



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

SAR EVALUATION REPORT

For
GSM/WCDMA/CDMA/LTE Phone + Bluetooth, WLAN 2.4GHz b/g/n, ANT+ and NFC

**Model: SM-G3589W
FCC ID: A3LSMG3589W**

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1. Attestation of Test Results

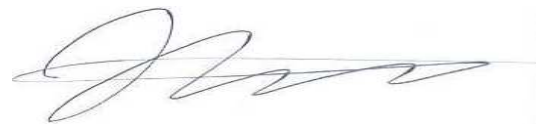
Applicant	Samsung Electronics Co., Ltd.			
DUT description	GSM/WCDMA/CDMA/LTE Phone + Bluetooth, WLAN 2.4GHz b/g/n, ANT+ and NFC			
Model	SM-G3589W			
Test device is	An identical prototype			
Device category	Portable			
Exposure category	General Population/Uncontrolled Exposure			
Date tested	05/13/2014 – 05/25/2014			
The highest reported SAR values	RF exposure condition	Licensed	DTS	UNII
	Head	1.050 W/kg	0.525 W/kg	NA
	Body-worn Accessory	0.764 W/kg	0.274 W/kg	NA
	Wireless Router (Hotspot)	0.764 W/kg	0.274 W/kg	NA
	Simultaneous Transmission	1.539 W/kg		NA
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.

Approved & Released By:

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UL Verification Services Inc.

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:

- o 447498 D01 General RF Exposure Guidance v05r02
- o 648474 D04 Handset SAR v01r02
- o 941225 D01 SAR test for 3G devices v02
- o 941225 D02 HSPA and 1x Advanced v02r02
- o 941225 D03 SAR Test Reduction GSM GPRS EDGE v01
- o 941225 D04 SAR for GSM E GPRS Dual Xfer Mode v01
- o 941225 D05 SAR for LTE Devices v02r03
- o 941225 D06 Hotspot Mode SAR v01r01
- o 248227 D01 SAR Meas for 802 11abg v01r02
- o 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r03
- o 865664 D02 SAR Reporting v01r01
- o 690783 D01 SAR Listings on Grants v01r03

3. Facilities and Accreditation

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

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

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

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

System Performance Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Synthesized Signal Generator	Agilent	8665B	3438A00633	6/13/2014
Power Meter	HP	438A	2822A05684	10/10/2014
Power Sensor	HP	8481A	2237A31744	10/2/2014
Power Sensor	HP	8481A	2349A36506	9/30/2014
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1808939	N/A
Directional coupler	Werlatone	C8060-102	2710	N/A
DC Power Supply	AMETEK	XT-15-4	1319A02778	N/A
Thermometer	Control Company	4242	122529162	9/19/2014
E-Field Probe	SPEAG	EX3DV4	3936	7/22/2014
Data Acquisition Electronics	SPEAG	DAE4	1380	7/15/2014
System Validation Dipole	SPEAG	D835V2	4d002	11/15/2014
System Validation Dipole	SPEAG	D1900V2	5d163	9/17/2014
System Validation Dipole	SPEAG	D2450V2	899	9/10/2014
System Validation Dipole	SPEAG	D2600V2	1006	9/11/2014

Others

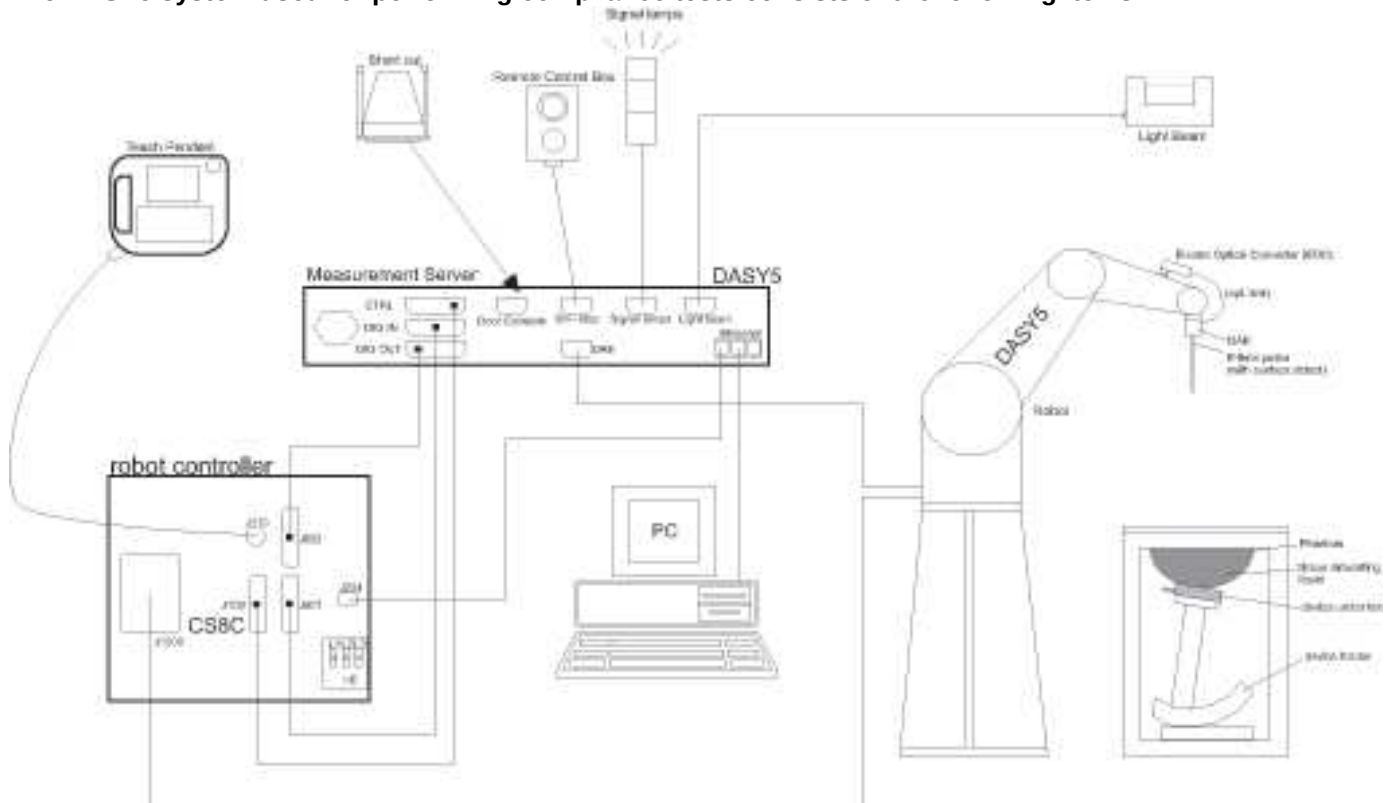
Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Base Station Simulator	R & S	CMU200	8281141032	7/23/2014
Base Station Simulator	R & S	CMW500	124595-SS	7/25/2014
Power Meter	Agilent	N1912A	MY53040015	6/29/2014
Power Sensor	Agilent	N1921A	MY52020012	9/25/2014

4.2. 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.

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.

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

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 1 mm	$\frac{1}{2} \cdot \delta \cdot \ln(2) \pm 0.5$ mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	$30^\circ \pm 1^\circ$	$20^\circ \pm 1^\circ$
Maximum area scan spatial resolution: $\Delta x_{\text{Area}}, \Delta y_{\text{Area}}$	≤ 2 GHz: ≤ 15 mm $2 - 3$ GHz: ≤ 12 mm	$3 - 4$ GHz: ≤ 12 mm $4 - 6$ GHz: ≤ 10 mm
	When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be $\leq$ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	

Step 3: Zoom Scan

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

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

			≤ 3 GHz	> 3 GHz
Maximum zoom scan spatial resolution: $\Delta x_{\text{Zoom}}, \Delta y_{\text{Zoom}}$			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{\text{Zoom}}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{\text{Zoom}}(1)$: between 1 st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{\text{Zoom}}(n>1)$: between subsequent points	$\leq 1.5 \cdot \Delta z_{\text{Zoom}}(n-1)$	
Minimum zoom scan volume	x, y, z		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm
Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.				
* When zoom scan is required and the <i>reported</i> SAR from the area scan based <i>1-g SAR estimation</i> procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.				

Step 4: Power drift measurement

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

Step 5: Z-Scan (FCC only)

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

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.

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 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)
Device dimension	Overall (Length x Width): 133.2 mm x 70.2mm Overall Diagonal: 139.8mm Display Diagonal: 117.4mm
Back Cover	☒ Normal Battery Cover ☐ Normal Battery Cover with NFC ☐ Wireless Charger Battery Cover ☐ Wireless Charger Battery Cover with NFC
Accessory	☒ Headset
Battery Options	☒ Standard – Lithium-ion battery, Rating 3.8Vdc, 7.6Wh ☐ Extended (large capacity)

7.2. Wireless Technologies

Wireless Technology and Frequency Bands	GSM: 850 / 1900 W-CDMA Band: V / II LTE Band 41 Wi-Fi : 2.4 GHz Bluetooth: 2.4 GHz.
Mode	GSM - ☒ Voice (GMSK) - ☒ GPRS (GMSK) - ☒ EGPRS (8PSK) W-CDMA - ☒ UMTS Rel. 99 (Voice & Data) - ☒ HSDPA (Rel. 5) - ☒ HSUPA (Rel. 6) - ☒ HSPA+ (Rel. 6) LTE - ☒ QPSK - ☒ 16QAM Wi-Fi 2.4GHz (802.11b/g/n) - ☒ 802.11b - ☒ 802.11g - ☒ 802.11n (HT20) 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%, W-CDMA: 100% LTE (TDD): 63.33% Duty Cycle Wi-Fi 802.11a/b/g/n: 100% Bluetooth: 32.25% (DH1), 66.68% (DH3), 77.52% (DH5)
GPRS Multi-Slot Class	☐ Class 8 - One Up ☐ Class 10 - Two Up ☐ Class 12 - Four Up ☒ Class 33 - Four Up
DTM (Dual Transfer Mode)	☐ Supported
VoIP (GPRS)	☒ Supported
SV-LTE & SV-DO	☐ Supported

7.3. RF Output Power Tolerance

Upper limit (dB): 0.5 ~ -1.5		RF Output Power (dBm)	
RF Air interface	Mode	Target	Max. tune-up tolerance limit
GSM850	Voice	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	27.5	28.0
	EGPRS 1 slot	27.0	27.5
	EGPRS 2 slots	26.0	26.5
	EGPRS 3 slots	25.0	25.5
	EGPRS 4 slots	23.5	24.0
GSM1900	Voice	29.5	30.0
	GPRS 1 slot	29.5	30.0
	GPRS 2 slots	27.0	27.5
	GPRS 3 slots	25.0	25.5
	GPRS 4 slots	23.5	24.0
	EGPRS 1 slot	26.0	26.5
	EGPRS 2 slots	25.0	25.5
	EGPRS 3 slots	24.0	24.5
	EGPRS 4 slots	22.5	23.0
W-CDMA Band V	R99	22.5	23.0
	HSDPA	22.5	23.0
	HSUPA	22.5	23.0
W-CDMA Band II	R99	22.5	23.0
	HSDPA	22.5	23.0
	HSUPA	22.5	23.0
LTE Band 41	QPSK	23.0	23.5

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	16.0	16.5
	802.11g	14.0	14.5
	802.11n HT20	13.0	13.5

Upper limit (dB): 0.5		RF Output Power (dBm)	
RF Air interface	Mode	Target	Max. tune-up tolerance limit
Bluetooth		11.0	11.5
Bluetooth LE		3.0	3.5

7.4. Simultaneous Transmission Condition

RF Exposure Condition	Capable Transmit Configurations
Head	- GSM 850/1900 Voice + Wi-Fi 2.4GHz - GSM 850/1900 (GPRS/EDGE) + Wi-Fi 2.4GHz (VoIP) - WCDMA Band V/II + Wi-Fi 2.4GHz - LTE B41 + Wi-Fi 2.4GHz
Body-worn Accessory	- GSM 850/1900 Voice + Wi-Fi 2.4GHz - GSM 850/1900 Voice + BT - GSM 850/1900 (GPRS/EDGE) + Wi-Fi 2.4GHz (VoIP) - GSM 850/1900 (GPRS/EDGE) + BT(VoIP) - WCDMA Band V/II + Wi-Fi 2.4GHz - WCDMA Band V/II + BT - LTE B41 + Wi-Fi 2.4GHz - LTE B41 + BT
Wireless Router (Hotspot) & Wi-Fi Direct	- GSM 850/1900 (GPRS/EDGE) + Wi-Fi 2.4GHz - WCDMA Band V/II + Wi-Fi 2.4GHz - LTE B41 + Wi-Fi 2.4GHz
Notes: - Wi-Fi 2.4GHz supports Hotspot and Wi-Fi Direct. - GPRS/EDGE, WCDMA, and LTE support Hotspot. - VoIP is support in GPRS/EDGE, WCDMA, and LTE. - Wi-Fi 2.4 GHz Radio cannot transmit simultaneously with Bluetooth Radio.	

7.5. General LTE SAR Test and Reporting Considerations

Item	Description																																												
	Band 41	Frequency range: Tx: 2496 to 2690 MHz - Rx: 2496 to 2690 MHz																																											
		Channel Bandwidth																																											
		20 MHz	15 MHz	10 MHz	5 MHz	3 MHz	1.4 MHz																																						
	Low	39750	39725	39700																																									
	Low-Mid	40185	40173	40160																																									
	Mid	40620	40620	40620																																									
	Mid-High	41055	41068	41080																																									
	High	41490	41515	41540																																									
LTE transmitter and antenna implementation	LTE has one TX/RX antenna and one Rx only antenna. Refer to Appendix “Antenna Locations and Separation Distances” for antenna locations																																												
Maximum power reduction (MPR)	Table 6.2.3-1: Maximum Power Reduction (MPR) for Power Class 3 <table><tr><th rowspan="2">Modulation</th><th colspan="6">Channel bandwidth / Transmission bandwidth (RB)</th><th rowspan="2">MPR (dB)</th></tr><tr><th>1.4 MHz</th><th>3.0 MHz</th><th>5 MHz</th><th>10 MHz</th><th>15 MHz</th><th>20 MHz</th></tr><tr><td>QPSK</td><td>> 5</td><td>> 4</td><td>> 8</td><td>> 12</td><td>> 16</td><td>> 18</td><td>≤ 1</td></tr><tr><td>16 QAM</td><td>≤ 5</td><td>≤ 4</td><td>≤ 8</td><td>≤ 12</td><td>≤ 16</td><td>≤ 18</td><td>≤ 1</td></tr><tr><td>16 QAM</td><td>> 5</td><td>> 4</td><td>> 8</td><td>> 12</td><td>> 16</td><td>> 18</td><td>≤ 2</td></tr></table> MPR Built-in by design A-MPR (additional MPR) was disabled during SAR testing							Modulation	Channel bandwidth / Transmission bandwidth (RB)						MPR (dB)	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz	QPSK	> 5	> 4	> 8	> 12	> 16	> 18	≤ 1	16 QAM	≤ 5	≤ 4	≤ 8	≤ 12	≤ 16	≤ 18	≤ 1	16 QAM	> 5	> 4	> 8	> 12	> 16	> 18	≤ 2
Modulation	Channel bandwidth / Transmission bandwidth (RB)						MPR (dB)																																						
	1.4 MHz	3.0 MHz	5 MHz	10 MHz	15 MHz	20 MHz																																							
QPSK	> 5	> 4	> 8	> 12	> 16	> 18	≤ 1																																						
16 QAM	≤ 5	≤ 4	≤ 8	≤ 12	≤ 16	≤ 18	≤ 1																																						
16 QAM	> 5	> 4	> 8	> 12	> 16	> 18	≤ 2																																						
Power reduction	No																																												
Spectrum plots for RB configurations	A properly configured base station simulator was used for the SAR and power measurements; therefore, spectrum plots for each RB allocation and offset configuration are not included in the SAR report.																																												

7.5.1. TDD LTE Considerations

According to KDB 941225 D05 SAR for LTE Devices v02r02, for Time-Division Duplex (TDD) systems, SAR must be tested using a fixed periodic duty factor according to the highest transmission duty factor implemented for the device and supported by the defined 3GPP LTE TDD configurations.

SAR was tested with the highest transmission duty factor (63.33%) using Uplink-downlink configuration 0 and Special subframe configuration 7.

LTE TDD Band 41 supports 3GPP TS 36.211 section 4.2 for Type 2 Frame Structure and Table 4.2-2 for uplink-downlink configurations and Table 4.2-1 for Special subframe configurations.

Table 4.2-1: Configuration of special subframe (lengths of DwPTS/GP/UpPTS).

Special subframe configuration	Normal cyclic prefix in downlink			Extended cyclic prefix in downlink		
	DwPTS	UpPTS		DwPTS	UpPTS	
		Normal cyclic prefix in uplink	Extended cyclic prefix in uplink		Normal cyclic prefix in uplink	Extended cyclic prefix in uplink
0	$6592 \cdot T_s$	$2192 \cdot T_s$	$2560 \cdot T_s$	$7680 \cdot T_s$	$2192 \cdot T_s$	$2560 \cdot T_s$
1	$19760 \cdot T_s$			$20480 \cdot T_s$		
2	$21952 \cdot T_s$			$23040 \cdot T_s$		
3	$24144 \cdot T_s$			$25600 \cdot T_s$		
4	$26336 \cdot T_s$	$4384 \cdot T_s$	$5120 \cdot T_s$	$7680 \cdot T_s$	$4384 \cdot T_s$	$5120 \cdot T_s$
5	$6592 \cdot T_s$			$20480 \cdot T_s$		
6	$19760 \cdot T_s$			$23040 \cdot T_s$		
7	$21952 \cdot T_s$			$12800 \cdot T_s$		
8	$24144 \cdot T_s$			-	-	-
9	$13168 \cdot T_s$			-	-	-

Table 4.2-2: Uplink-downlink configurations.

Uplink-downlink configuration	Downlink-to-Uplink Switch-point periodicity	Subframe number									
		0	1	2	3	4	5	6	7	8	9
0	5 ms	D	S	U	U	U	D	S	U	U	U
1	5 ms	D	S	U	U	D	D	S	U	U	D
2	5 ms	D	S	U	D	D	D	S	U	D	D
3	10 ms	D	S	U	U	U	D	D	D	D	D
4	10 ms	D	S	U	U	D	D	D	D	D	D
5	10 ms	D	S	U	D	D	D	D	D	D	D
6	5 ms	D	S	U	U	U	D	S	U	U	D

Calculated Duty Cycle

Uplink-Downlink Configuration	Downlink-to-Uplink Switch-point Periodicity	Subframe Number										Calculated Duty Cycle (%)
		0	1	2	3	4	5	6	7	8	9	
0	5 ms	D	S	U	U	U	D	S	U	U	U	63.33
1	5 ms	D	S	U	U	D	D	S	U	U	D	43.33
2	5 ms	D	S	U	D	D	D	S	U	D	D	23.33
3	10 ms	D	S	U	U	U	D	D	D	D	D	31.67
4	10 ms	D	S	U	U	D	D	D	D	D	D	21.67
5	10 ms	D	S	U	D	D	D	D	D	D	D	11.67
6	5 ms	D	S	U	U	U	D	S	U	U	D	53.33

Calculated Duty Cycle = Extended cyclic prefix in uplink $\times (T_s) \times \#$ of S + $\#$ of U

Example for Calculated Duty Cycle for Uplink-Downlink Configuration 0:

Calculated Duty Cycle = $5120 \times [1/(15000 \times 2048)] \times 2 + 6 \text{ ms} = 63.33\%$

where

$T_s = 1/(15000 \times 2048)$ seconds

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, LTE 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 and LTE and Wi-Fi

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

8.3. Hotspot Exposure Conditions and Wi-Fi Direct

For GSM850, W-CDMA Band V and LTE Band 41

Test Configurations	Antenna-to-edge/surface	SAR Required	Note
Rear	0.2 mm	Yes	
Front	3 mm	Yes	
Edge 1 (Top)	2 mm	Yes	
Edge 2 (Right)	55 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
Edge 3 (Bottom)	105 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
Edge 4 (Left)	1.4 mm	Yes	

For GSM1900 and W-CDMA Band II

Test Configurations	Antenna-to-edge/surface	SAR Required	Note
Rear	0.2 mm	Yes	
Front	3 mm	Yes	
Edge 1 (Top)	115 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
Edge 2 (Right)	9.8 mm	Yes	
Edge 3 (Bottom)	3 mm	Yes	
Edge 4 (Left)	15.3 mm	Yes	

For Wi-Fi

Test Configurations	Antenna-to-edge/surface	SAR Required	Note
Rear	0.2 mm	Yes	
Front	3 mm	Yes	
Edge 1 (Top)	2 mm	Yes	
Edge 2 (Right)	1.4 mm	Yes	
Edge 3 (Bottom)	110 mm	No	SAR is not required because the distance from the antenna to the edge is > 25 mm as per KDB 648474 D04 Handset SAR
Edge 4 (Left)	65 mm	No	SAR is not required because the distance from the antenna to the edge is > 25 mm as per KDB 648474 D04 Handset SAR

9. RF Output Power Measurement

9.1. GSM

Band	Mode	Coding Scheme	Time Slots	Ch No.	Freq. (MHz)	Burst Pwr (dBm)	Frame Pwr (dBm)
850	GSM (Voice)	CS1	1	128	824.2	32.9	23.9
				190	836.6	33.0	24.0
				251	848.8	33.0	24.0
	GPRS (GMSK)	CS1	1	128	824.2	32.9	23.9
				190	836.6	33.0	24.0
				251	848.8	33.0	24.0
			2	128	824.2	30.0	24.0
				190	836.6	30.1	24.1
				251	848.8	30.1	24.1
			3	128	824.2	28.2	23.9
				190	836.6	28.3	24.0
				251	848.8	28.3	24.1
			4	128	824.2	27.0	24.0
				190	836.6	27.1	24.1
				251	848.8	27.1	24.1
	EGPRS (8PSK)	MCS5	1	128	824.2	27.4	18.4
				190	836.6	27.5	18.5
				251	848.8	27.5	18.5
			2	128	824.2	26.4	20.4
				190	836.6	26.5	20.5
				251	848.8	26.5	20.5
			3	128	824.2	24.0	19.7
				190	836.6	24.0	19.7
				251	848.8	24.0	19.7
			4	128	824.2	23.6	20.6
				190	836.6	23.7	20.7
				251	848.8	23.7	20.7

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 4 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

Band	Mode	Coding Scheme	Time Slots	Ch No.	Freq. (MHz)	Burst Pwr (dBm)	Frame Pwr (dBm)
1900	GSM (Voice)	CS1	1	512	1850.2	29.9	20.9
				661	1880.0	30.0	21.0
				810	1909.8	30.0	21.0
	GPRS (GMSK)	CS1	1	512	1850.2	29.9	20.9
				661	1880.0	30.0	21.0
				810	1909.8	30.0	21.0
			2	512	1850.2	27.2	21.2
				661	1880.0	27.3	21.2
				810	1909.8	27.3	21.3
			3	512	1850.2	24.9	20.6
				661	1880.0	25.0	20.7
				810	1909.8	24.9	20.6
			4	512	1850.2	23.5	20.5
				661	1880.0	23.6	20.5
				810	1909.8	23.5	20.5
	EGPRS (8PSK)	MCS5	1	512	1850.2	25.9	16.9
				661	1880.0	26.0	17.0
				810	1909.8	26.0	17.0
			2	512	1850.2	25.4	19.4
				661	1880.0	25.5	19.5
				810	1909.8	25.5	19.5
			3	512	1850.2	22.7	18.4
				661	1880.0	22.8	18.5
				810	1909.8	22.8	18.5
			4	512	1850.2	22.6	19.6
				661	1880.0	22.7	19.7
				810	1909.8	22.6	19.6

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

9.2. W-CDMA

Release 99

The following tests were completed according to the test requirements outlined in section 5.2 of the 3GPP TS34.121-1 specification. The DUT supports power Class 3, which has a nominal maximum output power of 24 dBm (+1.7/-3.7).

Mode	Subtest	Rel99
WCDMA General Settings	Loopback Mode	Test Mode 1
	Rel99 RMC	12.2kbps RMC
	Power Control Algorithm	Algorithm2
	β_c/β_d	8/15

Measured Results

Band	Mode	UL Ch No.	Freq. (MHz)	Avg Pwr (dBm)
W-CDMA Band V	Rel 99 (RMC, 12.2 kbps)	4132	826.4	22.8
		4183	836.6	22.9
		4233	846.6	22.9
W-CDMA Band II	Rel 99 (RMC, 12.2 kbps)	9262	1852.4	22.5
		9400	1880.0	22.6
		9538	1907.6	22.6

HSDPA

The following 4 Sub-tests were completed according to Release 5 / 6 procedures in section 5.2 of 3GPP TS34.121-1. A summary of these settings are illustrated below:

	Mode	HSDPA	HSDPA	HSDPA	HSDPA
	Subtest	1	2	3	4
W-CDMA General Settings	Loopback Mode	Test Mode 1			
	Rel99 RMC	12.2kbps RMC			
	HSDPA FRC	H-Set1			
	Power Control Algorithm	Algorithm 2			
	β_c	2/15	12/15	15/15	15/15
	β_d	15/15	15/15	8/15	4/15
	Bd (SF)	64			
	β_c/β_d	2/15	12/15	15/8	15/4
	β_{hs}	4/15	24/15	30/15	30/15
HSDPA Specific Settings	MPR (dB)	0	0	0.5	0.5
	D_{ACK}	8			
	D_{NAK}	8			
	DCQI	8			
	Ack-Nack repetition factor	3			
	CQI Feedback (Table 5.2B.4)	4ms			
	CQI Repetition Factor (Table 5.2B.4)	2			
	Abs= β_{hs}/β_c	30/15			

Measured Results

Band	Mode	UL Ch No.	Freq. (MHz)	Avg Pwr (dBm)
W-CDMA Band V	Subtest 1	4132	826.4	21.5
		4183	836.6	21.5
		4233	846.6	21.6
	Subtest 2	4132	826.4	21.5
		4183	836.6	21.5
		4233	846.6	21.5
	Subtest 3	4132	826.4	21.6
		4183	836.6	21.6
		4233	846.6	21.6
	Subtest 4	4132	826.4	21.4
		4183	836.6	21.5
		4233	846.6	21.5
W-CDMA Band II	Subtest 1	9262	1852.4	21.4
		9400	1880.0	21.5
		9538	1907.6	21.6
	Subtest 2	9262	1852.4	21.5
		9400	1880.0	21.6
		9538	1907.6	21.6
	Subtest 3	9262	1852.4	21.5
		9400	1880.0	21.6
		9538	1907.6	21.6
	Subtest 4	9262	1852.4	21.5
		9400	1880.0	21.6
		9538	1907.6	21.6

Maximum output power levels that are possible for all subtests reported.

HSPA (HSDPA & HSUPA)

The following 5 Sub-tests were completed according to Release 7 procedures in section 5.2 of 3GPP TS34.121. A summary of these settings are illustrated below:

	Mode	HSPA				
	Subtest	1	2	3	4	5
WCDMA General Settings	Loopback Mode	Test Mode 1				
	Rel99 RMC	12.2kbps RMC				
	HSDPA FRC	H-Set 1				
	HSUPA Test	HSPA				
	Power Control Algorithm	Algorithm 2				Algorithm 1
	β_c	11/15	6/15	15/15	2/15	15/15
	β_d	15/15	15/15	9/15	15/15	0
	β_{ec}	209/225	12/15	30/15	2/15	5/15
	β_c/β_d	11/15	11/15	15/9	2/15	15/0
	β_{hs}	22/15	12/15	30/15	4/15	5/15
	β_{ed}	1309/225	94/75	47/15 47/15	56/75	47/15
	CM (dB)	1	3	2	3	1
HSDPA Specific Settings	DACK	8				0
	DNAK	8				0
	DCQI	8				0
	Ack-Nack repetition factor	3				
	CQI Feedback (Table 5.2B.4)	4ms				
	CQI Repetition Factor (Table 5.2B.4)	2				
	$A_{hs} = \beta_{hs}/\beta_c$	30/15				
HSUPA Specific Settings	E-DPDCCH	6	8	8	5	7
	DHARQ	0	0	0	0	0
	AG Index	20	12	15	17	21
	ETFCI (from 34.121 Table C.11.1.3)	75	67	92	71	81
	Associated Max UL Data Rate kbps	242.1	174.9	482.8	205.8	308.9
	Reference E-TFCIs	5	5	2	5	1
	Reference E-TFCI	11	11	11	11	67
	Reference E-TFCI PO	4	4	4	4	18
	Reference E-TFCI	67	67	92	67	67
	Reference E-TFCI PO	18	18	18	18	18
	Reference E-TFCI	71	71	71	71	71
	Reference E-TFCI PO	23	23	23	23	23
	Reference E-TFCI	75	75	75	75	75
	Reference E-TFCI PO	26	26	26	26	26
	Reference E-TFCI	81	81	81	81	81
	Reference E-TFCI PO	27	27	27	27	27
	Maximum Channelisation Codes	2xSF2				SF4

Measured Results

Band	Mode	UL Ch No.	Freq. (MHz)	Avg Pwr (dBm)
W-CDMA Band V	Subtest 1	4132	826.4	21.9
		4183	836.6	21.9
		4233	846.6	21.8
	Subtest 2	4132	826.4	21.3
		4183	836.6	21.3
		4233	846.6	21.4
	Subtest 3	4132	826.4	21.8
		4183	836.6	21.9
		4233	846.6	21.8
	Subtest 4	4132	826.4	21.7
		4183	836.6	21.7
		4233	846.6	21.7
	Subtest 5	4132	826.4	21.6
		4183	836.6	21.6
		4233	846.6	21.6
W-CDMA Band II	Subtest 1	9262	1852.4	21.5
		9400	1880.0	21.5
		9538	1907.6	21.5
	Subtest 2	9262	1852.4	21.1
		9400	1880.0	21.2
		9538	1907.6	21.2
	Subtest 3	9262	1852.4	21.4
		9400	1880.0	21.5
		9538	1907.6	21.5
	Subtest 4	9262	1852.4	21.4
		9400	1880.0	21.5
		9538	1907.6	21.5
	Subtest 5	9262	1852.4	21.4
		9400	1880.0	21.4
		9538	1907.6	21.5

9.3. LTE Band

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

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

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

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

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

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

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

Note 1: Applies to the lower block of Band 23, i.e. a carrier placed in the 2000-2010 MHz region.

LTE Band 41 Measured Results

Procedure used to establish SAR test signal for LTE TDD Band 41

Set to CMW-500 with following parameters:

- Turn the LTE Signaling off using "ON | OFF" key
- Operating Band: Select Band 41 and TDD
- Go to "Config...."

LTE Signaling 1 - X3.2.10.6

Connection Status

Cell: OFF

Packet Switched: OFF

RRC State: Idle

Event Log

- 03:21:26 State 'Cell Off'
- 03:21:17 State 'Cell On'
- 03:21:16 Signaling Failure
- 03:21:13 Network Originated Detach
- 03:21:02 State 'Connection Established'
- 03:21:02 EPS Dedicated Bearer Established
- 03:20:57 State 'Attached'
- 03:20:57 EPS Default Bearer Established

UE Info

IMEI: ---

IMSI: ---

UE IPv4 Address [0]: ---

UE IPv6 Prefix [0]: ---

Connection Setup

Scheduling: RMC

	Downlink	Uplink
Channel	40620 Ch	40620 Ch
Frequency	2593.0 MHz	2593.0 MHz
Cell Bandwidth	20.0 MHz	20.0 MHz
RS EPRE	-85.8 dBm/15kHz	
Full Cell BW Pow.	-55.0 dBm	
PUSCH Open Loop Nom. Power		23 dBm
PUSCH Closed Loop Target Power		23.0 dBm
# RB	100	100
RB Pos./Start RB	low 0	low 0
Modulation	QPSK	QPSK
TBS Idx / Value	5 8760	2 4584
Throughput	3.970 Mbit/s	1.834 Mbit/s

LTE Signaling OFF

Config ...

- Go to "Physical Cell Setup"
- Select "TDD" and Set "Uplink Downlink Configuration" to "0"
- Turn the cell on using "ON | OFF" key

The screenshot shows the 'LTE Signaling Configuration' window. The 'PCC' tab is selected. The path is 'Physical Cell Setup/TDD/Uplink Downlink Configuration'. The 'Duplex Mode' is set to 'TDD'. The 'Scenario' is 'Standard Cell'. The 'DL Cell Bandwidth' is '20.0 MHz' and the 'UL Cell Bandwidth' is '20.0 MHz'. The 'Physical Cell ID' is '0' and the 'Cyclic Prefix' is 'Normal'. The 'Sounding RS (SRS)' checkbox is unchecked. The 'TDD' section is expanded, and 'Uplink Downlink Configuration' is set to '0'. Below this, a table shows the subframe configuration for 10 subframes (0-9). The 'Subframe Number' row shows 0-9. The 'Direction' row shows 'S' for subframes 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. The 'Special Subframe' row shows '7' for subframes 0, 1, 2, 3, 4, 5, 6, 7, 8, 9. The 'PRACH' checkbox is checked. The 'Network' section is expanded, showing 'Connection', 'CQI Reporting', and 'UE Measurement Report'. On the right side, the 'LTE' button is highlighted. Below it, the 'LTE 1 TX Meas.' button is highlighted. Below that, the 'LTE 1 Ext.BLER' button is highlighted. Below that, the 'Go to...' button is highlighted. Below that, the 'Routing' button is highlighted. Below that, the 'LTE Signaling ON' button is highlighted. Below that, the 'Config ...' button is highlighted.

- Turn the cell on using “ON | OFF” key
- After EUT is Attached
- Select “Connect”

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Max Power Setting

- Select "LTE 1 TX Meas."
- Press "RESTART | STOP" Soft key

The screenshot displays the 'LTE Signaling 1 - X3.2.10.6' application window. The interface is divided into several sections:

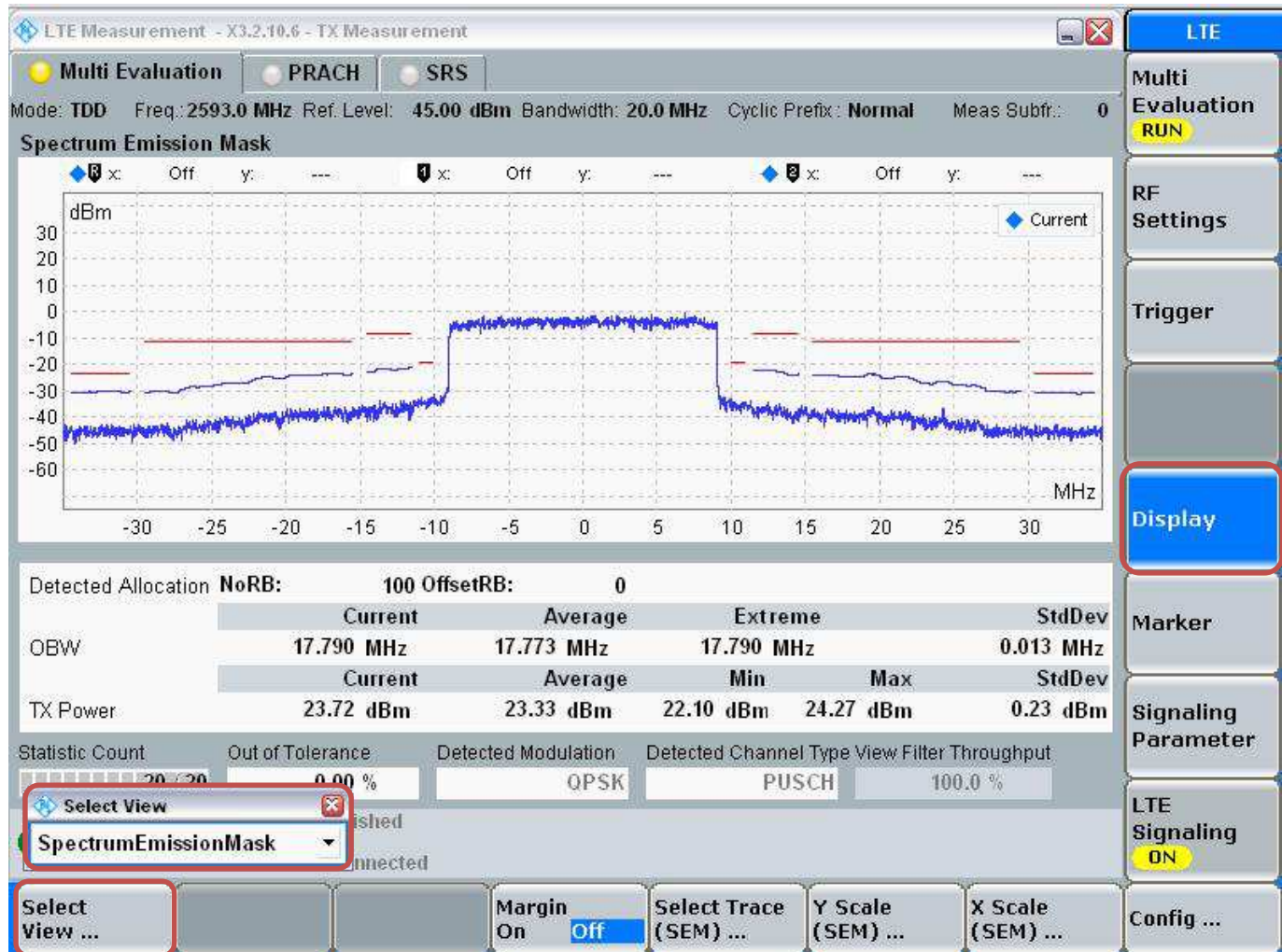
- Connection Status:** Shows 'Cell' with a signal icon, 'Packet Switched' with a laptop icon, and 'RRC State' as 'Connected'. A 'Connection Established' message is visible.
- Event Log:** A list of events with timestamps and descriptions, such as '03:33:07 State 'Connection Established'', '03:33:07 EPS Dedicated Bearer Established', '03:31:31 State 'Attached'', '03:31:31 EPS Default Bearer Established', '03:31:31 RRC Connection Established', '03:31:02 State 'Cell On'', '03:31:00 State 'Cell Off'', and '03:30:23 State 'Cell On''.
- UE Info:** A dropdown menu showing 'UE Info' with a checkbox. Below it, fields for IMEI (001027009999998), IMSI (001010123456789), UE IPv4 Address [0] (192.168.48.129), and UE IPv6 Prefix [0] (fc01:abab:cdcd:efe0::) are displayed.
- Connection Setup:** A section with a 'Scheduling' dropdown set to 'RMC'. It includes fields for '# RB' (Downlink: 100, Uplink: 100), 'RB Pos./Start RB' (Downlink: low, Uplink: low), 'Modulation' (Downlink: QPSK, Uplink: QPSK), 'TBS Idx / Value' (Downlink: 5 / 8760, Uplink: 2 / 4584), and 'Throughput' (Downlink: 3.970 Mbit/s, Uplink: 1.834 Mbit/s).
- Power Settings:** A section with 'Operating Band' set to 'Band 41' and 'TDD' mode. It shows 'Channel' (40620 Ch), 'Frequency' (2593.0 MHz), 'Cell Bandwidth' (20.0 MHz), 'RS EPRE' (-85.8 dBm/15kHz), 'Full Cell BW Pow.' (-55.0 dBm), 'PUSCH Open Loop Nom.Power' (23 dBm), and 'PUSCH Closed Loop Target Power' (23.0 dBm).
- Right Sidebar:** A vertical stack of buttons including 'LTE', 'LTE 1 TX Meas.' (highlighted with a red box), 'LTE 1 Ext.BLER', 'Go to...', 'Routing', and 'LTE Signaling ON' (highlighted with a red box).
- Bottom Bar:** A row of buttons including 'Detach', 'Disconnect', 'Send SMS', 'Handover ...', and 'Config ...'.

- Select "Signaling Parameter"
- Select "TX Power Control (TPC)" > Select "Active TPC Setup" to "Max Power" > Set "Closed Loop Target Power" to "23 dBm"

The screenshot displays the 'LTE Measurement - X3.2.10.6 - TX Measurement' window. The main interface includes several measurement plots: EVM, Inband Emissions, Equalizer Spectrum Flatness, Spectrum ACLR, and Spectrum. A 'Signaling TPC' dialog box is open, showing the 'TX Power Control (TPC)' settings. The 'Active TPC Setup' is set to 'Max Power', and the 'Closed Loop Target Power' is set to '23.0 dBm'. The 'Signaling Parameter' button on the right sidebar is highlighted with a red box. The 'Multi Evaluation' button is also highlighted with a yellow 'RUN' label. The 'LTE Signaling' button is highlighted with a yellow 'ON' label. The bottom toolbar contains buttons for 'Cell Setup ...', 'Connection Setup ...', 'DL Error Insertion ...', 'TPC ...', 'Power ...', 'Enable ...', and 'Config ...'.

View TX Power

- Go to "Display"
- Select "Select View..."
- Select "Spectrum Emission Mask"



LTE Band 41 Measured Results

Band	BW (MHz)	Mode	RB Allocation	RB offset	Target MPR	Meas. MPR	Avg Pwr (dBm)				
							2506 MHz	2549.5 MHz	2593 MHz	2636.5 MHz	2680 MHz
LTE Band 41	20	QPSK	1	0	0	0	23.5	23.4	23.4	23.5	23.4
			1	50	0	0	23.5	23.4	23.4	23.4	23.4
			1	99	0	0	23.4	23.4	23.4	23.4	23.4
			50	0	1	1	22.5	22.4	22.4	22.5	22.4
			50	25	1	1	22.5	22.4	22.4	22.4	22.4
			50	50	1	1	22.5	22.5	22.3	22.4	22.5
			100	0	1	1	22.5	22.5	22.3	22.4	22.4
		16QAM	1	0	1	1	22.5	22.4	22.5	22.5	22.5
			1	50	1	1	22.5	22.5	22.5	22.4	22.4
			1	99	1	1	22.5	22.4	22.4	22.4	22.4
			50	0	2	2	21.4	21.4	21.4	21.4	21.4
			50	25	2	2	21.5	21.4	21.4	21.4	21.4
			50	50	2	2	21.5	21.4	21.4	21.4	21.4
			100	0	2	2	21.5	21.4	21.4	21.4	21.4
Band	BW (MHz)	Mode	RB Allocation	RB offset	Target MPR	Meas. MPR	Avg Pwr (dBm)				
							2503.5 MHz	2548.3 MHz	2593 MHz	2637.8 MHz	2682.5 MHz
LTE Band 41	15	QPSK	1	0	0	0	23.5	23.4	23.4	23.5	23.3
			1	36	0	0	23.4	23.4	23.4	23.4	23.3
			1	74	0	0	23.4	23.4	23.4	23.4	23.3
			36	0	1	1	22.4	22.4	22.3	22.4	22.3
			36	18	1	1	22.4	22.4	22.3	22.4	22.3
			36	37	1	1	22.5	22.4	22.3	22.4	22.4
			75	0	1	1	22.4	22.4	22.3	22.4	22.3
		16QAM	1	0	1	1	22.5	22.4	22.5	22.4	22.4
			1	36	1	1	22.5	22.5	22.4	22.4	22.3
			1	74	1	1	22.4	22.4	22.4	22.4	22.3
			36	0	2	2	21.4	21.4	21.4	21.4	21.3
			36	18	2	2	21.5	21.4	21.4	21.4	21.3
			36	37	2	2	21.4	21.4	21.4	21.4	21.3
			75	0	2	2	21.5	21.4	21.4	21.4	21.3
Band	BW (MHz)	Mode	RB Allocation	RB offset	Target MPR	Meas. MPR	Avg Pwr (dBm)				
							2501 MHz	2547 MHz	2593 MHz	2639 MHz	2685 MHz
LTE Band 41	10	QPSK	1	0	0	0	23.5	23.4	23.4	23.5	23.3
			1	25	0	0	23.4	23.4	23.4	23.4	23.3
			1	49	0	0	23.4	23.4	23.4	23.4	23.3
			25	0	1	1	22.4	22.4	22.3	22.4	22.3
			25	12	1	1	22.4	22.4	22.3	22.4	22.3
			25	25	1	1	22.5	22.4	22.3	22.4	22.4
			50	0	1	1	22.4	22.4	22.3	22.4	22.3
		16QAM	1	0	1	1	22.5	22.4	22.5	22.4	22.4
			1	25	1	1	22.5	22.4	22.4	22.4	22.3
			1	49	1	1	22.4	22.4	22.4	22.4	22.3
			25	0	2	2	21.4	21.4	21.4	21.4	21.3
			25	12	2	2	21.5	21.4	21.4	21.4	21.3
			25	25	2	2	21.4	21.4	21.4	21.4	21.3
			50	0	2	2	21.5	21.4	21.4	21.4	21.3

9.5. 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 $\frac{1}{4}$ dB $\geq$ 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	16.1	Yes
			6	2437	16.1	
			11	2462	15.9	
	802.11g	6 Mbps	1	2412	14.1	No
			6	2437	14.1	
			11	2462	13.9	
	802.11n (HT20)	MCS0	1	2412	13.2	No
			6	2437	13.2	
			11	2462	12.9	

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	16.1	Yes
			2 Mbps	16.0	No
			5.5 Mbps	16.0	No
			11 Mbps	15.7	No

9.5. Bluetooth

Maximum tune-up tolerance limit is 11.5 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.

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
6000	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 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

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 ₂ O	Water, 35 – 58%
Sucrose	Sugar, white, refined, 40-60%
NaCl	Sodium Chloride, 0-6%
Hydroxyethyl-cellulose	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-methyl-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 ₂ O	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

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 $\pm 2^\circ\text{C}$ of the temperature when the tissue parameters are characterized.

The dielectric parameters must be measured before the tissue-equivalent medium is used in a series of SAR measurements. The parameters should be re-measured after each 3 – 4 days of use; or earlier if the dielectric parameters can become out of tolerance; for example, when the parameters are marginal at the beginning of the measurement series.

Tissue dielectric parameters were measured at the low, middle and high frequency of each operating frequency range of the test device.

SAR Room 4

	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
5/13/2014	Head 835	e'	43.1100	Relative Permittivity (ε _r):	43.11	41.50	3.88	5
		e"	20.0100	Conductivity (σ):	0.93	0.90	3.23	5
	Head 820	e'	43.3000	Relative Permittivity (ε _r):	43.30	41.60	4.08	5
		e"	20.0600	Conductivity (σ):	0.91	0.90	1.80	5
	Head 850	e'	42.9300	Relative Permittivity (ε _r):	42.93	41.50	3.45	5
		e"	19.9600	Conductivity (σ):	0.94	0.92	3.10	5
5/13/2014	Body 835	e'	52.8400	Relative Permittivity (ε _r):	52.84	55.20	-4.28	5
		e"	21.9000	Conductivity (σ):	1.02	0.97	4.82	5
	Body 820	e'	53.0200	Relative Permittivity (ε _r):	53.02	55.28	-4.08	5
		e"	21.9800	Conductivity (σ):	1.00	0.97	3.48	5
	Body 850	e'	52.6800	Relative Permittivity (ε _r):	52.68	55.16	-4.49	5
		e"	21.8300	Conductivity (σ):	1.03	0.99	4.52	5
5/14/2014	Body 1900	e'	53.5900	Relative Permittivity (ε _r):	53.59	53.30	0.54	5
		e"	14.2700	Conductivity (σ):	1.51	1.52	-0.82	5
	Body 1850	e'	53.7600	Relative Permittivity (ε _r):	53.76	53.30	0.86	5
		e"	14.1200	Conductivity (σ):	1.45	1.52	-4.44	5
	Body 1910	e'	53.5500	Relative Permittivity (ε _r):	53.55	53.30	0.47	5
		e"	14.2800	Conductivity (σ):	1.52	1.52	-0.23	5
5/14/2014	Head 1900	e'	39.1000	Relative Permittivity (ε _r):	39.10	40.00	-2.25	5
		e"	13.3400	Conductivity (σ):	1.41	1.40	0.67	5
	Head 1850	e'	39.3000	Relative Permittivity (ε _r):	39.30	40.00	-1.75	5
		e"	13.2100	Conductivity (σ):	1.36	1.40	-2.94	5
	Head 1910	e'	39.0600	Relative Permittivity (ε _r):	39.06	40.00	-2.35	5
		e"	13.3500	Conductivity (σ):	1.42	1.40	1.27	5

SAR Room 4 Liquid Check continue

	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
5/19/2014	Head 2450	e'	38.1300	Relative Permittivity (ε _r):	38.13	39.20	-2.73	5
		e"	13.4100	Conductivity (σ):	1.83	1.80	1.49	5
	Head 2410	e'	38.2800	Relative Permittivity (ε _r):	38.28	39.28	-2.54	5
		e"	13.3300	Conductivity (σ):	1.79	1.76	1.47	5
	Head 2475	e'	38.0400	Relative Permittivity (ε _r):	38.04	39.17	-2.88	5
		e"	13.4600	Conductivity (σ):	1.85	1.83	1.39	5
5/19/2014	Body 2450	e'	50.3300	Relative Permittivity (ε _r):	50.33	52.70	-4.50	5
		e"	14.4700	Conductivity (σ):	1.97	1.95	1.09	5
	Body 2410	e'	50.4800	Relative Permittivity (ε _r):	50.48	52.76	-4.32	5
		e"	14.4300	Conductivity (σ):	1.93	1.91	1.37	5
	Body 2475	e'	50.2500	Relative Permittivity (ε _r):	50.25	52.67	-4.59	5
		e"	14.5500	Conductivity (σ):	2.00	1.99	0.87	5
5/24/2014	Head 2600	e'	38.4200	Relative Permittivity (ε _r):	38.42	39.01	-1.51	5
		e"	14.0000	Conductivity (σ):	2.02	1.96	3.15	5
	Head 2500	e'	38.8000	Relative Permittivity (ε _r):	38.80	39.14	-0.86	5
		e"	13.7800	Conductivity (σ):	1.92	1.85	3.32	5
	Head 2700	e'	38.0600	Relative Permittivity (ε _r):	38.06	38.88	-2.12	5
		e"	14.1800	Conductivity (σ):	2.13	2.07	2.83	5
5/24/2014	Body 2600	e'	51.3100	Relative Permittivity (ε _r):	51.31	52.51	-2.29	5
		e"	14.9700	Conductivity (σ):	2.16	2.16	0.16	5
	Body 2500	e'	51.6200	Relative Permittivity (ε _r):	51.62	52.64	-1.93	5
		e"	14.7400	Conductivity (σ):	2.05	2.02	1.42	5
	Body 2700	e'	51.0100	Relative Permittivity (ε _r):	51.01	52.38	-2.62	5
		e"	15.1800	Conductivity (σ):	2.28	2.30	-0.97	5

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
D835V2	4d002	11/15/2013	835	1g	9.49	9.43
				10g	6.18	6.21
D1900V2	5d163	09/17/2013	1900	1g	40.9	40.1
				10g	21.2	21.2
D2450V2	899	09/10/2013	2450	1g	51.3	49.7
				10g	23.9	23.3
D2600V2	1006	09/11/2013	2600	1g	56.5	55.7
				10g	25.2	24.8

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 4

Date Tested	System Dipole		T.S. Liquid	Measured Results			Target (Ref. Value)	Delta $\pm 10\%$	Est./Zoom Ratio	Plot No.
	Type	Serial #		Area Scan	Zoom Scan	Normalize to 1 W				
5/13/2014	D835V2	4d002	Head	1g	0.98	0.96	9.64	9.49	1.58	
				10g	0.66	0.63	6.31	6.18	2.10	
5/13/2014	D835V2	4d002	Body	1g	0.98	0.98	9.78	9.43	3.71	1,2
				10g	0.66	0.64	6.44	6.21	3.70	
5/14/2014	D1900V2	5d163	Head	1g	3.99	3.89	38.90	40.90	-4.89	3,4
				10g	2.06	2.02	20.20	21.20	-4.72	
5/14/2014	D1900V2	5d163	Body	1g	3.79	3.82	38.20	40.10	-4.74	
				10g	1.90	2.03	20.30	21.20	-4.25	
5/19/2014	D2450V2	899	Head	1g	5.57	5.49	54.90	51.3	7.02	5,6
				10g	2.45	2.53	25.30	23.9	5.86	
5/19/2014	D2450V2	899	Body	1g	5.25	5.28	52.80	49.7	6.24	
				10g	2.27	2.45	24.50	23.3	5.15	
5/24/2014	D2600V2	1006	Head	1g	5.65	5.43	54.30	56.5	-3.89	7,8
				10g	2.53	2.40	24.00	25.2	-4.76	
5/24/2014	D2600V2	1006	Body	1g	5.93	5.72	57.20	55.70	2.69	
				10g	2.58	2.53	25.30	24.80	2.02	

12. SAR Test 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:

Body SAR is also measured for HSPA when the maximum average output of each RF channel with HSPA active is at least $\frac{1}{4}$ dB higher than that measured without HSPA using 12.2 kbps RMC or the maximum SAR for 12.2 kbps RMC is above 75% of the SAR limit. Body SAR for HSPA is measured with E-DCH Sub-test 5, using H-Set 1 and QPSK for FRC and a 12.2 kbps RMC configured in Test Loop Mode 1 with power control algorithm 2.

KDB 941225 D05 SAR for LTE Devices:

SAR test reduction is applied using the following criteria:

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

12.1. 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	33.0	0.432	0.432	
			Left Tilt	190	836.6	33.0	33.0	0.269	0.269	
			Right Touch	190	836.6	33.0	33.0	0.384	0.384	
			Righttt Tilt	190	836.6	33.0	33.0	0.245	0.245	
Head VoIP	GPRS 4 Slots	0	Left Touch	190	836.6	28.0	27.1	0.206	0.253	
			Left Tilt	190	836.6	28.0	27.1	0.138	0.170	
			Right Touch	190	836.6	28.0	27.1	0.478	0.588	1
			Righttt Tilt	190	836.6	28.0	27.1	0.314	0.386	
Body-worn	Voice	10	Rear	190	836.6	33.0	33.0	0.173	0.173	2
			Front	190	836.6	33.0	33.0	0.160	0.160	
Body-worn(VoIP) & Hotspot	GPRS 4 Slots	10	Rear	190	836.6	28.0	27.1	0.106	0.130	3
			Front	190	836.6	28.0	27.1	0.075	0.092	
Hotspot			Edge 1	190	836.6	28.0	27.1	0.066	0.081	
			Edge 4	190	836.6	28.0	27.1	0.089	0.109	

12.2. 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	30.0	0.528	0.528	
			Left Tilt	661	1880.0	30.0	30.0	0.155	0.155	
			Right Touch	661	1880.0	30.0	30.0	0.264	0.264	
			Righttt Tilt	661	1880.0	30.0	30.0	0.189	0.189	
Head VoIP	GPRS 2 Slots	0	Left Touch	661	1880.0	27.5	27.3	0.518	0.542	4
			Left Tilt	661	1880.0	27.5	27.3	0.160	0.168	
			Right Touch	661	1880.0	27.5	27.3	0.243	0.254	
			Righttt Tilt	661	1880.0	27.5	27.3	0.184	0.193	
Body-worn	Voice	10	Rear	661	1880.0	30.0	30.0	0.451	0.451	
			Front	661	1880.0	30.0	30.0	0.482	0.482	5
Body-worn(VoIP) & Hotspot	GPRS 2 Slots	10	Rear	661	1880.0	27.5	27.3	0.416	0.436	
Front			661	1880.0	27.5	27.3	0.466	0.488	6	
Hotspot			Edge 2	661	1880.0	27.5	27.3	0.047	0.049	
			Edge 3	661	1880.0	27.5	27.3	0.106	0.111	
			Edge 4	661	1880.0	27.5	27.3	0.213	0.223	

12.3. W-CDMA Band V

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	Rel 99 RMC	0	Left Touch	4183	836.6	23.0	22.9	0.169	0.173	
			Left Tilt	4183	836.6	23.0	22.9	0.118	0.121	
			Right Touch	4183	836.6	23.0	22.9	0.391	0.400	7
			Rightt Tilt	4183	836.6	23.0	22.9	0.238	0.244	
Body-worn & Hptspot	Rel 99 RMC	10	Rear	4183	836.6	23.0	22.9	0.176	0.180	8
			Front	4183	836.6	23.0	22.9	0.131	0.134	
Hotspot	Rel 99 RMC	10	Edge 1	4183	836.6	23.0	22.9	0.103	0.105	
			Edge 4	4183	836.6	23.0	22.9	0.152	0.156	

12.4. W-CDMA Band II

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	Rel 99 RMC	0	Left Touch	9262	1852.4	23.0	22.5	0.871	0.977	9
				9400	1880.0	23.0	22.6	0.858	0.941	
				9538	1907.6	23.0	22.6	0.925	1.014	
			Left Tilt	9400	1880.0	23.0	22.6	0.224	0.246	
			Right Touch	9400	1880.0	23.0	22.6	0.475	0.521	
Body-worn & Hptspot	Rel 99 RMC	10	Rear	9400	1880.0	23.0	22.6	0.667	0.731	10
			Front	9400	1880.0	23.0	22.6	0.697	0.764	
Hotspot	Rel 99 RMC	10	Edge 2	9400	1880.0	23.0	22.6	0.075	0.082	
			Edge 3	9400	1880.0	23.0	22.6	0.166	0.182	
			Edge 4	9400	1880.0	23.0	22.6	0.334	0.366	

12.5. LTE Band 41 (20MHz Bandwidth)

RF Exposure Conditions	Mode	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	RB Allocation	RB offset	Power (dBm)		1-g SAR (W/kg)		Plot No.
								Tune-up limit	Meas.	Meas.	Scaled	
Head	QPSK	0	Left Touch	39750	2506.0	1	0	23.5	23.5	0.440	0.440	11
						50	50	22.5	22.5	0.351	0.353	
			Left Tilt	39750	2506.0	1	0	23.5	23.5	0.412	0.412	
						50	50	22.5	22.5	0.308	0.309	
			Right Touch	39750	2506.0	1	0	23.5	23.5	1.050	1.050	
						50	50	22.5	22.5	0.795	0.799	
						100	0	22.5	22.5	0.802	0.809	
				40185	2549.5	1	0	23.5	23.4	0.976	0.990	
						50	50	22.5	22.5	0.733	0.741	
				40620	2593.0	1	0	23.5	23.4	0.688	0.698	
						50	0	22.5	22.4	0.557	0.575	
				41055	2636.5	1	0	23.5	23.5	0.731	0.736	
						50	0	22.5	22.5	0.589	0.596	
				41490	2680.0	1	0	23.5	23.4	0.668	0.680	
						50	50	22.5	22.5	0.491	0.496	
			Right Tilt	39750	2506.0	1	0	23.5	23.5	0.561	0.561	
						50	50	22.5	22.5	0.493	0.495	
Body-worn & Hptspot	QPSK	10	Rear	39750	2560.0	1	0	23.5	23.5	0.391	0.391	12
						50	50	22.5	22.5	0.372	0.374	
			Front	39750	2560.0	1	0	23.5	23.4	0.209	0.212	
						50	0	22.5	22.4	0.171	0.177	
Hotspot	QPSK	10	Edge 1	39750	2560.0	1	0	23.5	23.5	0.152	0.152	
						50	50	22.5	22.5	0.146	0.147	
			Edge 4	39750	2560.0	1	0	23.5	23.5	0.243	0.243	
						50	50	22.5	22.5	0.206	0.207	

12.6. Wi-Fi (DTS Band)

RF Exposure Conditions	Mode	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		Plot No.
						Tune-up limit	Meas.	Meas.	Scaled	
Head	802.11b 1 Mbps	0	Left Touch	6	2437.0	16.5	16.1	0.479	0.525	13
			Left Tilt	6	2437.0	16.5	16.1	0.244	0.268	
			Right Touch	6	2437.0	16.5	16.1	0.283	0.310	
			Right Tilt	6	2437.0	16.5	16.1	0.219	0.240	
Body-worn & Hptspot	802.11b 1 Mbps	10	Rear	6	2437.0	16.5	16.1	0.250	0.274	14
			Front	6	2437.0	16.5	16.1	0.096	0.105	
Hotspot	802.11b 1 Mbps	10	Edge 1	6	2437.0	16.5	16.1	0.068	0.075	
			Edge 2	6	2437.0	16.5	16.1	0.124	0.136	

12.7. Bluetooth

12.7.1. 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:

$[(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm})] \cdot [\sqrt{f(\text{GHz})}] \leq 3.0$, for 1-g SAR and ≤ 7.5 for 10-g extremity SAR, where

- $f_{(\text{GHz})}$ 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)			
11.5	14	10	2.480	2.2

Conclusion:

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

12.7.2. 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:

- $(\text{max. power of channel, including tune-up tolerance, mW}) / (\text{min. test separation distance, mm}) \cdot [\sqrt{f_{(\text{GHz})}/x}]$ 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	14	10	2.480	0.294

13. SAR Measurement Variability

In accordance with published RF Exposure KDB procedure 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 .

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)	Repeated SAR (Yes/No)
850	GSM 850	0.432			No
	WCDMA Band V	0.391			No
1900	GSM 1900	0.528			No
	WCDMA Band II	0.925			Yes
2400	Wi-Fi 802.11b/g/n	0.479			No
2600	LTE Band 41	1.05			Yes

13.2 Repeated Measurement Results

Head Exposure Condition

Frequency band	Test Position	Mode	Ch #.	Freq. (MHz)	Meas. SAR (W/kg)		Largest to Smallest SAR Ratio	Note
					Original	Repeated		
WCDMA Band II	LHS Touch	Rel 99 RMC	9538	1907.6	0.925	0.922	1.00	1
LTE Band 41	RHS Touch	QPSK	39750	2506.0	1.050	1.010	1.04	1

Body-worn Accessory Exposure Condition

Not Applicable.

Hotspot Mode Exposure Conditions and Wi-Fi Direct

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 .

14. 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:

SAR₁ is the highest reported or estimated SAR for the first of a pair of simultaneous transmitting antennas, in a specific test operating mode and exposure condition

SAR₂ is the highest reported 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:

$$[(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2]$$

A new threshold of 0.04 is also introduced in the KDB 447498. Thus, in order for a pair of simultaneously 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 GSM850 & Wi-Fi & BT

RF Exposure conditions	Test Position		Simultaneous Transmission Scenario			Σ 1-g SAR (mW/g)	SPLSR (Yes/ No)
			GSM 850	Wi-Fi (DTS)	Bluetooth		
Head	Left Touch	WWAN + Wi-Fi(DTS)	0.432	0.525		0.957	No
	Left Tilt	WWAN + Wi-Fi(DTS)	0.269	0.268		0.537	No
	Right Touch	WWAN + Wi-Fi(DTS)	0.588	0.310		0.898	No
	Right Tilt	WWAN + Wi-Fi(DTS)	0.386	0.240		0.626	No
Body-worn Accessory & Hotspot	Rear	WWAN + Wi-Fi(DTS)	0.173	0.274		0.447	No
		WWAN + BT	0.173		0.294	0.467	No
	Front	WWAN + Wi-Fi(DTS)	0.160	0.105		0.265	No
		WWAN + BT	0.160		0.294	0.454	No
Hotspot	Edge 1	WWAN + Wi-Fi(DTS)	0.081	0.075		0.156	No
	Edge 2	WWAN + Wi-Fi(DTS)		0.136		0.136	No
	Edge 3	WWAN + Wi-Fi(DTS)				0	No
	Edge 4	WWAN + Wi-Fi(DTS)	0.109			0.109	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.

Conclusion:

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

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

RF Exposure conditions	Test Position		Simultaneous Transmission Scenario			Σ 1-g SAR (mW/g)	SPLSR (Yes/ No)
			GSM 1900	Wi-Fi (DTS)	Bluetooth		
Head	Left Touch	WWAN + Wi-Fi(DTS)	0.542	0.525		1.067	No
	Left Tilt	WWAN + Wi-Fi(DTS)	0.168	0.268		0.436	No
	Right Touch	WWAN + Wi-Fi(DTS)	0.264	0.310		0.574	No
	Right Tilt	WWAN + Wi-Fi(DTS)	0.193	0.240		0.433	No
Body-worn Accessory & Hotspot	Rear	WWAN + Wi-Fi(DTS)	0.451	0.274		0.725	No
		WWAN + BT	0.451		0.294	0.745	No
	Front	WWAN + Wi-Fi(DTS)	0.488	0.105		0.593	No
		WWAN + BT	0.488		0.294	0.782	No
Hotspot	Edge 1	WWAN + Wi-Fi(DTS)		0.075		0.075	No
	Edge 2	WWAN + Wi-Fi(DTS)	0.049	0.136		0.185	No
	Edge 3	WWAN + Wi-Fi(DTS)	0.111			0.111	No
	Edge 4	WWAN + Wi-Fi(DTS)	0.223			0.223	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.

Conclusion:

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

14.3. Sum of the SAR for WCDMA Band V & Wi-Fi & BT

RF Exposure conditions	Test Position		Simultaneous Transmission Scenario			Σ 1-g SAR (mW/g)	SPLSR (Yes/ No)
			W-CDMA Band V	Wi-Fi (DTS)	Bluetooth		
Head	Left Touch	WWAN + Wi-Fi(DTS)	0.173	0.525		0.698	No
	Left Tilt	WWAN + Wi-Fi(DTS)	0.121	0.268		0.389	No
	Right Touch	WWAN + Wi-Fi(DTS)	0.400	0.310		0.710	No
	Right Tilt	WWAN + Wi-Fi(DTS)	0.244	0.240		0.484	No
Body-worn Accessory & Hotspot	Rear	WWAN + Wi-Fi(DTS)	0.180	0.274		0.454	No
		WWAN + BT	0.180		0.294	0.474	No
	Front	WWAN + Wi-Fi(DTS)	0.134	0.105		0.239	No
		WWAN + BT	0.134		0.294	0.428	No
Hotspot	Edge 1	WWAN + Wi-Fi(DTS)	0.105	0.075		0.180	No
	Edge 2	WWAN + Wi-Fi(DTS)		0.136		0.136	No
	Edge 3	WWAN + Wi-Fi(DTS)				0	No
	Edge 4	WWAN + Wi-Fi(DTS)	0.156			0.156	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.

Conclusion:

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

14.4. Sum of the SAR for WCDMA Band II & Wi-Fi & BT

RF Exposure conditions	Test Position		Simultaneous Transmission Scenario			Σ 1-g SAR (mW/g)	SPLSR (Yes/ No)
			W-CDMA Band II	Wi-Fi (DTS)	Bluetooth		
Head	Left Touch	WWAN + Wi-Fi(DTS)	1.014	0.525		1.539	No
	Left Tilt	WWAN + Wi-Fi(DTS)	0.246	0.268		0.514	No
	Right Touch	WWAN + Wi-Fi(DTS)	0.521	0.310		0.831	No
	Right Tilt	WWAN + Wi-Fi(DTS)	0.311	0.240		0.551	No
Body-worn Accessory & Hotspot	Rear	WWAN + Wi-Fi(DTS)	0.731	0.274		1.005	No
		WWAN + BT	0.731		0.294	1.025	No
	Front	WWAN + Wi-Fi(DTS)	0.764	0.105		0.869	No
		WWAN + BT	0.764		0.294	1.058	No
Hotspot	Edge 1	WWAN + Wi-Fi(DTS)		0.075		0.075	No
	Edge 2	WWAN + Wi-Fi(DTS)	0.085	0.136		0.221	No
	Edge 3	WWAN + Wi-Fi(DTS)	0.182			0.182	No
	Edge 4	WWAN + Wi-Fi(DTS)	0.366			0.366	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.

Conclusion:

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

14.5. Sum of the SAR for LTE Band 41 & Wi-Fi & BT

RF Exposure conditions	Test Position		Simultaneous Transmission Scenario			Σ 1-g SAR (mW/g)	SPLSR (Yes/ No)
			LTE Band 41	Wi-Fi (DTS)	Bluetooth		
Head	Left Touch	WWAN + Wi-Fi(DTS)	0.440	0.525		0.965	No
	Left Tilt	WWAN + Wi-Fi(DTS)	0.412	0.268		0.680	No
	Right Touch	WWAN + Wi-Fi(DTS)	1.050	0.310		1.360	No
	Right Tilt	WWAN + Wi-Fi(DTS)	0.561	0.240		0.801	No
Body-worn Accessory & Hotspot	Rear	WWAN + Wi-Fi(DTS)	0.391	0.274		0.665	No
		WWAN + BT	0.391		0.294	0.685	No
	Front	WWAN + Wi-Fi(DTS)	0.212	0.105		0.317	No
		WWAN + BT	0.212		0.294	0.506	No
Hotspot	Edge 1	WWAN + Wi-Fi(DTS)	0.152	0.075		0.075	No
	Edge 2	WWAN + Wi-Fi(DTS)		0.136		0.136	No
	Edge 3	WWAN + Wi-Fi(DTS)				0	No
	Edge 4	WWAN + Wi-Fi(DTS)	0.243			0.243	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.

Conclusion:

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

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 3936**
- 15.5. Calibration Certificate for D835V2 - SN 4d002**
- 15.6. Calibration Certificate for D1900V2- SN 5d163**
- 15.7. Calibration Certificate for D2450V2 - SN 899**
- 15.8. Calibration Certificate for D2600V2 - SN 1006**

END OF REPORT