5GHzV2	1138	11/19/2014
System Validation Dipole	SPEAG	D5GHzV2	1168	12/12/2014

Others

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Base Station Simulator	R & S	CMU200	106301	7/3/2014
Base Station Simulator	R & S	CMW500	124594-HX	7/2/2014
Base Station Simulator	R & S	CMW500	132909-bp	2/19/2014
Power Meter	Agilent	N1912A	MY53040016	4/4/2014
Power Sensor	Agilent	N1921A	MY52020011	5/13/2014

4.2. Measurement Uncertainty

Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r01 Section 2.8.1., 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.

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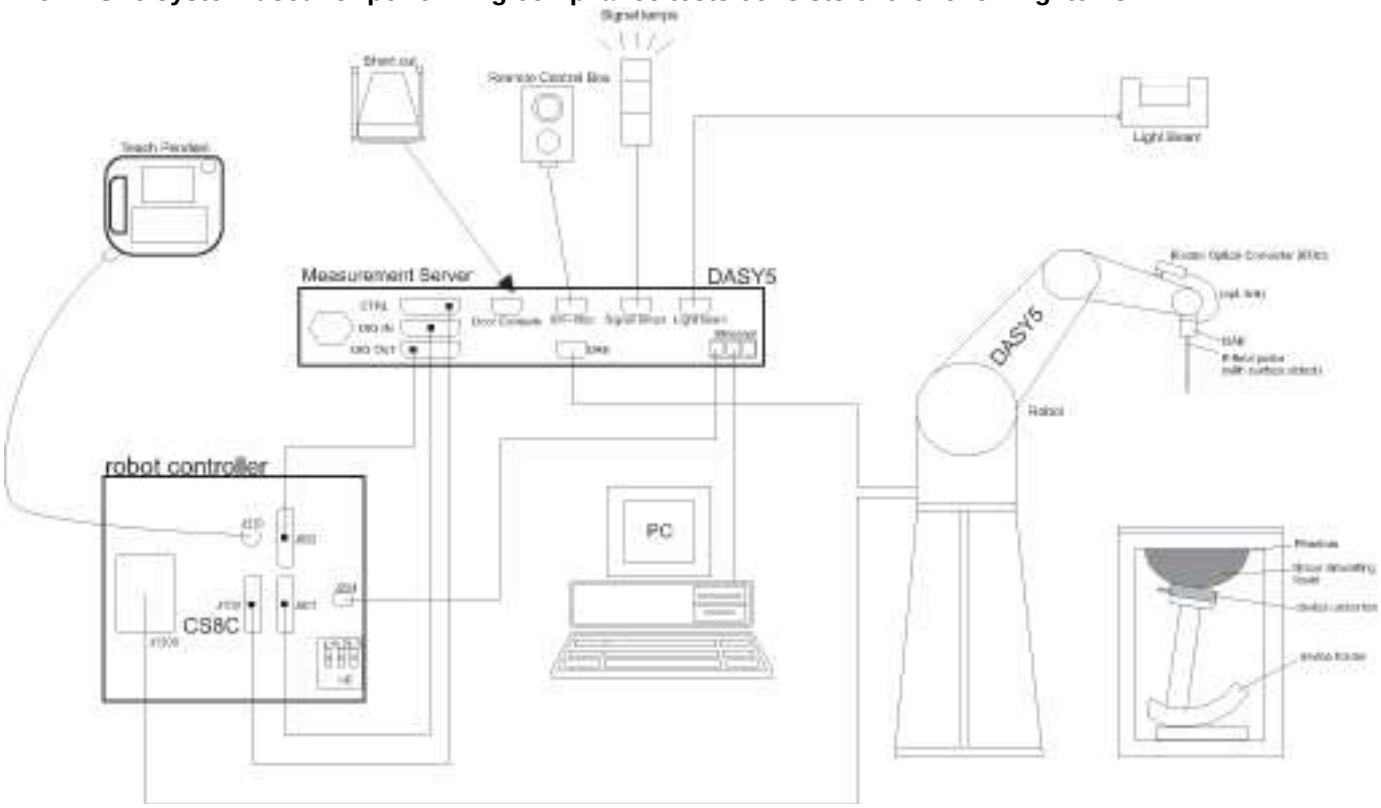
5. Measurement System Description and Setup

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.

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6. SAR Measurement Procedure

6.1. Normal SAR Measurement Procedure

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 v01r01

	≤ 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.	

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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 v01r01

			≤ 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	$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$	
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.

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6.2. Volume Scan Procedures

Step 1: Repeat Step 1-4 in Section 6.1

Step 2: Volume Scan
Volume Scans are used to assess peak SAR and averaged SAR measurements in largely extended 3-dimensional volumes within any phantom. This measurement does not need any previous area scan. The grid can be anchored to a user specific point or to the current probe location.

Step 3: Power drift measurement
The Power Drift Measurement measures the field at the same location as the most recent power reference measurement within the same procedure, and with the same settings. The Power Drift Measurement gives the field difference in dB from the reading conducted within the last Power Reference Measurement. This allows a user to monitor the power drift of the device under test within a batch process. The measurement procedure is the same as Step 1.

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7. Device Under Test

7.1. General Information

Operating Configuration(s)	Held to head, Body-worn (Voice call)
Mobile 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 AP, FCC: Ch.1 ~ Ch.11) ☐ Mobile Hotspot (Wi-Fi 5 GHz)
Wi-Fi Direct	Wi-Fi Direct enabled devices transfer data directly between each other ☒ Mobile Hotspot (Wi-Fi 2.4 GHz) (Mobile AP, FCC: Ch.1 ~ Ch.11)) ☐ Wi-Fi Direct (Wi-Fi 5 GHz)
Device dimension	Overall (Length x Width): 116.4 mm x 59.6 mm (Closed) Overall (Length x Width):230mm x 59.6 mm (open) Overall Diagonal: 129 mm Display Diagonal: 94.5 mm (exterior) Display Diagonal: 94.5 mm (interior)
Back Cover	☒ Normal Battery Cover ☐ Wireless Charger Battery Cover ☐ Normal Battery Cover with NFC
Accessory	☒ Headset
Battery Options	☒ Standard – Lithium-ion battery, Rating 3.8 Vdc, 7.22 Wh ☐ Extended (large capacity)

7.2. Wireless Technologies

Wireless Technology and Frequency Bands	GSM: 1900 Wi-Fi : 2.4 / 5 GHz Bluetooth: 2.4 GHz.
Mode	GSM - ☒ Voice (GMSK) - ☒ GPRS (GMSK) - ☒ EGPRS (8PSK) Wi-Fi 2.4GHz (802.11b/g/n) - ☒ 802.11b - ☒ 802.11g - ☒ 802.11n (HT20) Wi-Fi 5GHz (802.11a/n/ac) - ☒ 802.11a - ☒ 802.11n (HT20) - ☒ 802.11n (HT40) - ☒ 802.11ac (20MHz) - ☒ 802.11ac (40MHz) - ☒ 802.11ac (80MHz) Bluetooth Ver. 4.0 (LE)
Duty Cycle	GSM Voice: 12.5%; GPRS 1 Slot: 12.5%; 2 Slots: 25%, 3 Slots: 37.5%,4 Slots: 50%, Wi-Fi 802.11a/b/g/n: 100%
GPRS Multi-Slot Class	☐ Class 8 - One Up ☐ Class 10 - Two Up ☒ Class 12 - Four Up
DTM (Dual Transfer Mode)	☐ Supported
VoIP (GPRS)	☒ Supported
SV-LTE & SV-DO	☐ Supported

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7.3. RF Output Power Tolerance

Upper limit (dB): 0.5 ~ -1.5		RF Output Power (dBm)							
		Target				Max. tune-up tolerance limit			
RF Air interface	Mode	1 Slot	2 Slot	3 Slot	4 Slot	1 Slot	2 Slot	3 Slot	4 Slot
GSM1900	Voice	30.0				**30.5**			
	GPRS	30.0	29.0	27.0	25.5	**30.5**	**29.5**	**27.5**	**26.0**
	EGPRS	25.7	24.5	22.5	21.2	**26.2**	**25.0**	**23.0**	**21.7**

Upper limit (dB): 0.5 ~ -1.5		RF Output Power (dBm)	
RF Air interface	Mode	Target	Max. tune-up tolerance limit
WiFi 2.4 GHz	802.11b	18.0	**18.5**
	802.11g	12.0	**12.5**
	802.11n HT20	14.0	**14.5**

Upper limit (dB): 0.5 ~ -1.5		RF Output Power (dBm)	
RF Air interface	Mode	Target	Max. tune-up tolerance limit
WiFi 5 GHz	802.11a	12.0	**12.5**
	802.11n HT20	12.0	**12.5**
	802.11n HT40	11.0	**11.5**
	802.11ac HT20	12.0	**12.5**
	802.11ac HT40	11.0	**11.5**
	802.11ac HT80	11.0	**11.5**

Upper limit (dB): 0.5		RF Output Power (dBm)	
RF Air interface	Mode	Target	Max. tune-up tolerance limit
Bluetooth	GFSK	10.0	**10.5**
	4.0 LE	0.0	**0.5**

7.4. Simultaneous Transmission Condition

RF Exposure Condition	Capable Transmit Configurations
Head	1. GSM 1900 Voice + Wi-Fi 2.4/5GHz 2. GSM 1900 (GPRS/EDGE) + Wi-Fi 2.4/5GHz (VoIP)
Body-worn Accessory	1. GSM 1900 Voice + Wi-Fi 2.4/5GHz 2. GSM 1900 Voice + BT 3. GSM 1900 (GPRS/EDGE) + Wi-Fi 2.4/5GHz (VoIP) 4. GSM 1900 (GPRS/EDGE) + BT(VoIP)
Wireless Router (Hotspot) & Wi-Fi Direct	1. GSM 1900 (GPRS/EDGE) + Wi-Fi 2.4GHz

Notes:
1. Wi-Fi 2.4GHz supports Hotspot and Wi-Fi Direct.
2. GPRS/EDGE supports Hotspot.
3. VoIP is supported in GSM.
4. 2.4 GHz WLAN, 2.4 GHz Bluetooth, and 5 GHz WLAN share the same antenna path and cannot transmit simultaneously.

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8. RF Exposure Conditions

Refer to Appendix "Antenna Locations and Separation Distances" for the specific details of the antenna-to-antenna and antenna-to-edge(s) distances.

8.1. Head Exposure Conditions

For WWAN and Wi-Fi

Test Configurations	SAR Required	Note
Left Touch	Yes	
Left Tilt (15°)	Yes	
Right Touch	Yes	
Right Tilt (15°)	Yes	

8.2. Body-worn Accessory Exposure Conditions

For WWAN

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

For Wi-Fi

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

8.3. Hotspot Exposure Conditions

For WWAN

Test Configurations	Antenna-to-edge/surface	SAR Required	Note
Rear	<25 mm	Yes	
Front	<25 mm	Yes	
Edge 1 (Top)	106.4 mm	No	SAR is not required because the distance from the antenna to the edge is > 25 mm as per KDB 941225 D06 Hot Spot SAR v01r01
Edge 2 (Right)	31.6 mm	No	SAR is not required because the distance from the antenna to the edge is > 25 mm as per KDB 941225 D06 Hot Spot SAR v01r01
Edge 3 (Bottom)	2.3 mm	Yes	
Edge 4 (Left)	2.5 mm	Yes	

For Wi-Fi

Test Configurations	Antenna-to-edge/surface	SAR Required	Note
Rear	<25 mm	Yes	
Front	<25 mm	Yes	
Edge 1 (Top)	26 mm	No	SAR is not required because the distance from the antenna to the edge is > 25 mm as per KDB 941225 D06 Hot Spot SAR v01r01
Edge 2 (Right)	3 mm	Yes	
Edge 3 (Bottom)	75 mm	No	SAR is not required because the distance from the antenna to the edge is > 25 mm as per KDB 941225 D06 Hot Spot SAR v01r01
Edge 4 (Left)	47.7 mm	No	SAR is not required because the distance from the antenna to the edge is > 25 mm as per KDB 941225 D06 Hot Spot SAR v01r01

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9. RF Output Power Measurement

9.1. GSM

GSM (GMSK) - Voice Mode

Band	Ch No.	Freq. (MHz)	Avg burst Pwr (dBm)
1900	512	1850.2	30.2
	661	1880.0	30.2
	810	1909.8	30.2

GPRS (GMSK) - Coding Scheme: CS1

Band	Ch No.	Freq. (MHz)	Avg Power (dBm)				Avg Power (dBm)			
			1 time slot		2 time slots		3 time slots		4 time slots	
			Burst	Frame	Burst	Frame	Burst	Frame	Burst	Frame
1900	512	1850.2	30.2	21.2	29.5	23.5	27.3	23.0	25.9	22.9
	661	1880.0	30.2	21.2	29.5	23.5	27.2	22.9	25.8	22.8
	810	1909.8	30.2	21.2	29.4	23.4	27.3	23.0	25.8	22.8

EGPRS (8PSK) - Coding Scheme: MCS5

Band	Ch No.	Freq. (MHz)	Avg Power (dBm)				Avg Power (dBm)			
			1 time slot		2 time slots		3 time slots		4 time slots	
			Burst	Frame	Burst	Frame	Burst	Frame	Burst	Frame
1900	512	1850.2	26.1	17.1	25.0	19.0	22.9	18.6	21.6	18.6
	661	1880.0	25.9	16.9	24.8	18.8	22.8	18.5	21.4	18.4
	810	1909.8	26.0	17.0	24.8	18.8	22.8	18.5	21.5	18.5

Notes:

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

- Head & Body-worn Accessory: GMSK Voice Mode
- Hotspot mode: GMSK (GPRS) mode with 2 time slots, based on the output power measurements above
- SAR is not required for EGPRS (8PSK) mode because its output power is less than that of GPRS Mode

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9.2. 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	**18.0**	Yes
			6	2437	**18.1**	
			11	2462	**18.0**	
	802.11g	6 Mbps	1	2412	12.0	No
			6	2437	12.0	
			11	2462	12.0	
	802.11n (HT20)	MCS0	1	2412	14.0	No
			6	2437	14.0	
			11	2462	14.0	

Note(s):

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	18.1	Yes
			2 Mbps	18.0	No
			5.5 Mbps	18.0	No
			11 Mbps	18.0	No

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9.3. Wi-Fi (5 GHz Bands)

Required Test Channels per KDB 248227 D01

Mode		Band	GHz	Channel	"Default Test Channels"	
					802.11a	
802.11a	UNII (15.407)	5.2 GHz	5.180	36	√	
			5.200	40		*
			2.220	44		*
			5.240	48	√	
		5.3 GHz	5.260	52	√	
			5.280	56		*
			5.300	60		*
			5.320	64	√	
		5.5 GHz	5.500	100		
			5.520	104	√	
			5.540	108		*
			5.560	112		*
			5.580	116	√	
			5.600	120		*
			5.620	124	√	
			5.640	128		*
			5.660	132		*
			5.680	136	√	
			5.700	140		*
	DTS (15.247)	5.8 GHz	5.745	149	√	
			5.765	153		*
			5.785	157	√	
			5.805	161		*
			5.825	165	√	

√ = "default test channels"

* = possible 802.11a channels with maximum average output > 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.

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Measured Results

Band (GHz)	Mode	Data Rate	Ch #	Freq. (MHz)	Avg Pwr (dBm)	SAR Test (Yes/No)
5.2 (UNII)	802.11a	6 Mbps	36	5180	12.3	Yes
			40	5200	12.2	
			44	5220	12.2	
			48	5240	12.2	
	802.11n (HT20)	MCS0	36	5180	12.0	No
			40	5200	12.0	
			48	5240	12.0	
	802.11n (HT40)	MCS0	38	5190	11.0	No
			46	5230	11.0	
	802.11ac (HT20)	MCS0	36	5180	12.0	Yes
			40	5200	12.0	
			44	5220	12.0	
			48	5240	12.0	
	802.11ac (HT40)	MCS0	38	5190	11.0	No
			46	5230	11.0	
	802.11ac (HT80)	MCS0	42	5210	11.0	No
5.3 (UNII)	802.11a	6 Mbps	52	5260	12.2	Yes
			56	5280	12.2	
			60	5300	12.2	
			64	5320	12.3	
	802.11n (HT20)	MCS0	52	5260	12.0	No
			60	5300	12.0	
			64	5320	12.0	
	802.11n (HT40)	MCS0	54	5270	11.0	No
			62	5310	11.0	
	802.11ac (HT20)	MCS0	52	5260	12.0	Yes
			56	5280	12.0	
			60	5300	12.0	
			64	5320	12.0	
	802.11ac (HT40)	MCS0	54	5270	11.0	No
			62	5310	11.0	
	802.11ac (HT80)	MCS0	58	5290	11.0	No

Note(s):

Per KDB 248227, SAR is not required for 802.11n HT20/HT40 channels when the maximum average output power is less than 1/4 dB higher than that measured on the corresponding 802.11a channels.

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Band (GHz)	Mode	Mode	Ch #	Freq. (MHz)	Avg Pwr (dBm)	SAR Test (Yes/No)
5.5 (UNII)	802.11a	6 Mbps	100	5500	12.0	Yes
			104	5520	12.0	
			108	5540	12.0	
			112	5560	12.0	
			116	5580	12.0	
			120	5600	12.0	
			124	5620	12.0	
			128	5640	12.0	
			132	5660	12.0	
			136	5680	12.0	
			140	5700	12.0	
	802.11n (HT20)	MCS0	100	5500	12.0	No
			116	5580	12.0	
			140	5700	12.0	
	802.11n (HT40)	MCS0	102	5510	11.0	No
			110	5550	11.0	
			134	5670	11.0	
	802.11ac (HT20)	MCS0	100	5500	12.0	Yes
			116	5580	12.0	
			140	5700	12.0	
	802.11ac (HT40)	MCS0	134	5670	11.0	No
			142	5710	11.0	
	802.11ac (HT80)	MCS0	106	5530	11.0	No
			138	5690	11.0	
5.8 (DTS)	802.11a	6 Mbps	149	5745	12.4	Yes
			153	5765	12.3	
			157	5785	12.3	
			161	5805	12.3	
			165	5825	12.3	
	802.11n (HT20)	MCS0	149	5745	12.0	No
			157	5785	12.0	
			161	5805	12.0	
	802.11n (HT40)	MCS0	151	5755	11.0	No
			159	5795	11.0	
	802.11ac (HT20)	MCS0	149	5745	12.0	Yes
			157	5785	12.0	
			165	5825	12.0	
	802.11ac (HT40)	MCS0	151	5755	11.0	No
			159	5795	11.0	
	802.11ac (HT80)	MCS0	155	5775	11.0	No

Note(s):

Per KDB 248227, SAR is not required for 802.11n HT20/HT40 channels when the maximum average output power is less than 1/4 dB higher than that measured on the corresponding 802.11a channels.

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Power measurements to determine worst-case data rates

Band	Mode	Ch #	Freq. (MHz)	Data Rate	Avg Pwr (dBm)	SAR test (Yes/No)
5.2 GHz (UNII)	802.11a	36	5180	6 Mbps	12.3	Yes
				9 Mbps	12.3	No
				12 Mbps	12.2	No
				18 Mbps	12.2	No
				24 Mbps	12.0	No
				36 Mbps	12.0	No
				48 Mbps	12.0	No
				54 Mbps	12.0	No
5.3 GHz (UNII)	802.11a	64	5320	6 Mbps	12.3	Yes
				9 Mbps	12.2	No
				12 Mbps	12.2	No
				18 Mbps	12.1	No
				24 Mbps	12.1	No
				36 Mbps	12.1	No
				48 Mbps	12.1	No
				54 Mbps	12.1	No
5.5 GHz (UNII)	802.11a	124	12.3	6 Mbps	12.0	Yes
				9 Mbps	12.0	No
				12 Mbps	12.0	No
				18 Mbps	12.0	No
				24 Mbps	12.0	No
				36 Mbps	12.0	No
				48 Mbps	12.0	No
				54 Mbps	12.0	No
5.8 GHz (DTS)	802.11a	149	5745	6 Mbps	12.4	Yes
				9 Mbps	12.2	No
				12 Mbps	12.2	No
				18 Mbps	12.3	No
				24 Mbps	12.3	No
				36 Mbps	12.3	No
				48 Mbps	12.3	No
				54 Mbps	12.3	No

9.4. Bluetooth

Maximum tune-up tolerance limit is 10.5 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.

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10. Tissue Dielectric Properties

IEEE Std 1528-2013

Target Frequency (MHz)	Head	
	ε_r	σ (S/m)
300	45.3	0.87
450	43.5	0.87
750	41.9	0.89
835	41.5	0.90
900	41.5	0.97
1450	40.5	1.20
1500	40.4	1.23
1640	40.2	1.31
1750	40.1	1.37
1800	40.0	1.40
1900	40.0	1.40
2000	40.0	1.40
2100	39.8	1.49
2300	39.5	1.67
2450	39.2	1.80
2600	39.0	1.96
3000	38.5	2.40
3500	37.9	2.91
4000	37.4	3.43
4500	36.8	3.94
5000	36.2	4.45
5200	36.0	4.66
5400	35.8	4.86
5600	35.5	5.07
5800	35.3	5.27
600	35.1	5.48

NOTE—For convenience, permittivity and conductivity values at some frequencies that are not part of the original data from Drossos et al. [B60] or the extension to 5800 MHz are provided (i.e., the values shown in italics). These values were linearly interpolated between the values in this table that are immediately above and below these values, except the values at 6000 MHz that were linearly extrapolated from the values at 3000 MHz and 5800 MHz.

FCC OET Bulletin 65 Supplement C 01-01

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

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10.1. Composition of Ingredients for the Tissue Material Used in the SAR Tests

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

Ingredients (% by weight)	Frequency (MHz)									
	450		835		915		1900		2450	
Tissue Type	Head	Body	Head	Body	Head	Body	Head	Body	Head	Body
Water	38.56	51.16	41.45	52.4	41.05	56.0	54.9	40.4	62.7	73.2
Salt (NaCl)	3.95	1.49	1.45	1.4	1.35	0.76	0.18	0.5	0.5	0.04
Sugar	56.32	46.78	56.0	45.0	56.5	41.76	0.0	58.0	0.0	0.0
HEC	0.98	0.52	1.0	1.0	1.0	1.21	0.0	1.0	0.0	0.0
Bactericide	0.19	0.05	0.1	0.1	0.1	0.27	0.0	0.1	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	36.8	0.0
DGBE	0.0	0.0	0.0	0.0	0.0	0.0	44.92	0.0	0.0	26.7
Dielectric Constant	43.42	58.0	42.54	56.1	42.0	56.8	39.9	54.0	39.8	52.5
Conductivity (S/m)	0.85	0.83	0.91	0.95	1.0	1.07	1.42	1.45	1.88	1.78

Salt: 99+% Pure Sodium Chloride Sugar: 98+% Pure Sucrose
Water: De-ionized, 16 MΩ+ resistivity HEC: Hydroxyethyl Cellulose
DGBE: 99+% Di(ethylene glycol) butyl ether, [2-(2-butoxyethoxy)ethanol]
Triton X-100 (ultra pure): Polyethylene glycol mono [4-(1,1, 3, 3-tetramethylbutyl)phenyl]ether

MSL/HSL750 (Body and Head liquids for 700 – 800 MHz)

Item	Head Tissue Simulation Liquids HSL750 Muscle (body) Tissue Simulation Liquids MSL750
Type No	SL AAH 075
Manufacturer	SPEAG
The item is composed of the following ingredients:	
H^2O	Water, 35 – 58%
Sucrese	Sugar, white, refined, 40-60%
NaCl	Sodium Chloride, 0-6%
Hydroxyethel-cellulsoe	Medium Viscosity (CAS# 9004-62-0), <0.3%
Preventol-D7	Preservative: aqueous preparation, (CAS# 55965-84-9), containing 5-chloro-2-methyl-3(2H)-isothiazolone and 2-methyyl-3(2H)-isothiazolone, 0.1-0.7%

MSL/HSL1750 (Body and Head liquids for 1700 – 1800 MHz)

Item	Head Tissue Simulation Liquids HSL1750 Muscle (body) Tissue Simulation Liquids MSL1750
Type No	SL AAM 175
Manufacturer	SPEAG
-The item is composed of the following ingredients:	
H^2O	Water, 52 – 75%
C8H18O3	Diethylene glycol monobutyl ether (DGBE), 25-48%
NaCl	Sodium Chloride, <1.0%

Simulating Liquids for 5 GHz, Manufactured by SPEAG

Ingredients	(% by weight)
Water	78
Mineral oil	11
Emulsifiers	9
Additives and Salt	2

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10.2. Tissue Dielectric Parameter Check 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 Room 1

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
1/21/2014	Body 1900	e'	53.1500	Relative Permittivity (ε_r):	53.15	53.30	-0.28	5
		e''	14.5900	Conductivity (σ):	1.54	1.52	1.41	5
	Body 1850	e'	53.3500	Relative Permittivity (ε_r):	53.35	53.30	0.09	5
		e''	14.4900	Conductivity (σ):	1.49	1.52	-1.94	5
	Body 1910	e'	53.1300	Relative Permittivity (ε_r):	53.13	53.30	-0.32	5
		e''	14.6000	Conductivity (σ):	1.55	1.52	2.01	5
1/23/2014	Body 5180	e'	47.6800	Relative Permittivity (ε_r):	47.68	49.05	-2.79	5
		e''	18.7000	Conductivity (σ):	5.39	5.27	2.18	5
	Body 5200	e'	47.6400	Relative Permittivity (ε_r):	47.64	49.02	-2.81	5
		e''	18.7800	Conductivity (σ):	5.43	5.29	2.55	5
	Body 5600	e'	46.9900	Relative Permittivity (ε_r):	46.99	48.48	-3.07	5
		e''	19.0800	Conductivity (σ):	5.94	5.76	3.13	5
	Body 5800	e'	46.7300	Relative Permittivity (ε_r):	46.73	48.20	-3.05	5
		e''	19.3100	Conductivity (σ):	6.23	6.00	3.79	5
	Body 5825	e'	46.6400	Relative Permittivity (ε_r):	46.64	48.20	-3.24	5
		e''	19.3100	Conductivity (σ):	6.25	6.00	4.24	5
1/24/2014	Head 1900	e'	40.7100	Relative Permittivity (ε_r):	40.71	40.00	1.78	5
		e''	13.3100	Conductivity (σ):	1.41	1.40	0.44	5
	Head 1850	e'	40.9500	Relative Permittivity (ε_r):	40.95	40.00	2.38	5
		e''	13.1500	Conductivity (σ):	1.35	1.40	-3.38	5
	Head 1910	e'	40.6700	Relative Permittivity (ε_r):	40.67	40.00	1.68	5
		e''	13.3500	Conductivity (σ):	1.42	1.40	1.27	5
1/15/2014	Head 5180	e'	36.4800	Relative Permittivity (ε_r):	36.48	36.01	1.30	5
		e''	15.4000	Conductivity (σ):	4.44	4.63	-4.21	5
	Head 5200	e'	36.4500	Relative Permittivity (ε_r):	36.45	35.99	1.28	5
		e''	15.4000	Conductivity (σ):	4.45	4.65	-4.26	5
	Head 5600	e'	35.9300	Relative Permittivity (ε_r):	35.93	35.53	1.11	5
		e''	15.6000	Conductivity (σ):	4.86	5.06	-4.01	5
	Head 5800	e'	35.7000	Relative Permittivity (ε_r):	35.70	35.30	1.13	5
		e''	15.7200	Conductivity (σ):	5.07	5.27	-3.80	5
	Head 5825	e'	35.6600	Relative Permittivity (ε_r):	35.66	35.30	1.02	5
		e''	15.7200	Conductivity (σ):	5.09	5.27	-3.39	5

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SAR Room 2

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
1/23/2014	Head 5180	e'	35.8100	Relative Permittivity (ε_r):	35.81	36.01	-0.56	5
		e"	15.3700	Conductivity (σ):	4.43	4.63	-4.40	5
	Head 5200	e'	35.7700	Relative Permittivity (ε_r):	35.77	35.99	-0.61	5
		e"	15.4000	Conductivity (σ):	4.45	4.65	-4.26	5
	Head 5600	e'	35.2400	Relative Permittivity (ε_r):	35.24	35.53	-0.83	5
		e"	15.5400	Conductivity (σ):	4.84	5.06	-4.38	5
	Head 5800	e'	35.0300	Relative Permittivity (ε_r):	35.03	35.30	-0.76	5
		e"	15.6700	Conductivity (σ):	5.05	5.27	-4.11	5
	Head 5825	e'	34.9800	Relative Permittivity (ε_r):	34.98	35.30	-0.91	5
		e"	15.6500	Conductivity (σ):	5.07	5.27	-3.82	5

SAR Room 3

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
1/14/2014	Body 2450	e'	51.6000	Relative Permittivity (ε_r):	51.60	52.70	-2.09	5
		e"	14.7700	Conductivity (σ):	2.01	1.95	3.18	5
	Body 2410	e'	51.7700	Relative Permittivity (ε_r):	51.77	52.76	-1.88	5
		e"	14.5900	Conductivity (σ):	1.96	1.91	2.50	5
	Body 2475	e'	51.5100	Relative Permittivity (ε_r):	51.51	52.67	-2.20	5
		e"	14.8300	Conductivity (σ):	2.04	1.99	2.81	5
1/14/2014	Head 2450	e'	40.0000	Relative Permittivity (ε_r):	40.00	39.20	2.04	5
		e"	13.5700	Conductivity (σ):	1.85	1.80	2.70	5
	Head 2410	e'	40.1500	Relative Permittivity (ε_r):	40.15	39.28	2.22	5
		e"	13.4300	Conductivity (σ):	1.80	1.76	2.23	5
	Head 2475	e'	39.9200	Relative Permittivity (ε_r):	39.92	39.17	1.92	5
		e"	13.6000	Conductivity (σ):	1.87	1.83	2.44	5

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11. System Performance 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.

11.1. 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 ± 0.5 cm for SAR measurements ≤ 3 GHz and ≥ 10.0 cm ± 0.5 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.

11.2. Reference SAR Values for System Performance Check

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 (mW/g)		
				1g/10g	Head	Body
D1900V2	5d140	04/18/2013	1900	1g	41.2	41.5
				10g	21.5	22.0
D2450V2	706	05/29/2013	2450	1g	53.7	49.9
				10g	25.0	23.3
D5GHzV2	1138	11/19/2013	5200	1g	78.5	72.9
				10g	22.5	20.4
			5600	1g	82.7	78.3
				10g	23.5	21.7
			5800	1g	78.3	72.8
				10g	22.4	20.1
D5GHzV2	1168	12/12/2013	5200	1g	79.3	75.2
				10g	22.7	21
			5600	1g	85.3	80.6
				10g	24.3	22.3
			5800	1g	81	75.7
				10g	22.9	20.9

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11.3. System Performance 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 Room 1

Date Tested	System Dipole		T.S. Liquid		Measured Results			Target (Ref. Value)	Delta ±10 %	Est./Zoom Ratio ±3 %	Plot No.
	Type	Serial #			Area Scan	Zoom Scan	Normalize to 1 W				
1/21/2014	D1900V2	5d140	Body	1g	4.16	4.09	40.90	41.50	-1.45	1.68	1, 2
				10g	2.11	2.13	21.30	22.00	-3.18		
1/23/2014	D5GHzV2 (5200)	1138	Body	1g	9.07	7.58	75.80	72.90	3.98	16.43	
				10g	2.50	2.15	21.50	20.40	5.39		
1/23/2014	D5GHzV2 (5600)	1138	Body	1g	7.21	7.61	76.10	78.30	-2.81	-5.55	
				10g	1.95	2.13	21.30	21.70	-1.84		
1/23/2014	D5GHzV2 (5800)	1138	Body	1g	8.33	7.71	77.10	72.8	5.91	7.44	3, 4
				10g	2.23	2.16	21.60	20.1	7.46		
1/24/2014	D1900V2	5d140	Head	1g	4.31	4.24	42.4	41.20	2.91	1.62	
				10g	2.20	2.21	22.1	21.50	2.79		

SAR Room 2

Date Tested	System Dipole		T.S. Liquid		Measured Results			Target (Ref. Value)	Delta ±10 %	Est./Zoom Ratio ±3 %	Plot No.
	Type	Serial #			Area Scan	Zoom Scan	Normalize to 1 W				
1/23/2014	D5GHzV2 (5200)	1168	Head	1g	7.16	7.49	74.9	79.3	-5.55	-4.61	
				10g	2.00	2.15	21.5	22.7	-5.29		
1/23/2014	D5GHzV2 (5600)	1168	Head	1g	8.65	9.16	91.6	85.3	7.39	-5.90	5, 6
				10g	2.40	2.61	26.1	24.3	7.41		
1/23/2014	D5GHzV2 (5800)	1168	Head	1g	8.7	8.08	80.8	81	-0.25	7.13	
				10g	2.41	2.3	23.0	22.9	0.44		
1/15/2014	D5GHzV2 (5200)	1138	Head	1g	7.61	7.99	79.9	78.5	1.78	-4.99	
				10g	2.09	2.30	23.0	22.5	2.22		
1/15/2014	D5GHzV2 (5600)	1138	Head	1g	7.69	8.37	83.7	82.7	1.21	-8.84	
				10g	2.16	2.38	23.8	23.5	1.28		
1/15/2014	D5GHzV2 (5800)	1138	Head	1g	7.67	8.28	82.8	78.3	5.75	-7.95	7, 8
				10g	2.13	2.36	23.6	22.4	5.36		

SAR Room 3

Date Tested	System Dipole		T.S. Liquid		Measured Results			Target (Ref. Value)	Delta ±10 %	Est./Zoom Ratio ±3 %	Plot No.
	Type	Serial #			Area Scan	Zoom Scan	Normalize to 1 W				
1/14/2014	D2450V2	706	Body	1g	5.17	5.17	51.7	49.00	5.51	0.00	9, 10
				10g	2.19	2.38	23.8	23.30	2.15		
1/14/2014	D2450V2	706	Head	1g	5.42	5.34	53.4	53.70	-0.56	1.48	
				10g	2.38	2.41	24.1	25.00	-3.60		

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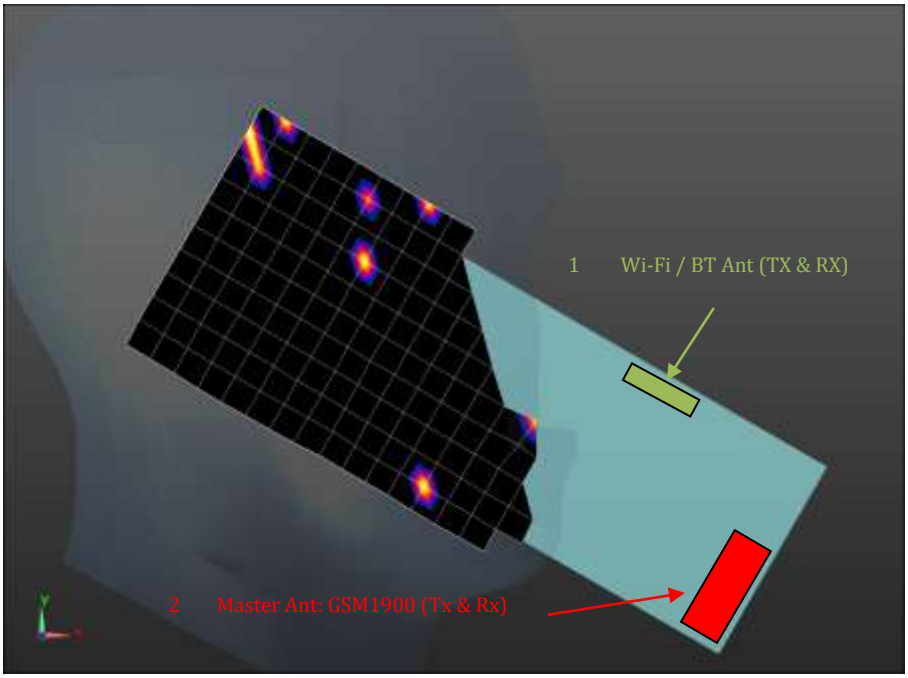
12. SAR Test Results

Justification for using Flat Phantom Measuring Head SAR

Due to the EUT with antenna located near the bottom and lower side edges near the mouth and jaw regions. The following head SAR plot is provided to show the measurements with truncated SAR distributions in the head measured with the SAM Phantom.



The following procedure was applied (KDB 648474 D04 Handset SAR v01r01):

- The phone was positioned with a separation distance of <4 mm between the ear reference point (ERP) and the outer surface of the flat phantom shell.
- While maintaining this distance at the ERP location of the phone, the low (bottom) edge of the phone is lowered from the phantom to establish the same separation distance at the peak SAR location identified by the truncated partial SAR distribution measured with the SAM phantom.
- The distance from the peak SAR location to the phone should be determined by the straight line passing perpendicularly through the phantom surface.

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12.1. GSM1900

RF Exposure Conditions	Test Position	Mode	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		Plot No.
						Tune-up limit	Meas.	Meas.	Scaled	
Head	Flat Phantom	Voice	7	661	1880.0	29.5	29.5	0.363	0.363	
Head (VoIP)	Flat Phantom	GPRS 2 Slots	7	661	1880.0	29.5	29.5	0.519	0.519	11
Body-worm	Rear	Voice	10	661	1880.0	30.5	30.2	0.405	0.434	12
	Front			661	1880.0	30.5	30.2	0.089	0.095	
Body (VoIP) & Hotspot	Rear	GPRS 2 Slots	10	661	1880.0	29.5	29.5	0.635	**0.635**	13
	Front			661	1880.0	29.5	29.5	0.163	0.163	
Hotspot	Edge 3			661	1880.0	29.5	29.5	0.355	0.355	
	Edge 4			661	1880.0	29.5	29.5	0.219	0.219	

Note(s):

1. 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
2. With headset attached. According to KDB 648474 Section 2.3, 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.

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12.2. Wi-Fi (DTS Band)

RF Exposure Conditions	Test Position	Mode	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		Plot No.
						Tune-up limit	Meas.	Meas.	Scaled	
Head	Flat Phantom	802.11b	7	6	2437.0	18.5	18.1	0.041	**0.045**	14
Body & Hotspot	Rear	802.11b	10	6	2437.0	18.5	18.1	0.141	0.155	15
	Front			6	2437.0	18.5	18.1	0.019	0.021	
Hotspot	Edge 1	802.11b	10	6	2437.0	18.5	18.1	0.083	0.090	
	Edge 2			6	2437.0	18.5	18.1	0.032	0.035	

RF Exposure Conditions	Test Position	Mode	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		Plot No.
						Tune-up limit	Meas.	Meas.	Scaled	
Head	Flat Phantom	802.11a	7	149	5745.0	12.5	12.4	0.016	0.016	16
Body-worm	Rear		10	149	5745.0	12.5	12.4	0.469	**0.480**	17
	Front			149	5745.0	12.5	12.4	<0.001	<0.001	
Head	Flat Phantom	802.11ac (20MHz)	7	149	5745.0	12.5	12.0	0.016	0.018	
Body-worm	Rear		10	149	5745.0	12.5	12.0	0.424	0.476	

12.3. Wi-Fi (UNII Band)

RF Exposure Conditions	Test Position	Mode	Dist. (mm)	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		Plot No.
						Tune-up limit	Meas.	Meas.	Scaled	
Head	Flat Phantom	802.11a	7	36	5180	12.5	12.3	0.033	0.035	18
				64	5320	12.5	12.3	0.038	0.040	19
				124	5620	12.5	12.0	0.088	**0.099**	20
Body-worm	Rear	802.11a	10	36	5180	12.5	12.3	0.184	0.193	21
				64	5320	12.5	12.3	0.377	0.395	22
				104	5520	12.5	12.0	0.391	0.439	
				116	5580	12.5	12.0	0.420	0.471	
				124	5620	12.5	12.0	0.454	**0.509**	23
				136	5680	12.5	12.0	0.423	0.475	
	Front	802.11a	10	36	5180	12.5	12.3	<0.001	<0.001	
				64	5320	12.5	12.3	<0.001	<0.001	
				124	5620	12.5	12.3	<0.001	<0.001	
Head	Flat Phantom	802.11ac (20MHz)	7	36	5180	12.5	12.0	<0.001	<0.001	
				64	5320	12.5	12.0	0.007	0.008	
				124	5620	12.5	12.0	0.018	0.021	
Body-worm	Rear	802.11ac (20MHz)	10	36	5180	12.5	12.0	0.130	0.146	
				64	5320	12.5	12.0	0.346	0.388	
				124	5620	12.5	12.0	0.450	0.505	

Note(s):

1. 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
2. Apply usual 802.11 test exclusion considerations, but include 802.11ac SAR for highest 802.11a configuration in each frequency band and each exposure condition according to April 2013 TCB Workshop Updates.

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12.4. Bluetooth

12.4.1. 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.

Body-worn Accessory Exposure Conditions

Max. tune-up tolerance limit		Min. test separation distance (mm)	Frequency (GHz)	Result
(dBm)	(mW)			
10.5	11	10	2.480	1.8

Conclusion:

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

12.4.2. Estimated SAR

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.

Estimated SAR Result for Body-worn Accessory Conditions:

Test Configuration	Max. tune-up tolerance limit (mW)	Min. test separation distance (mm)	Frequency (GHz)	Estimated 1-g SAR (W/kg)
Rear/Front	11	10	2.480	0.231

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13. SAR Measurement Variability

In accordance with published RF Exposure KDB procedure 865664 D01 SAR measurement 100 MHz to 6 GHz v01r01. 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.

13.1. The Highest Measured SAR Configuration in Each Frequency Band

Frequency Band (MHz)	Air Interface	Head (W/kg)	Body-worn Accessory (W/kg)	Hotspot/Wi-Fi Direct (W/kg)
1900	GSM 1900		0.635 W/kg	
2400	Wi-Fi 802.11b/g/n		0.141 W/kg	
5200	Wi-Fi 802.11a/n/ac		0.184W/kg	
5300	Wi-Fi 802.11a/n/ac		0.377 W/kg	
5500	Wi-Fi 802.11a/n/ac		0.454 W/kg	
5800	Wi-Fi 802.11a/n/ac		0.469 W/kg	

13.2. Repeated Measurement Results

Head Exposure Condition
Not Applicable.

Body-worn Accessory Exposure Condition
Not Applicable.

Hotspot Mode Exposure Conditions
Not Applicable.

Note(s):
1. 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.

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14. Simultaneous Transmission SAR Analysis

KDB 447498 D01 General RF Exposure Guidance v05, 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 $[(x_1-x_2)^2 + (y_1-y_2)^2 + (z_1-z_2)^2]$

A new threshold of 0.04 is also introduced in the draft KDB. Thus, 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:

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

14.1. Sum of the SAR for GSM1900 & Wi-Fi & BT

RF Exposure conditions	Test Position	Simultaneous Transmission Scenario				∑ 1-g SAR (mW/g)	SPLSR (Yes/ No)
		GSM 1900	WiFi DTS Band	WiFi UNII Band	Bluetooth		
Head	Flat Phantom	0.519	0.045			0.564	No
		0.519		0.099		0.618	No
Body-worn Accessory & Hotspot	Rear	0.635	0.480			**1.115**	No
		0.635		0.509		**1.144**	No
		0.635			0.231	0.866	No
	Front	0.163	0.021			0.184	No
		0.163		0.001		0.164	No
		0.163			0.231	0.394	No
Hotspot	Edge 1	0.000	0.090			0.090	No
	Edge 2	0.000	0.035			0.035	No
	Edge 3	0.355				0.355	No
	Edge 4	0.219				0.219	No

SAR to Peak Location Separation Ratio (SPLSR)

As the Sum of the SAR is not greater than 1.6 W/kg SPLSR assessment is not required.

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15. Appendixes

Refer to separated files for the following appendixes.

15.1. Photos and Antenna Locations

15.2. System Performance Check Plots

15.3. Highest SAR Test Plots

15.4. Calibration Certificate for E-Field Probe EX3DV4 - SN 3773

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

15.6. Calibration Certificate for E-Field Probe EX3DV4 - SN 3929

15.7. Calibration Certificate for D1900V2- SN 5d140

15.8. Calibration Certificate for D2450V2 - SN 706

15.9. Calibration Certificate for D5GHzV2 - SN 1138

15.10. Calibration Certificate for D5GHzV2 - SN 1168

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