SAR EVALUATION REPORT

FCC 47 CFR § 2.1093
IEEE Std 1528-2013

For
GSM/WCDMA/LTE Tablet + Bluetooth, DTS/UNII a/b/g/n & ANT+

FCC ID: A3LSMT239
Model Name: SM-T239

Report Number: 15I19878-S1B
Issue Date: 3/6/2015

Prepared for
SAMSUNG ELECTRONICS CO., LTD.
129 SAMSUNG-RO, YEONGTONG-GU,
SUWON CITY, GYEONGGI-DO, KOREA 443-742

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

NVLAP LAB CODE 200065-0

Revision History

Rev.	Date	Revisions	Revised By
--	2/25/2015	Initial Issue	--
	2/26/2015	Updated Appendix A	Yu Chen
	3/6/2015	Updated LTE Band 5 reduce power to new tune up limit of 18.0dBm. Fixed typo on section 10.6	Yu Chen

This report shall not be reproduced without the written approval of UL Verification Services Inc.

Table of Contents

1. Attestation of Test Results 5

2. Test Specification, Methods and Procedures 6

3. Facilities and Accreditation 6

4. SAR Measurement System & Test Equipment 7

4.1. SAR Measurement System 7

4.2. SAR Scan Procedures 8

4.3. Test Equipment 10

5. Measurement Uncertainty 11

6. Device Under Test (DUT) Information 12

6.1. DUT Description 12

6.2. Wireless Technologies 13

6.3. Nominal and Maximum Output Power 14

6.4. General LTE SAR Test and Reporting Considerations 16

6.5. Power Reduction by Proximity Sensing 17

6.5.1. Proximity Sensor Triggering Distance (KDB 616217 §6.2) 17

6.5.2. Proximity Sensor Triggering Distance Measurement Results 18

6.5.3. Proximity Sensor Coverage (KDB 616217 §6.3) 30

6.5.4. Proximity Sensor Tilt Angle Assessment (KDB 616217 §6.4) 30

7. RF Exposure Conditions (Test Configurations) 31

7.1. Head Exposure Conditions 31

7.2. Standalone SAR Test Exclusion Considerations 32

7.3. Required Test Configurations 34

8. Dielectric Property Measurements & System Check 35

8.1. Dielectric Property Measurements 35

8.2. System Check 38

9. Conducted Output Power Measurements 41

9.1. GSM 41

9.2. W-CDMA 43

9.3. LTE 47

9.4. Wi-Fi 2.4GHz 52

9.5. Wi-Fi 5GHz 53

9.6. Bluetooth 54

10. Measured and Reported (Scaled) SAR Results 55

This report shall not be reproduced without the written approval of UL Verification Services Inc.

10.1. GSM850 ... 58
10.2. GSM1900 ... 58
10.3. W-CDMA Band V ... 59
10.4. W-CDMA Band II ... 59
10.5. LTE Band 5 (10MHz Bandwidth) ... 60
10.6. Wi-Fi (DTS Band) ... 61
10.7. Wi-Fi (U-NII Band) ... 61
10.8. Bluetooth ... 62

11. SAR Measurement Variability ... 63

12. Simultaneous Transmission SAR Analysis ... 64
12.1. Sum of the SAR for GSM850 & Wi-Fi & BT ... 66
12.2. Sum of the SAR for GSM1900 & Wi-Fi & BT ... 66
12.3. Sum of the SAR for WCDMA Band V & Wi-Fi & BT ... 67
12.4. Sum of the SAR for WCDMA Band II & Wi-Fi & BT ... 67
12.5. Sum of the SAR for LTE Band 5 & Wi-Fi & BT ... 68

Appendixes ... 78
A_15I19878v0 SAR Photos & Ant. Locations ... 78
B_15I19878v0 SAR System Check Plots ... 78
C_15I19878v0 SAR Highest Test Plots ... 78
D_15I19878v0 SAR Tissue Ingredients ... 78
E_15I19878v0 SAR Probe Cal. Certificates ... 78
F_15I19878v0 SAR Dipole Cal. Certificates ... 78

This report shall not be reproduced without the written approval of UL Verification Services Inc.

1. Attestation of Test Results

Applicant Name	SAMSUNG ELECTRONICS CO. LTD			
FCC ID	A3LSMT239			
Model Name	SM-T239			
Applicable Standards	FCC 47 CFR § 2.1093 Published RF exposure KDB procedures IEEE Std 1528-2013			
SAR Limits (W/Kg)				
Exposure Category	Peak spatial-average(1g of tissue)		Extremities (hands, wrists, ankles, etc.) (10g of tissue)	
General population / Uncontrolled exposure	1.6		4	
The Highest Reported SAR (W/kg)				
RF Exposure Conditions	**Equipment Class**			
	Licensed	**DTS**	**U-NII**	**DSS (BT)**
Head	0.448	0.037	0.075	N/A
Body-worn	1.093	1.098	0.982	N/A
Simultaneous TX Head	0.523	0.485	0.523	N/A
Simultaneous TX Body-worn	1.518	1.133	1.518	N/A
Date Tested	1/26/2015 to 2/12/2015 ; 3/2/2015 to 3/4/2015			
Test Results	Pass			

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

Note: The results documented in this report apply only to the tested sample, under the conditions and modes of operation as described herein. This document may not be altered or revised in any way unless done so by UL Verification Services Inc. and all revisions are duly noted in the revisions section. Any alteration of this document not carried out by UL Verification Services Inc. will constitute fraud and shall nullify the document. This report must not be used by the client to claim product certification, approval, or endorsement by NVLAP, NIST, any agency of the Federal Government, or any agency of any government (NIST Handbook 150, Annex A). This report is written to support regulatory compliance of the applicable standards stated above.

Approved & Released By:	Prepared By:
Bobby Bayani Senior Engineer UL Verification Services Inc.	Yu Chen Laboratory Technician UL Verification Services Inc.

This report shall not be reproduced without the written approval of UL Verification Services Inc.

2. Test Specification, Methods and Procedures

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

- 248227 D01 SAR meas for 802.11 v02
- 447498 D01 General RF Exposure Guidance v05r02
- 447498 D03 Supplement C Cross-Reference
- 616217 D04 SAR for laptop and tablets v01r01
- 648474 D04 Handset SAR v01r02
- 690783 D01 SAR Listings on Grants v01r03
- 865664 D01 SAR measurement 100 MHz to 6 GHz v01r03
- 865664 D02 RF Exposure Reporting v01r01
- 941225 D01 3G SAR Procedures v03
- 941225 D05 SAR for LTE Devices v02r03

3. Facilities and Accreditation

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

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

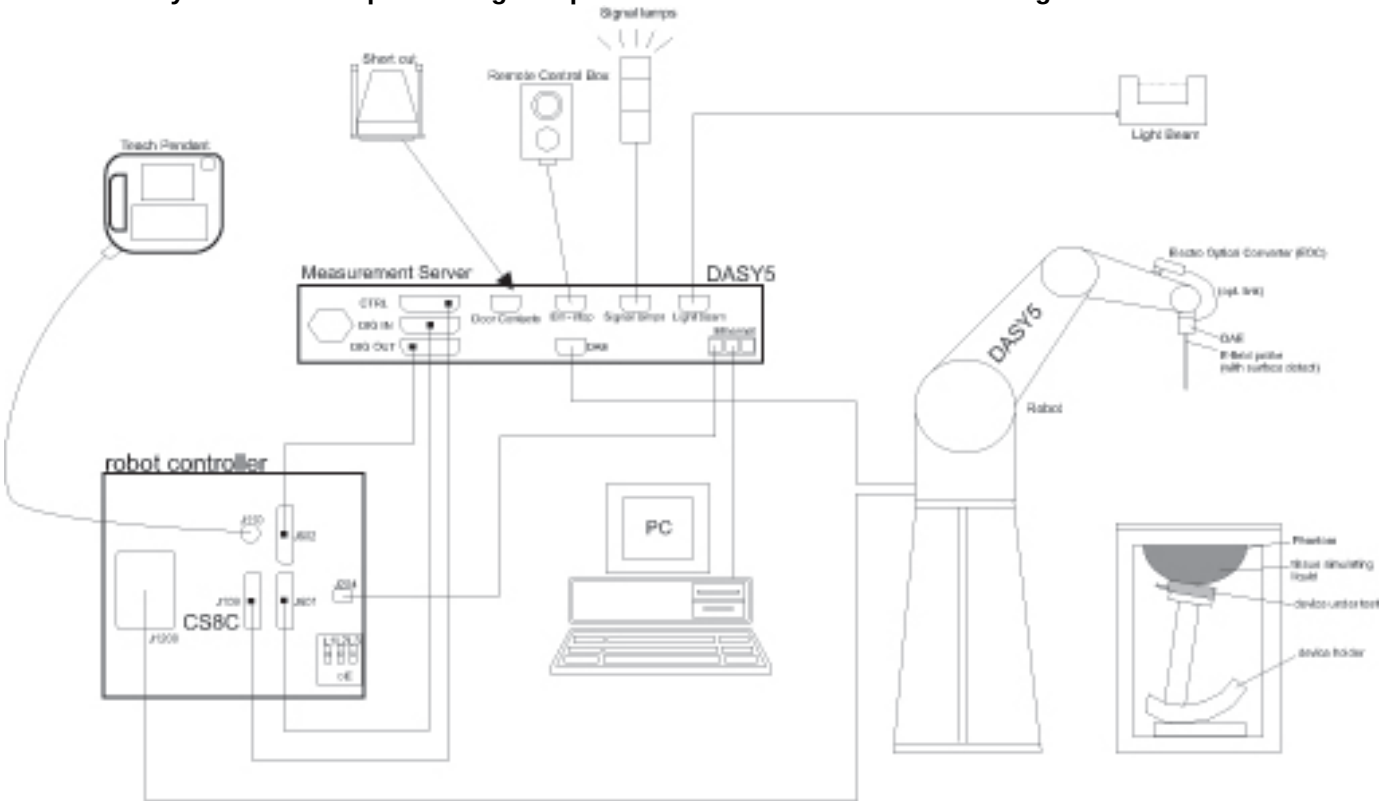
UL Verification Services Inc. is accredited by NVLAP, Laboratory Code 200065-0.

This report shall not be reproduced without the written approval of UL Verification Services Inc.

4. SAR Measurement System & Test Equipment

4.1. SAR Measurement System

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



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

This report shall not be reproduced without the written approval of UL Verification Services Inc.

4.2. SAR Scan Procedures

Step 1: Power Reference Measurement

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

Step 2: Area Scan

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

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

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 1 mm	½·δ·ln(2) ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}	≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
	When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	

This report shall not be reproduced without the written approval of UL Verification Services Inc.

Step 3: Zoom Scan

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

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

			≤ 3 GHz	> 3 GHz
Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{Zoom}(n>1)$: between subsequent points	$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$	
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.

This report shall not be reproduced without the written approval of UL Verification Services Inc.

4.3. Test Equipment

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

Dielectric Property Measurements

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Network Analyzer	Agilent	8753ES	MY40001647	7/17/2015
Dielectronic Probe kit	SPEAG	DAK-3.5	1103	2/18/2015
Dielectronic Probe kit	SPEAG	DAK-3.5 Short	SM DAK 200 BA	N/A
Thermometer	Traceable Calibration Control Co.	4242	122529162	10/8/2015

System Check

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Synthesized Signal Generator	HP	8665B	3744A01084	5/20/2015
Power Meter	Agilent	N1912A	MY53040016	5/5/2015
Power Sensor	Agilent	E9323A	MY53070005	5/1/2015
Power Sensor	Agilent	E9323A	MY53070009	5/28/2015
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1795093	N/A
Directional coupler	Werlatone	C8060-102	2149	N/A
DC Power Supply	AMETEK	XT 15-4	1319A02778	N/A
Synthesized Signal Generator	HP	8665B	3744A01155	3/12/2015
Power Meter	HP	437B	3125U11364	8/27/2015
Power Meter	HP	437B	3125U12345	8/15/2015
Power Sensor	HP	8481A	1926A27048	8/15/2015
Power Sensor	HP	8481A	2702A76223	9/17/2015
Amplifier	MITEQ	AMF-4D-00400600-50-30P	1795092	N/A
Directional coupler	Werlatone	C8060-102	2141	N/A
DC Power Supply	BK PRECISION	1611	215-02292	N/A
E-Field Probe (SAR Lab F)	SPEAG	EX3DV4	3936	7/24/2015
E-Field Probe (SAR Lab G)	SPEAG	EX3DV4	3990	4/15/2015
E-Field Probe (SAR Lab H)	SPEAG	EX3DV4	3686	3/18/2015
Data Acquisition Electronics (SAR Lab F)	SPEAG	DAE4	1239	4/15/2015
Data Acquisition Electronics (SAR Lab G)	SPEAG	DAE4	1434	4/14/2015
Data Acquisition Electronics (SAR Lab H)	SPEAG	DAE4	1258	5/15/2015
System Validation Dipole	SPEAG	D835V2	4d117	5/16/2015
System Validation Dipole	SPEAG	D1900V2	5d043	11/7/2015
System Validation Dipole	SPEAG	D1900V2	5d140	4/23/2015
System Validation Dipole	SPEAG	D2450V2	706	5/20/2015
System Validation Dipole	SPEAG	D5GHzV2	1138	9/18/2015

Other

Name of Equipment	Manufacturer	Type/Model	Serial No.	Cal. Due Date
Power Sensor	Agilent	N1921A	MY52200012	9/26/2015
Power Meter	Agilent	N1911A	MY53060009	5/5/2015
Base Station Simulator	R & S	CMW500	134855-bw	7/15/2015
Base Station Simulator	R & S	CMW500	134853-ud	7/17/2015

This report shall not be reproduced without the written approval of UL Verification Services Inc.

5. Measurement Uncertainty

Per KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval.

This report shall not be reproduced without the written approval of UL Verification Services Inc.

6. Device Under Test (DUT) Information

6.1. DUT Description

Device Dimension	Overall (Length x Width): 186.9mm x 107.9 mm Overall Diagonal: 206mm Display Diagonal: 180mm
Battery Back Cover	☒ The rechargeable battery is not user accessible.
Battery Options	☒ The rechargeable battery is not user accessible.
Accessory	Headset
Wireless Router (Hotspot)	Wi-Fi Hotspot mode permits the device to share its cellular data connection with other Wi-Fi-enabled devices. ☒ Mobile Hotspot (Wi-Fi 2.4 GHz) ☒ Mobile Hotspot (Wi-Fi 5.8 GHz Only)
Wi-Fi Direct	Wi-Fi Direct enabled devices transfer data directly between each other ☒ Wi-Fi Direct (Wi-Fi 2.4 GHz) ☒ Wi-Fi Direct (Wi-Fi 5.8 GHz Only)

This report shall not be reproduced without the written approval of UL Verification Services Inc.

6.2. Wireless Technologies

Wireless technologies	Frequency bands	Operating mode		Duty Cycle used for SAR testing
GSM	850 1900	Voice (GMSK) GPRS (GMSK) EGPRS (8PSK)	GPRS Multi-Slot Class: ☐ Class 8 - One Up ☐ Class 10 - Two Up ☒ Class 12 - Four Up ☐ Class 33 - Four Up	GSM Voice: 12.5% (E)GPRS: 1 Slot: 12.5% 2 Slots: 25% 3 Slots: 37.5% 4 Slots: 50%
	Does this device support DTM (Dual Transfer Mode)? ☐ Yes ☒ No			
	Does this device support SV-DO (1xRTT-1xEVDO)? ☐ Yes ☒ No			
W-CDMA (UMTS)	Band II Band V	UMTS Rel. 99 (Voice & Data) HSDPA (Rel. 5) HSUPA (Rel. 6) HSPA+ (Rel. 6)		100%
LTE (FDD)	Band 5	QPSK 16QAM (Rel. 9) ☒ Does not support Carrier Aggregation (CA). ☐ Rel. 10 Carrier Aggregation (1 Uplink and 2 Downlinks) ☐ Rel. 11 Carrier Aggregation (2 Uplink and 2 Downlinks)		100%
	Does this device support SV-LTE (1xRTT-LTE)? ☐ Yes ☒ No			
	Does this device support SV-LTE (1xRTT-LTE)? ☐ Yes ☒ No			
Wi-Fi	2.4 GHz	802.11b 802.11g 802.11n (HT20)		100%
	5 GHz	802.11a 802.11n (HT20) 802.11n (HT40)		100%
	Does this device support TDWR (Terminal Doppler Weather Radar)? ☒ Yes ☐ No			
	Does this device support Band gap channel? ☐ Yes ☒ No			
Bluetooth	2.4 GHz	Version 1.2 Version 2.0 + EDR Version 2.1 + EDR Version 3.0 + HS Version 4.0 LE		N/A

This report shall not be reproduced without the written approval of UL Verification Services Inc.

6.3. Nominal and Maximum Output Power

KDB 447498 sec.4.1.(3) at the maximum rated output power and within the tune-up tolerance range specified for the product, but not more than 2 dB lower than the maximum tune-up tolerance limit

Upper limit (dB): -1.5 ~ 0.5		Maximum RF Output Pow er (dBm)	
RF Air interface	Mode	Target	Max. tune-up tolerance limit
GSM850	Voice	31.8	**32.3**
	GPRS 1 slot	31.8	**32.3**
	GPRS 2 slots	30.5	**31.0**
	GPRS 3 slots	28.9	**29.4**
	GPRS 4 slots	27.0	**27.5**
	EGPRS 1 slot	26.5	**27.0**
	EGPRS 2 slots	24.5	**25.0**
	EGPRS 3 slots	23.5	**24.0**
	EGPRS 4 slots	21.7	**22.2**
GSM1900	Voice	29.5	**30.0**
	GPRS 1 slot	29.5	**30.0**
	GPRS 2 slots	28.0	**28.5**
	GPRS 3 slots	26.0	**26.5**
	GPRS 4 slots	24.5	**25.0**
	EGPRS 1 slot	25.5	**26.0**
	EGPRS 2 slots	23.8	**24.3**
	EGPRS 3 slots	22.7	**23.2**
	EGPRS 4 slots	21.2	**21.7**
W-CDMA Band V	R99	23.0	**23.5**
	HSDPA	21.5	**22.0**
	HSUPA	21.5	**22.0**
W-CDMA Band II	R99	22.5	**23.0**
	HSDPA	21.5	**22.0**
	HSUPA	21.5	**22.0**
LTE Band 5	QPSK	22.5	**23.0**

This report shall not be reproduced without the written approval of UL Verification Services Inc.

Upper limit (dB): -1.5 ~ 0.5		Reduced RF Output Pow er (dBm)	
RF Air interface	Mode	Target	Max. tune-up tolerance limit
GSM850	Voice	22.0	**22.5**
	GPRS 1 slot	22.0	**22.5**
	GPRS 2 slots	22.0	**22.5**
	GPRS 3 slots	22.0	**22.5**
	GPRS 4 slots	21.0	**21.5**
	EGPRS 1 slot	14.0	**14.5**
	EGPRS 2 slots	14.0	**14.5**
	EGPRS 3 slots	14.0	**14.5**
	EGPRS 4 slots	14.0	**14.5**
GSM1900	Voice	13.0	**13.5**
	GPRS 1 slot	13.0	**13.5**
	GPRS 2 slots	13.0	**13.5**
	GPRS 3 slots	13.0	**13.5**
	GPRS 4 slots	13.0	**13.5**
	EGPRS 1 slot	9.0	**9.5**
	EGPRS 2 slots	9.0	**9.5**
	EGPRS 3 slots	9.0	**9.5**
	EGPRS 4 slots	9.0	**9.5**
W-CDMA Band V	R99	18.5	**19.0**
	HSDPA	17.5	**18.0**
	HSUPA	17.5	**18.0**
W-CDMA Band II	R99	7.5	**8.0**
	HSDPA	7.5	**8.0**
	HSUPA	7.5	**8.0**
LTE Band 5	QPSK	17.5	**18.0**

Upper limit (dB): -1.5 ~ 0.5		RF Output Pow er (dBm)	
RF Air interface	Mode	Target	Max. tune-up tolerance limit
WiFi 2.4 GHz	802.11b	12.0	**12.5**
	802.11g	11.0	**11.5**
	802.11n HT20	10.0	**10.5**
WiFi 5 GHz	802.11a	9.0	**9.5**
	802.11n HT20	8.0	**8.5**
	802.11n HT40	8.0	**8.5**
Bluetooth		7.0	**7.5**
Bluetooth LE		6.0	**6.5**

This report shall not be reproduced without the written approval of UL Verification Services Inc.

6.4. General LTE SAR Test and Reporting Considerations

General LTE SAR Test and Reporting Considerations

<table>
<tr><td rowspan="5">Frequency range, Channel Bandwidth, Numbers and Frequencies</td><td rowspan="3">Band 5</td><td colspan="6">Frequency range: 824 - 849 MHz</td></tr>
<tr><td colspan="6">Channel Bandwidth</td></tr>
<tr><td>20 MHz</td><td>15 MHz</td><td>10 MHz</td><td>5 MHz</td><td>3 MHz</td><td>1.4 MHz</td></tr>
<tr><td>Low</td><td></td><td></td><td>20450/ 829</td><td>20425/ 826.5</td><td>20415/ 825.5</td><td>20407/ 824.7</td></tr>
<tr><td>Mid</td><td></td><td></td><td>20525/ 836.5</td><td>20525/ 836.5</td><td>20525/ 836.5</td><td>20525/ 836.5</td></tr>
<tr><td></td><td>High</td><td></td><td></td><td>20600/ 844</td><td>20625/ 846.5</td><td>20635/ 847.5</td><td>20643/ 848.3</td></tr>
<tr><td>LTE transmitter and antenna implementation</td><td colspan="7">LTE has one (1) TX/RX antennas and one (1) RX antennas
Refer to Appendix A...</td></tr>
<tr><td>Maximum power reduction (MPR)</td><td colspan="7">

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

<table>
<tr><th rowspan="2">Modulation</th><th colspan="6">Channel bandwidth / Transmission bandwidth (RB)</th><th rowspan="2">MPR (dB)</th></tr>
<tr><th>1.4 MHz</th><th>3.0 MHz</th><th>5 MHz</th><th>10 MHz</th><th>15 MHz</th><th>20 MHz</th></tr>
<tr><td>QPSK</td><td>> 5</td><td>> 4</td><td>> 8</td><td>> 12</td><td>> 16</td><td>> 18</td><td>≤ 1</td></tr>
<tr><td>16 QAM</td><td>≤ 5</td><td>≤ 4</td><td>≤ 8</td><td>≤ 12</td><td>≤ 16</td><td>≤ 18</td><td>≤ 1</td></tr>
<tr><td>16 QAM</td><td>> 5</td><td>> 4</td><td>> 8</td><td>> 12</td><td>> 16</td><td>> 18</td><td>≤ 2</td></tr>
</table>

MPR Built-in by design
A-MPR (additional MPR) was disabled during SAR testing

</td></tr>
<tr><td>Power reduction</td><td colspan="7">Yes</td></tr>
<tr><td>Spectrum plots for RB configurations</td><td colspan="7">A properly configured base station simulator was used for the SAR and power measurements; therefore, spectrum plots for each RB allocation and offset configuration are not included in the SAR report.</td></tr>
</table>

This report shall not be reproduced without the written approval of UL Verification Services Inc.

6.5. Power Reduction by Proximity Sensing

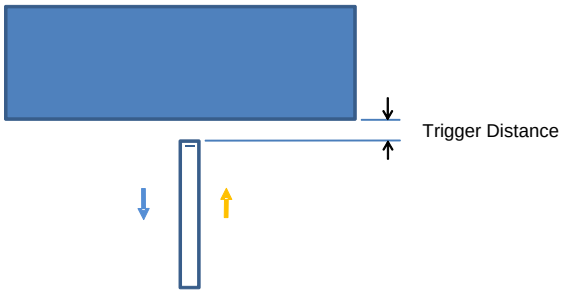
6.5.1. Proximity Sensor Triggering Distance (KDB 616217 §6.2)

Rear surface of the DUT was placed directly below the flat phantom. The DUT was moved toward the phantom in accordance with the steps outlined in KDB 616217 §6.2 to determine the trigger distance for enabling power reduction. The DUT was moved away from the phantom to determine the trigger distance for resuming full power.

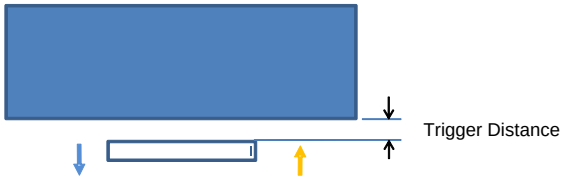
The measurement was then repeated for the Front surface and Edge 1.

The DUT featured a visual indicator on its display that showed the status of the proximity sensor (Triggered or not triggered). This was used to determine the status of the sensor during the proximity sensor assessment as monitoring the output power directly was not practical without affecting the measurement.

It was confirmed separately that the output power was altered according to the proximity sensor status indication. This was achieved by observing the proximity sensor status at the same time as monitoring the conducted power. Section 9 contains both the full and reduced conducted power measurements.



Proximity Sensor Trigger Distance Assessment
KDB 616217 §6.2 , **Edge 1**



Proximity Sensor Trigger Distance Assessment
KDB 616217 §6.2, **Rear & Front**

LEGEND

Direction of DUT travel for determination of power reduction triggering point

Direction of DUT travel for determination of full power resumption triggering point

Summary of Trigger Distances

Tissue simulating liquid	Trigger distance (Rear)		Trigger distance (Front)		Trigger distance (Edge 1)	
	Moving toward phantom	Moving from phantom	Moving toward phantom	Moving from phantom	Moving toward phantom	Moving from phantom
850 MHz	20 mm	20 mm	13 mm	13 mm	12 mm	12 mm
1900 MHz	20 mm	20 mm	13 mm	13 mm	12 mm	12 mm

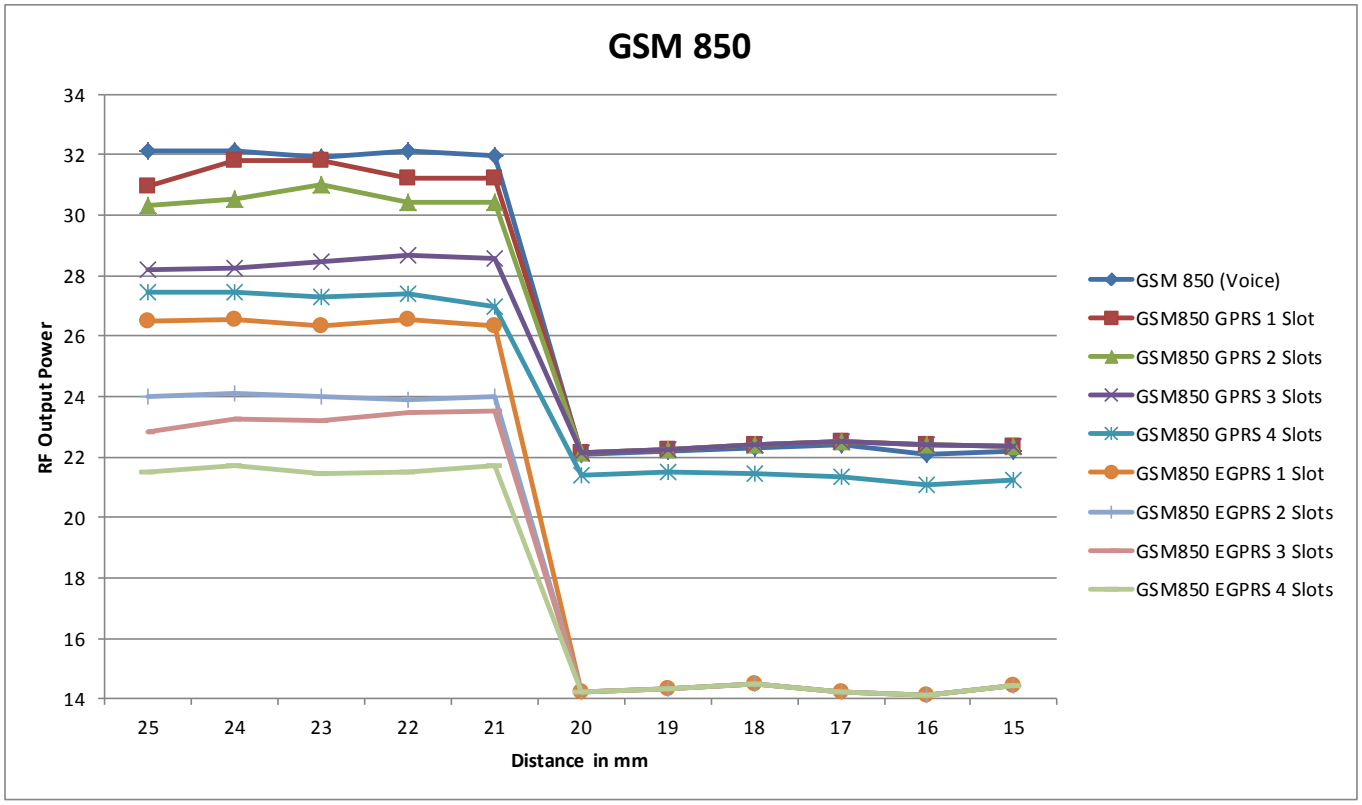
This report shall not be reproduced without the written approval of UL Verification Services Inc.

6.5.2. Proximity Sensor Triggering Distance Measurement Results

GSM850

Rear, DUT Moving Toward (Trigger) and Away (Release) from the Phantom

Distance to DUT vs. Output Power in dBm											
Distance (mm)	25	24	23	22	21	20	19	18	17	16	15
GSM 850 (Voice)	32.1	32.1	31.9	32.1	32.0	22.1	22.2	22.3	22.4	22.1	22.2
GSM850 GPRS 1 Slot	31.0	31.8	31.8	31.2	31.2	22.1	22.2	22.4	22.5	22.4	22.3
GSM850 GPRS 2 Slots	30.3	30.5	31.0	30.4	30.4	22.1	22.2	22.4	22.5	22.4	22.3
GSM850 GPRS 3 Slots	28.2	28.2	28.5	28.7	28.6	22.1	22.2	22.4	22.5	22.4	22.3
GSM850 GPRS 4 Slots	27.5	27.5	27.3	27.4	27.0	21.4	21.5	21.4	21.3	21.1	21.2
GSM850 EGPRS 1 Slot	26.48	26.56	26.35	26.55	26.32	14.20	14.32	14.50	14.23	14.11	14.42
GSM850 EGPRS 2 Slots	23.98	24.12	24.00	23.89	23.98	14.20	14.32	14.50	14.23	14.11	14.42
GSM850 EGPRS 3 Slots	22.85	23.25	23.20	23.45	23.50	14.20	14.32	14.50	14.23	14.11	14.42
GSM850 EGPRS 4 Slots	21.48	21.69	21.45	21.48	21.69	14.20	14.32	14.50	14.23	14.11	14.42

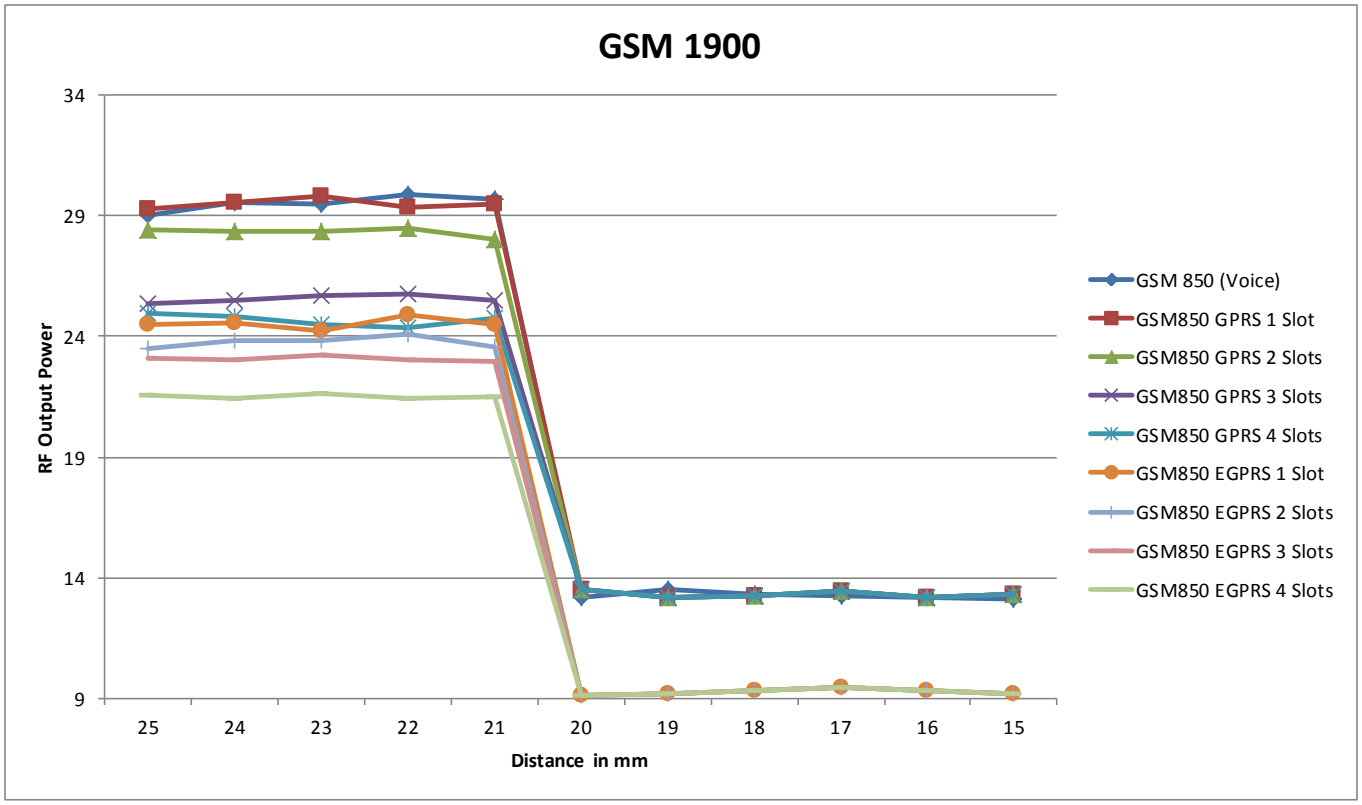


This report shall not be reproduced without the written approval of UL Verification Services Inc.

GSM1900

Rear, DUT Moving Toward (Trigger) and Away (Release) from the Phantom

Distance to DUT vs. Output Power in dBm											
Distance (mm)	25	24	23	22	21	20	19	18	17	16	15
GSM 850 (Voice)	29.0	29.5	29.5	29.9	29.7	13.2	13.5	13.3	13.3	13.2	13.2
GSM850 GPRS 1 Slot	29.3	29.5	29.8	29.3	29.4	13.5	13.2	13.3	13.5	13.2	13.3
GSM850 GPRS 2 Slots	28.4	28.3	28.3	28.5	28.0	13.5	13.2	13.3	13.5	13.2	13.3
GSM850 GPRS 3 Slots	25.3	25.5	25.7	25.8	25.5	13.5	13.2	13.3	13.5	13.2	13.3
GSM850 GPRS 4 Slots	24.9	24.8	24.5	24.4	24.8	13.5	13.2	13.3	13.5	13.2	13.3
GSM850 EGPRS 1 Slot	24.45	24.55	24.21	24.88	24.50	9.15	9.21	9.35	9.45	9.33	9.24
GSM850 EGPRS 2 Slots	23.48	23.81	23.80	24.10	23.53	9.15	9.21	9.35	9.45	9.33	9.24
GSM850 EGPRS 3 Slots	23.11	23.05	23.20	23.01	22.98	9.15	9.21	9.35	9.45	9.33	9.24
GSM850 EGPRS 4 Slots	21.54	21.43	21.65	21.42	21.52	9.12	9.21	9.35	9.45	9.33	9.24

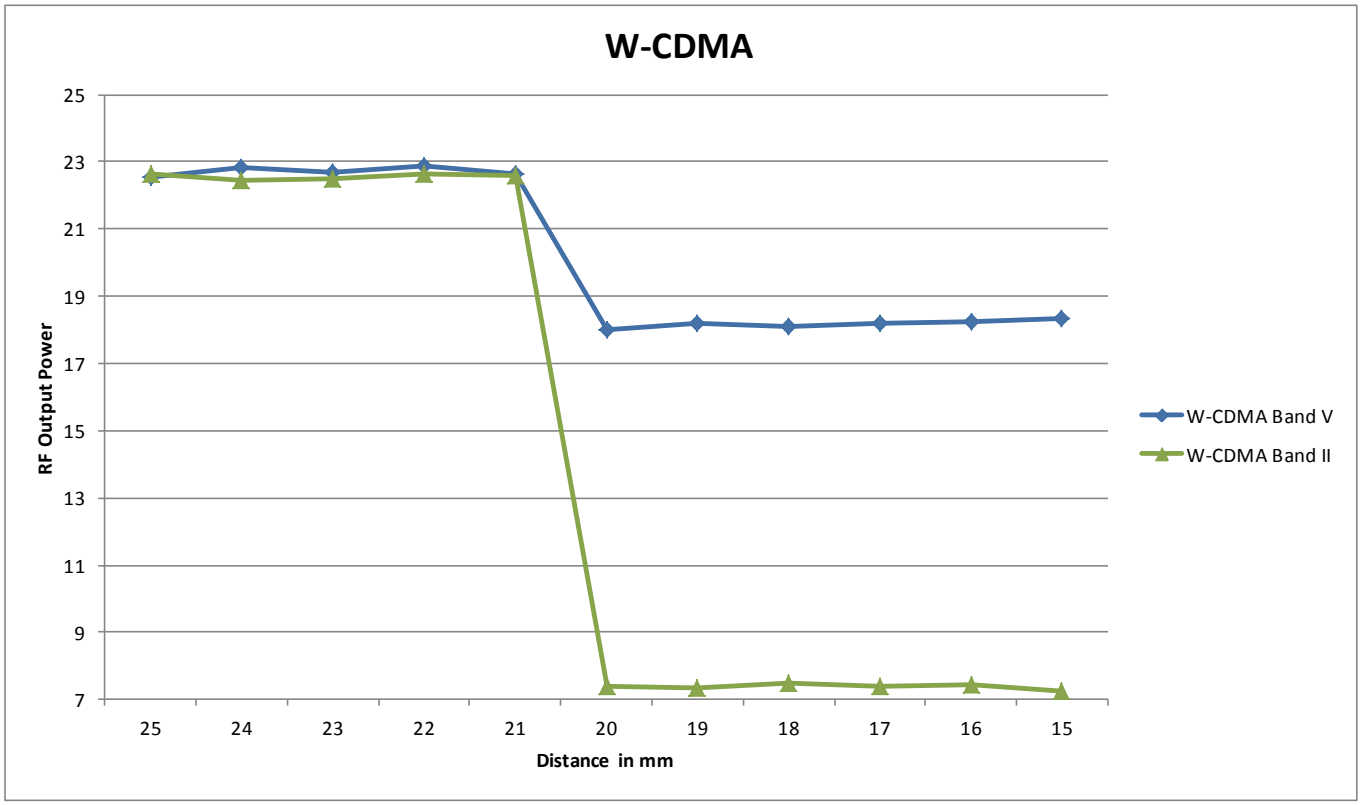


This report shall not be reproduced without the written approval of UL Verification Services Inc.

W-CDMA

Rear, DUT Moving Toward (Trigger) and Away (Release) from the Phantom

Distance to DUT vs. Output Power in dBm											
Distance (mm)	25	24	23	22	21	20	19	18	17	16	15
W-CDMA Band V	22.6	22.8	22.7	22.9	22.7	18.0	18.2	18.1	18.2	18.2	18.4
W-CDMA Band II	22.6	22.5	22.5	22.6	22.6	7.4	7.4	7.5	7.4	7.4	7.3



This report shall not be reproduced without the written approval of UL Verification Services Inc.

LTE

Rear, DUT Moving Toward (Trigger) and Away (Release) from the Phantom

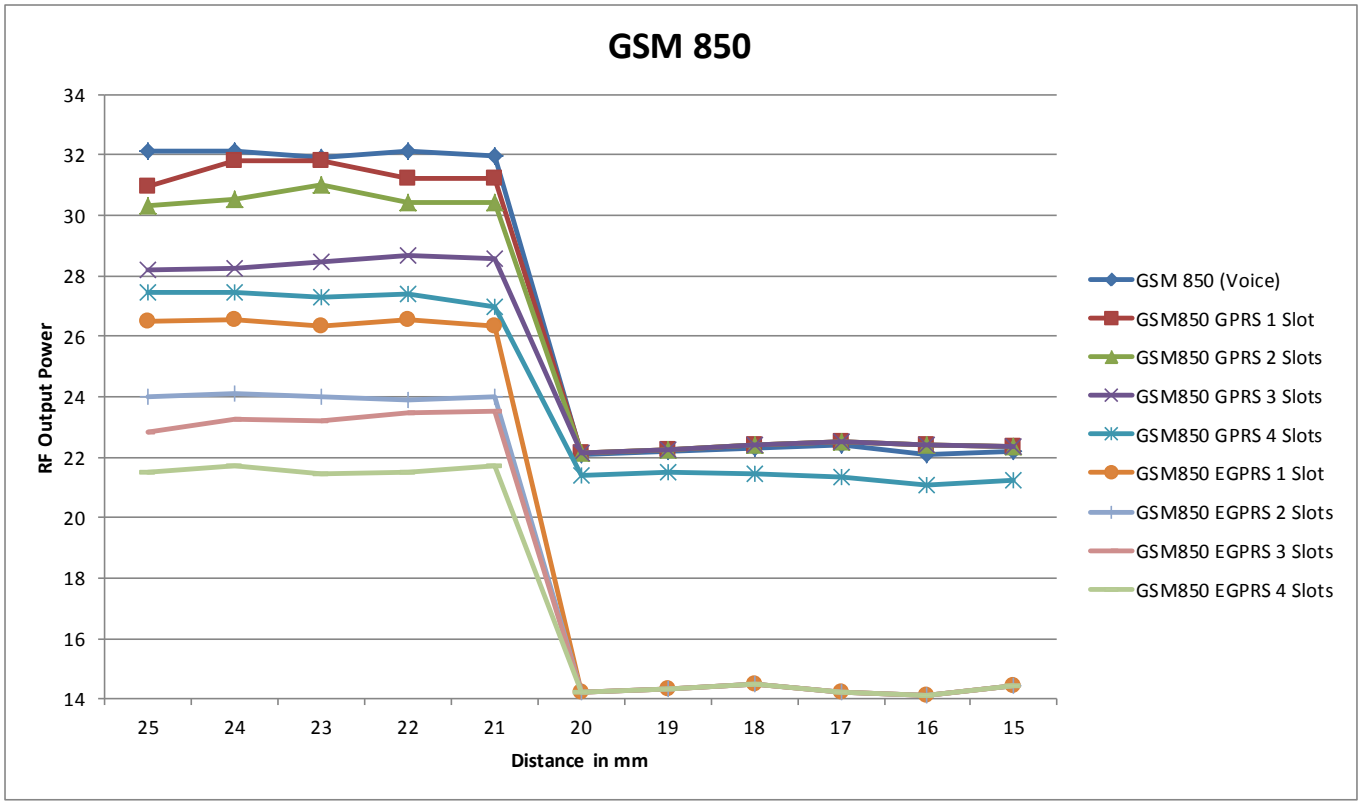
Distance to DUT vs. Output Power in dBm											
Distance (mm)	25	24	23	22	21	20	19	18	17	16	15
LTE Band 5	22.5	22.3	22.7	22.7	22.5	17.4	17.2	17.2	17.5	17.3	17.7

This report shall not be reproduced without the written approval of UL Verification Services Inc.

GSM850

Front, DUT Moving Toward (Trigger) and Away (Release) from the Phantom

Distance to DUT vs. Output Power in dBm											
Distance (mm)	18	17	16	15	14	13	12	11	10	9	8
GSM 850 (Voice)	32.1	32.0	31.9	31.4	32.2	22.2	22.1	21.2	21.5	22.3	22.0
GSM850 GPRS 1 Slot	31.0	31.1	31.8	32.0	32.1	22.0	22.1	21.8	21.9	22.5	22.0
GSM850 GPRS 2 Slots	30.3	31.2	31.0	29.5	30.4	22.0	22.1	21.8	21.9	22.5	22.0
GSM850 GPRS 3 Slots	28.2	27.5	28.5	28.3	28.7	22.0	22.1	21.8	21.9	22.5	22.0
GSM850 GPRS 4 Slots	27.5	27.2	27.3	27.0	27.4	21.3	21.4	21.1	21.4	21.2	21.0
GSM850 EGPRS 1 Slot	26.48	26.32	26.35	26.32	26.55	13.98	14.21	13.88	13.50	14.44	13.92
GSM850 EGPRS 2 Slots	23.98	23.50	24.12	24.32	23.89	13.98	14.21	13.88	13.50	14.44	13.92
GSM850 EGPRS 3 Slots	22.85	22.64	23.20	23.43	23.50	13.98	14.21	13.88	13.50	14.44	13.92
GSM850 EGPRS 4 Slots	21.48	21.26	21.45	21.50	21.69	13.98	14.21	13.88	13.50	14.44	13.92

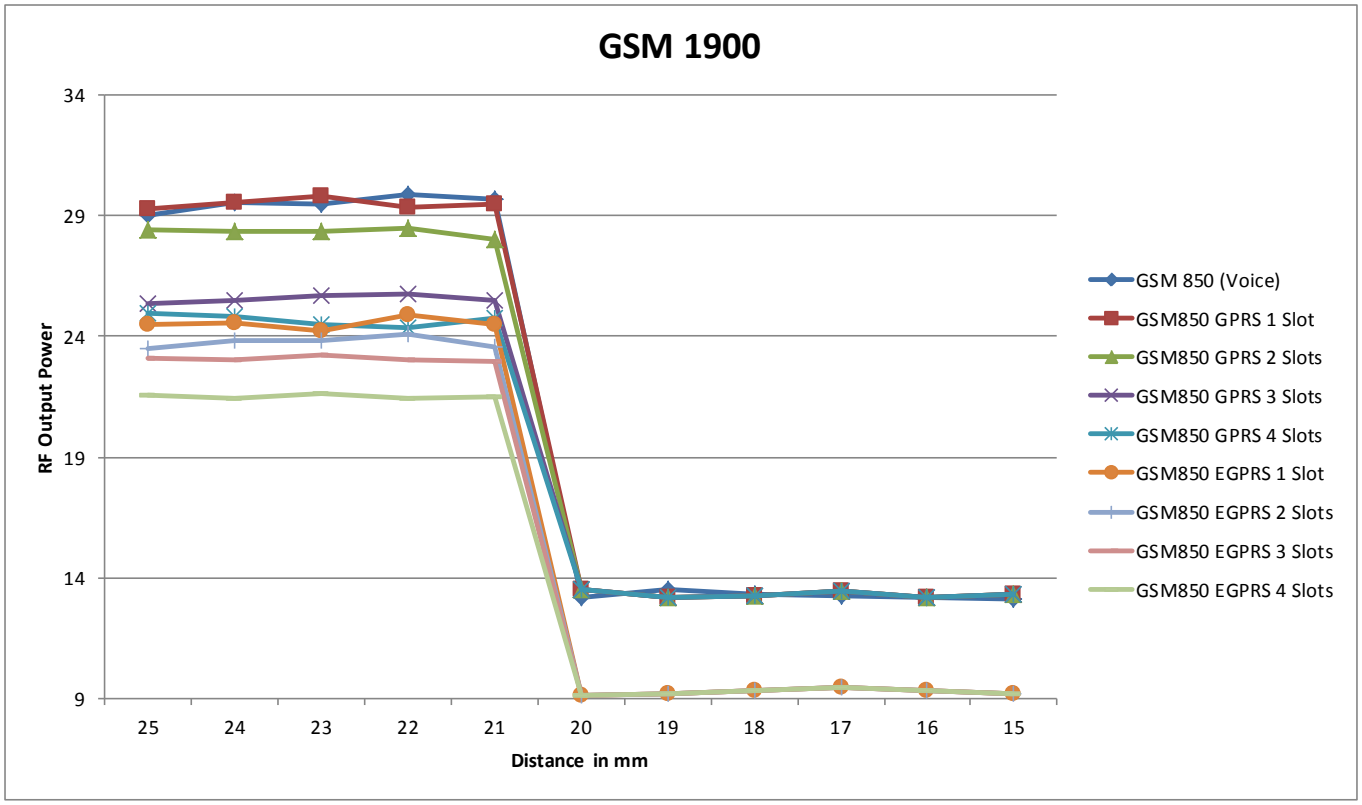


This report shall not be reproduced without the written approval of UL Verification Services Inc.

GSM1900

Front, DUT Moving Toward (Trigger) and Away (Release) from the Phantom

Distance to DUT vs. Output Power in dBm											
Distance (mm)	18	17	16	15	14	13	12	11	10	9	8
GSM 850 (Voice)	29.0	29.4	29.5	29.8	29.7	13.1	13.3	13.1	13.2	13.3	13.0
GSM850 GPRS 1 Slot	29.3	29.3	29.8	29.5	29.3	13.2	13.4	13.1	13.2	13.5	13.0
GSM850 GPRS 2 Slots	28.4	27.0	28.0	28.4	28.5	13.2	13.4	13.1	13.2	13.5	13.0
GSM850 GPRS 3 Slots	25.3	26.2	25.7	26.0	25.8	13.2	13.4	13.1	13.2	13.5	13.0
GSM850 GPRS 4 Slots	24.3	24.2	24.5	24.6	24.4	13.2	13.4	13.1	13.2	13.5	13.0
GSM850 EGPRS 1 Slot	24.45	25.20	24.21	25.40	24.88	9.01	9.02	9.00	9.01	9.21	8.98
GSM850 EGPRS 2 Slots	23.48	23.50	23.80	23.68	23.50	9.01	9.02	9.00	9.01	9.21	8.98
GSM850 EGPRS 3 Slots	22.87	23.10	23.09	22.98	23.01	9.01	9.02	9.00	9.01	9.21	8.98
GSM850 EGPRS 4 Slots	21.54	20.98	21.45	21.30	21.42	9.01	9.02	9.00	9.01	9.21	8.98

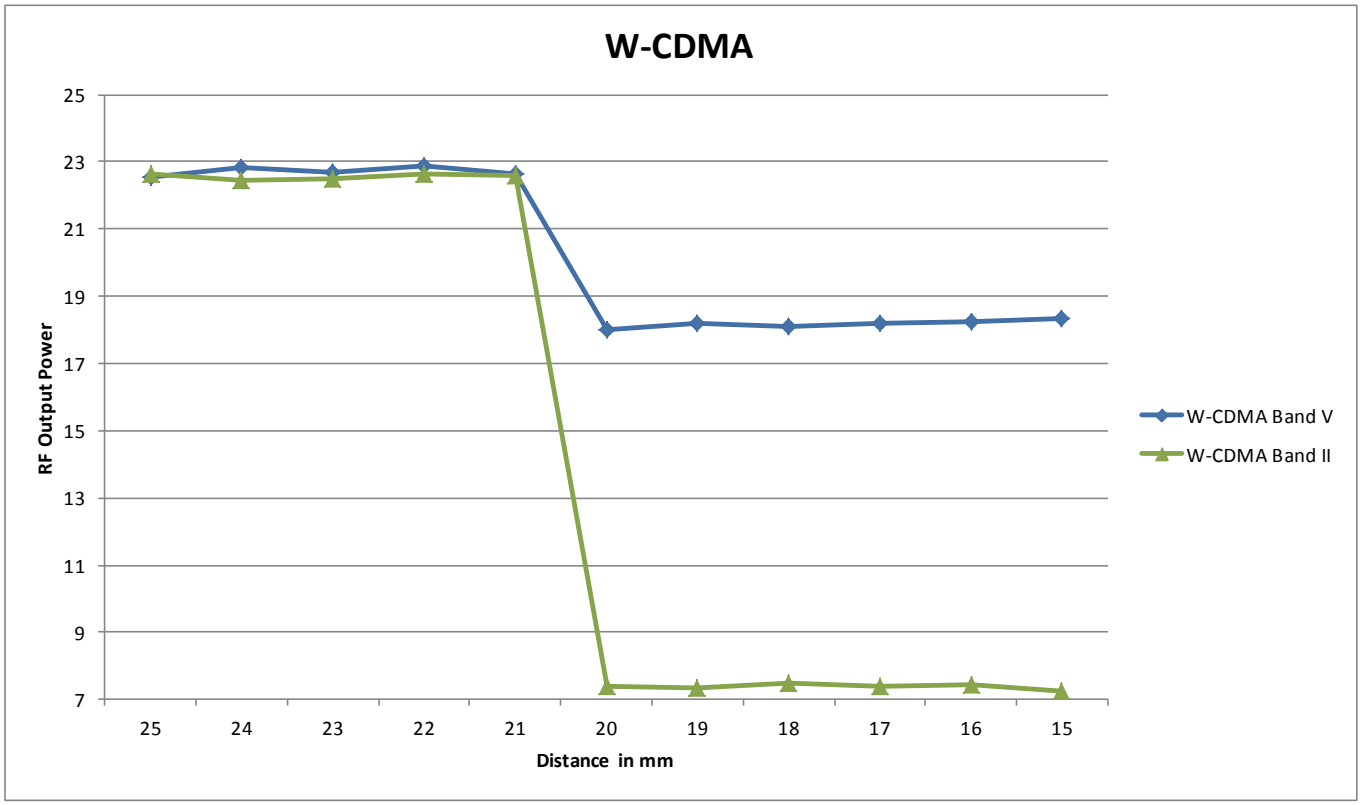


This report shall not be reproduced without the written approval of UL Verification Services Inc.

W-CDMA

Front, DUT Moving Toward (Trigger) and Away (Release) from the Phantom

Distance to DUT vs. Output Power in dBm											
Distance (mm)	18	17	16	15	14	13	12	11	10	9	8
W-CDMA Band V	22.6	21.6	22.7	22.9	22.9	18.2	18.2	18.2	18.4	18.2	18.4
W-CDMA Band II	23.2	23.6	23.0	22.4	22.6	7.2	7.3	7.2	7.2	7.2	7.3



This report shall not be reproduced without the written approval of UL Verification Services Inc.

LTE

Front, DUT Moving Toward (Trigger) and Away (Release) from the Phantom

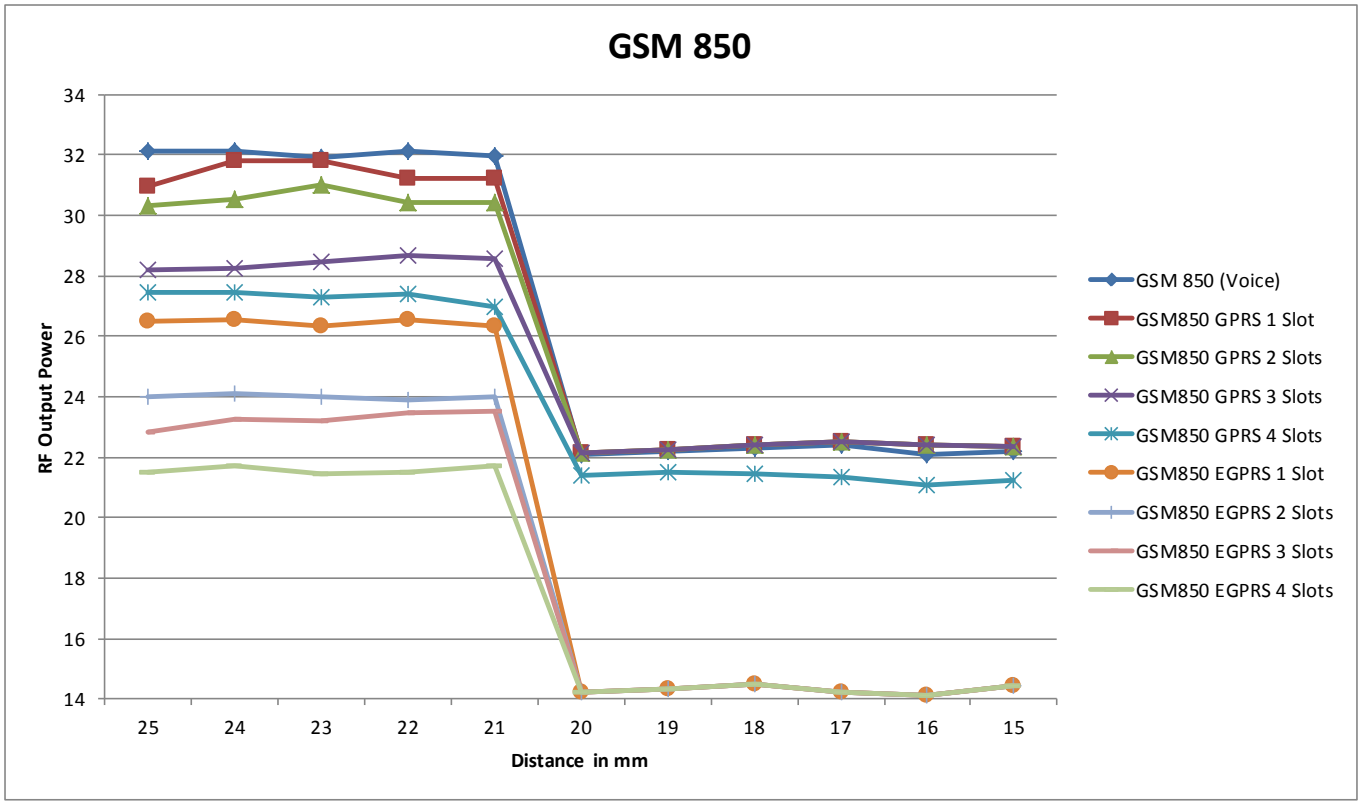
Distance to DUT vs. Output Power in dBm											
Distance (mm)	18	17	16	15	14	13	12	11	10	9	8
LTE Band 5	22.5	22.5	22.7	22.6	22.7	17.3	17.0	16.9	16.9	17.2	17.0

This report shall not be reproduced without the written approval of UL Verification Services Inc.

GSM850

Edge 1, DUT Moving Toward (Trigger) and Away (Release) from the Phantom

Distance to DUT vs. Output Power in dBm											
Distance (mm)	17	16	15	14	13	12	11	10	9	8	7
GSM 850 (Voice)	32.1	32.0	31.9	31.4	32.2	22.1	22.1	21.2	21.5	22.3	22.0
GSM850 GPRS 1 Slot	31.0	31.1	31.8	32.0	32.1	22.3	22.1	21.8	21.9	22.5	22.0
GSM850 GPRS 2 Slots	30.3	31.2	31.0	29.5	30.4	22.3	22.1	21.8	21.9	22.5	22.0
GSM850 GPRS 3 Slots	28.2	27.5	28.5	28.3	28.7	22.3	22.1	21.8	21.9	22.5	22.0
GSM850 GPRS 4 Slots	27.5	27.2	27.3	27.0	27.4	21.5	21.4	21.1	21.4	21.2	21.0
GSM850 EGPRS 1 Slot	26.48	26.32	26.35	26.32	26.55	14.42	14.21	13.88	13.50	14.44	13.92
GSM850 EGPRS 2 Slots	23.98	23.50	24.12	24.32	23.89	14.42	14.21	13.88	13.50	14.44	13.92
GSM850 EGPRS 3 Slots	22.85	22.64	23.20	23.43	23.50	14.42	14.21	13.88	13.50	14.44	13.92
GSM850 EGPRS 4 Slots	21.48	21.26	21.45	21.50	21.69	14.42	14.21	13.88	13.50	14.44	13.92

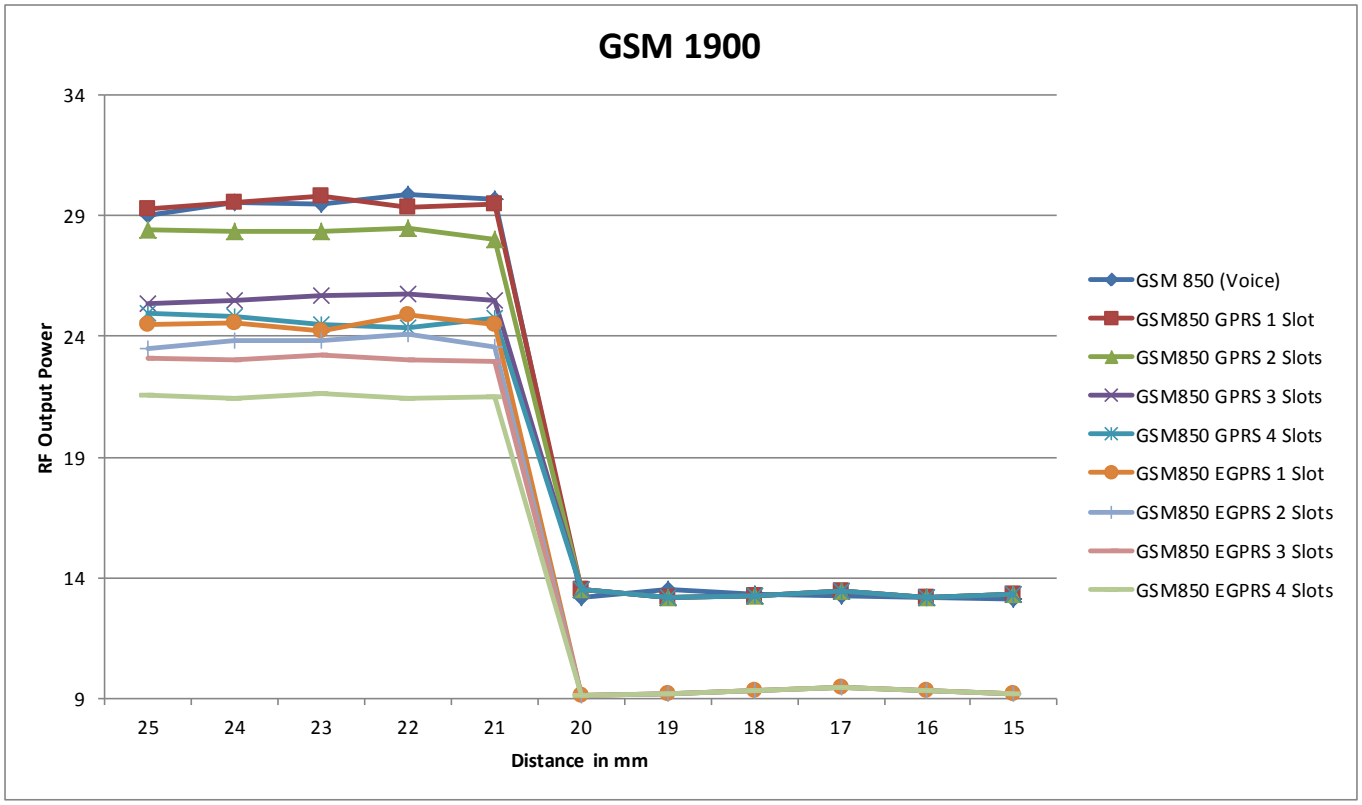


This report shall not be reproduced without the written approval of UL Verification Services Inc.

GSM1900

Edge 1, DUT Moving Toward (Trigger) and Away (Release) from the Phantom

Distance to DUT vs. Output Power in dBm											
Distance (mm)	17	16	15	14	13	12	11	10	9	8	7
GSM 850 (Voice)	29.0	29.4	29.5	29.8	29.7	13.2	13.3	13.1	13.2	13.3	13.0
GSM850 GPRS 1 Slot	29.3	29.3	29.8	29.5	29.3	13.3	13.4	13.1	13.2	13.5	13.0
GSM850 GPRS 2 Slots	28.4	27.0	28.0	28.4	28.5	13.3	13.4	13.1	13.2	13.5	13.0
GSM850 GPRS 3 Slots	25.3	26.2	25.7	26.0	25.8	13.3	13.4	13.1	13.2	13.5	13.0
GSM850 GPRS 4 Slots	24.3	24.2	24.5	24.6	24.4	13.3	13.4	13.1	13.2	13.5	13.0
GSM850 EGPRS 1 Slot	24.45	25.20	24.21	25.40	24.88	9.15	9.02	9.00	9.01	9.21	8.98
GSM850 EGPRS 2 Slots	23.48	23.50	23.80	23.68	23.50	9.15	9.02	9.00	9.01	9.21	8.98
GSM850 EGPRS 3 Slots	22.87	23.10	23.09	22.98	23.01	9.15	9.02	9.00	9.01	9.21	8.98
GSM850 EGPRS 4 Slots	21.54	20.98	21.45	21.30	21.42	9.12	9.02	9.00	9.01	9.21	8.98

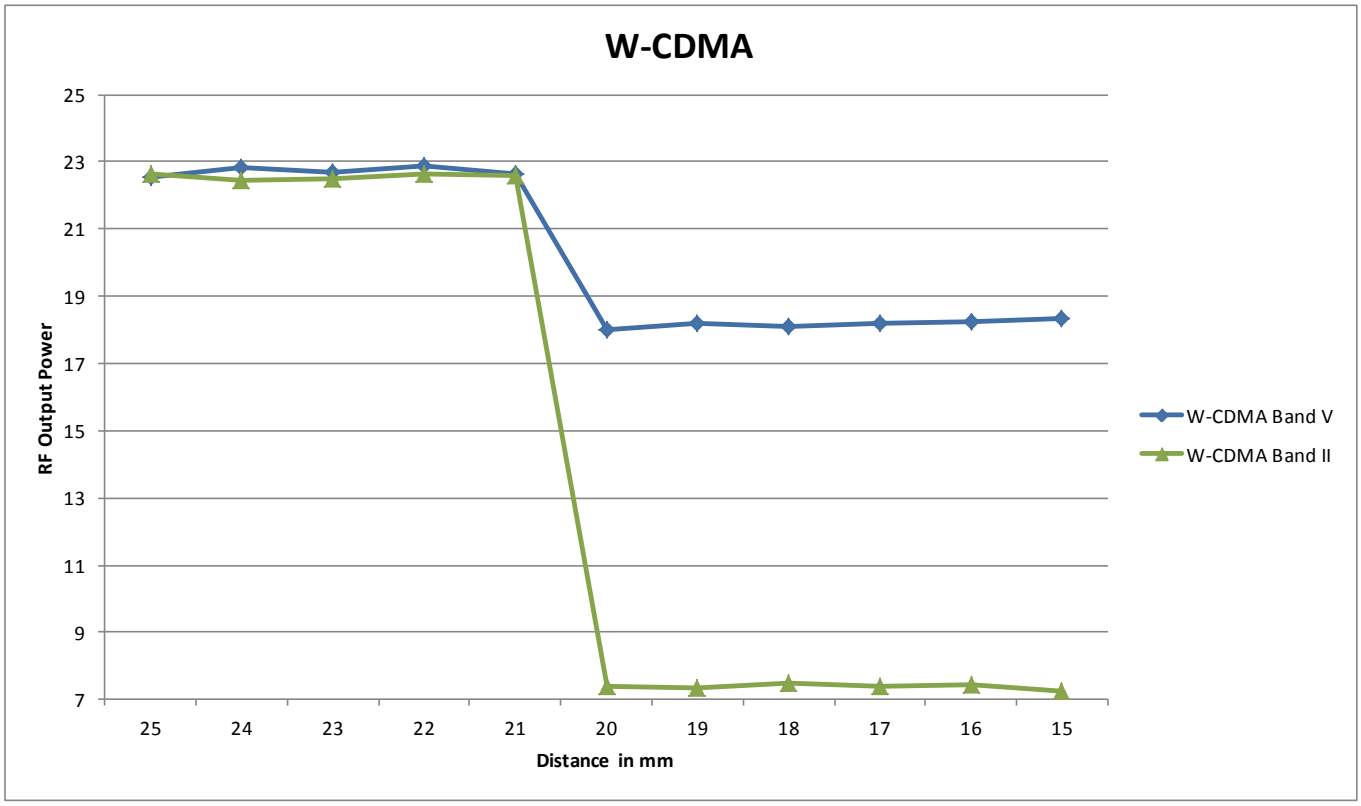


This report shall not be reproduced without the written approval of UL Verification Services Inc.

W-CDMA

Edge 1, DUT Moving Toward (Trigger) and Away (Release) from the Phantom

Distance to DUT vs. Output Power in dBm											
Distance (mm)	17	16	15	14	13	12	11	10	9	8	7
W-CDMA Band V	22.6	21.6	22.7	22.9	22.9	18.1	18.2	18.2	18.4	18.2	18.4
W-CDMA Band II	23.2	23.6	23.0	22.4	22.6	7.4	7.3	7.2	7.2	7.2	7.3



This report shall not be reproduced without the written approval of UL Verification Services Inc.

LTE

Edge 1, DUT Moving Toward (Trigger) and Away (Release) from the Phantom

Distance to DUT vs. Output Power in dBm											
Distance (mm)	17	16	15	14	13	12	11	10	9	8	7
LTE Band 5	22.5	22.5	22.7	22.6	22.7	17.4	16.9	16.8	17.2	17.5	17.3

This report shall not be reproduced without the written approval of UL Verification Services Inc.

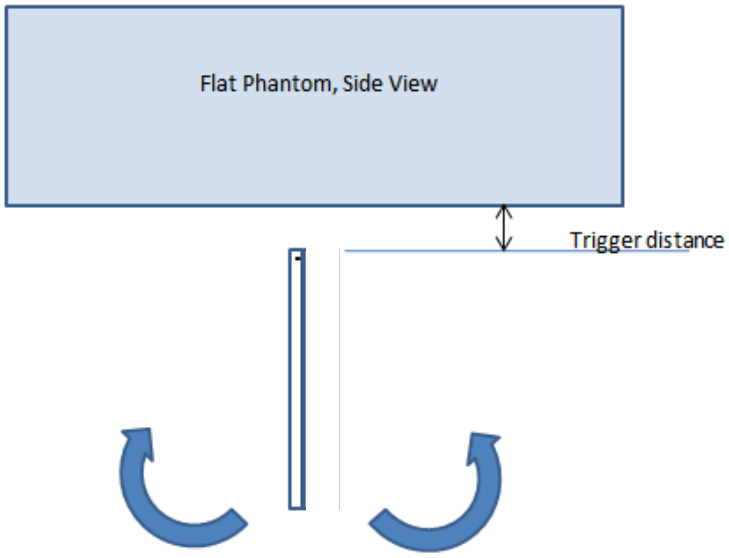
6.5.3. Proximity Sensor Coverage (KDB 616217 §6.3)

As there is no spatial offset between the antenna and the proximity sensor element, proximity sensor coverage did not need to be assessed.

6.5.4. Proximity Sensor Tilt Angle Assessment (KDB 616217 §6.4)

The DUT was positioned directly below the flat phantom at the minimum measured trigger distance with Edge 1 parallel to the base of the flat phantom for each band.

The EUT was rotated about Edge 1 for angles up to +/- 45°. If the output power increased during the rotation the DUT was moved 1mm toward the phantom and the rotation repeated. This procedure was repeated until the power remained reduced for all angles up to +/- 45°.



Proximity sensor tilt angle assessment (Edge 1) KDB 616217 §6.4

Summary of Tablet Tilt Angle Influence to Proximity Sensor Triggering for Edge 1

Band (MHz)	Minimum trigger distance measured according to KDB 616217 §6.2	Minimum distance at which power reduction was maintained over +/-45°	Power reduction status										
			-45°	-40°	-30°	-20°	-10°	0°	10°	20°	30°	40°	45°
850	12 mm	12 mm	On	On	On	On	On	On	On	On	On	On	On
1900	12 mm	12 mm	On	On	On	On	On	On	On	On	On	On	On

This report shall not be reproduced without the written approval of UL Verification Services Inc.

7. RF Exposure Conditions (Test Configurations)

This product is a phone supporting next to ear operations with diagonal dimensions greater than 20 cm. As such, testing in accordance with both KDB 648474 and 616217 is required in order to satisfy, respectively, the head SAR and body SAR exposure conditions. The usual body-worn accessory and hotspot mode testing required for phones are however not performed as they are effectively covered by the more conservative test requirements for tablets.

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

7.1. Head Exposure Conditions

Wireless technologies	RF Exposure Conditions	DUT-to-User Separation	Test Position	Antenna-to-edge/surface	SAR Required	Note
WWAN	Head	0 mm	Left Touch	N/A	Yes	
			Left Tilt (15°)	N/A	Yes	
			Right Touch	N/A	Yes	
			Right Tilt (15°)	N/A	Yes	
WLAN	Head	0 mm	Left Touch	N/A	Yes	
			Left Tilt (15°)	N/A	Yes	
			Right Touch	N/A	Yes	
			Right Tilt (15°)	N/A	Yes	

This report shall not be reproduced without the written approval of UL Verification Services Inc.

7.2. Standalone SAR Test Exclusion Considerations

Since the *Dedicated Host Approach* is applied, the standalone SAR test exclusion procedure in KDB 447498 § 4.3.1 is applied in conjunction with KDB 616217 § 4.3 to determine the minimum test separation distance:

- When the separation distance from the antenna to an adjacent edge is ≤ 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.
- When the separation distance from the antenna to an adjacent edge is > 5 mm, the actual antenna-to-edge separation distance is applied to determine SAR test exclusion.

SAR Test Exclusion Calculations for WWAN

Antennas < 50mm to adjacent edges

Antenna	Tx Interface	Frequency (MHz)	Output Power		Separation Distances (mm)						Calculated Threshold Value					
			dBm	mW	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front
Full Power, Proximity Sensor Off. A test seperation distance of 19 mm is included for Rear, 12 mm for front and 11 mm for Edge 1																
Cellular	GPRS 2 Slots	848.8	31.00	315	19	15.1	49	172	5		15.3 -MEASURE-	19.3 -MEASURE-	5.9 -MEASURE-	> 50 mm	58 -MEASURE-	
Cellular	GPRS 2 Slots	1909.8	28.50	177	19	15.1	49	172	5		12.9 -MEASURE-	16.3 -MEASURE-	5 -MEASURE-	> 50 mm	48.9 -MEASURE-	
Cellular	W-CDMA 2	1907.6	23.00	200	19	15.1	49	172	5		14.5 -MEASURE-	18.4 -MEASURE-	5.6 -MEASURE-	> 50 mm	55.2 -MEASURE-	
Cellular	W-CDMA 5	846.6	23.50	224	19	15.1	49	172	5		10.8 -MEASURE-	13.7 -MEASURE-	4.2 -MEASURE-	> 50 mm	41.2 -MEASURE-	
Cellular	LTE Band 5	844	23.00	200	19	15.1	49	172	5		9.7 -MEASURE-	12.2 -MEASURE-	3.7 -MEASURE-	> 50 mm	36.7 -MEASURE-	
Power Back-off, Proximity Sensor On																
Cellular	GPRS 4 Slots	848.8	21.50	71	5	5	49	172	5		13.1 -MEASURE-	13.1 -MEASURE-	1 -EXEMPT-	> 50 mm	13.1 -MEASURE-	
Cellular	GPRS 4 Slots	1909.8	13.50	11	5	5	49	172	5		3 -MEASURE-	3 -MEASURE-	0 -EXEMPT-	> 50 mm	3 -MEASURE-	
Cellular	W-CDMA 2	1907.6	8.00	6	5	5	49	172	5		2 -EXEMPT-	2 -EXEMPT-	0 -EXEMPT-	> 50 mm	2 -EXEMPT-	
Cellular	W-CDMA 5	846.6	19.00	79	5	5	49	172	5		14.5 -MEASURE-	14.5 -MEASURE-	1 -EXEMPT-	> 50 mm	14.5 -MEASURE-	
Cellular	LTE Band 5	844	18.00	63	5	5	49	172	5		11.6 -MEASURE-	11.6 -MEASURE-	1 -EXEMPT-	> 50 mm	11.6 -MEASURE-	

Note(s):

1. According to KDB 447498, if the calculated threshold value is >3 then SAR testing is required.

Antennas > 50mm to adjacent edges

Antenna	Tx Interface	Frequency (MHz)	Output Power		Separation Distances (mm)						Calculated Threshold Value					
			dBm	mW	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front
Full Power, Proximity Sensor Off. A test seperation distance of 19 mm is included for Rear, 12 mm for front and 11 mm for Edge 1																
Cellular	GPRS 2 Slots	848.8	31.00	315	19	15.1	49	172	5		< 50 mm	< 50 mm	< 50 mm	853.2 mW -EXEMPT-	< 50 mm	
Cellular	GPRS 2 Slots	1909.8	28.50	177	19	15.1	49	172	5		< 50 mm	< 50 mm	< 50 mm	1328.5 mW -EXEMPT-	< 50 mm	
Cellular	W-CDMA 2	1907.6	23.00	200	19	15.1	49	172	5		< 50 mm	< 50 mm	< 50 mm	1328.6 mW -EXEMPT-	< 50 mm	
Cellular	W-CDMA 5	846.6	23.50	224	19	15.1	49	172	5		< 50 mm	< 50 mm	< 50 mm	851.6 mW -EXEMPT-	< 50 mm	
Cellular	LTE Band 5	844	23.00	200	19	15.1	49	172	5		< 50 mm	< 50 mm	< 50 mm	849.7 mW -EXEMPT-	< 50 mm	
Power Back-off, Proximity Sensor On																
Cellular	GPRS 4 Slots	848.8	21.50	71	5	5	49	172	5		< 50 mm	< 50 mm	< 50 mm	853.2 mW -EXEMPT-	< 50 mm	
Cellular	GPRS 4 Slots	1909.8	13.50	11	5	5	49	172	5		< 50 mm	< 50 mm	< 50 mm	1328.5 mW -EXEMPT-	< 50 mm	
Cellular	W-CDMA 2	1907.6	8.00	6	5	5	49	172	5		< 50 mm	< 50 mm	< 50 mm	1328.6 mW -EXEMPT-	< 50 mm	
Cellular	W-CDMA 5	846.6	19.00	79	5	5	49	172	5		< 50 mm	< 50 mm	< 50 mm	851.6 mW -EXEMPT-	< 50 mm	
Cellular	LTE Band 5	844	18.00	63	5	5	49	172	5		< 50 mm	< 50 mm	< 50 mm	849.7 mW -EXEMPT-	< 50 mm	

Note(s):

1. According to KDB 447498, if the calculated Power threshold is less than the output power then SAR testing is required.

This report shall not be reproduced without the written approval of UL Verification Services Inc.

SAR Test Exclusion Calculations for WLAN

Antennas < 50mm to adjacent edges

Tx Interface	Frequency (MHz)	Output Power		Separation Distances (mm)						Calculated Threshold Value					
		dBm	mW	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front
Wi-Fi Full Power															
Wi-Fi 2.4 GHz	2462	12.50	18	5	167.1	78.7	5	5		5.6 -MEASURE-	> 50 mm	> 50 mm	5.6 -MEASURE-	5.6 -MEASURE-	
Wi-Fi 5.2 GHz	5240	9.50	9	5	167.1	78.7	5	5		4.1 -MEASURE-	> 50 mm	> 50 mm	4.1 -MEASURE-	4.1 -MEASURE-	
Wi-Fi 5.3 GHz	5320	9.50	9	5	167.1	78.7	5	5		4.2 -MEASURE-	> 50 mm	> 50 mm	4.2 -MEASURE-	4.2 -MEASURE-	
Wi-Fi 5.5 GHz	5700	9.50	9	5	167.1	78.7	5	5		4.3 -MEASURE-	> 50 mm	> 50 mm	4.3 -MEASURE-	4.3 -MEASURE-	
Wi-Fi 5.8 GHz	5825	9.50	9	5	167.1	78.7	5	5		4.3 -MEASURE-	> 50 mm	> 50 mm	4.3 -MEASURE-	4.3 -MEASURE-	
Bluetooth	2480	7.50	6	5	167.1	78.7	5	5		1.9 -EXEMPT-	> 50 mm	> 50 mm	1.9 -EXEMPT-	1.9 -EXEMPT-	

Note(s):

1. According to KDB 447498, if the calculated threshold value is >3 then SAR testing is required.

Antennas > 50mm to adjacent edges

Tx Interface	Frequency (MHz)	Output Power		Separation Distances (mm)						Calculated Threshold Value					
		dBm	mW	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front
Wi-Fi Full Power															
Wi-Fi 2.4 GHz	2462	12.50	18	5	167.1	78.7	5	5		< 50 mm	1266.6 mW -EXEMPT-	382.6 mW -EXEMPT-	< 50 mm	< 50 mm	
Wi-Fi 5.2 GHz	5240	9.50	9	5	167.1	78.7	5	5		< 50 mm	1236.5 mW -EXEMPT-	352.5 mW -EXEMPT-	< 50 mm	< 50 mm	
Wi-Fi 5.3 GHz	5320	9.50	9	5	167.1	78.7	5	5		< 50 mm	1236 mW -EXEMPT-	352 mW -EXEMPT-	< 50 mm	< 50 mm	
Wi-Fi 5.5 GHz	5700	9.50	9	5	167.1	78.7	5	5		< 50 mm	1233.8 mW -EXEMPT-	349.8 mW -EXEMPT-	< 50 mm	< 50 mm	
Wi-Fi 5.8 GHz	5825	9.50	9	5	167.1	78.7	5	5		< 50 mm	1233.2 mW -EXEMPT-	349.2 mW -EXEMPT-	< 50 mm	< 50 mm	
Bluetooth	2480	7.50	6	5	167.1	78.7	5	5		< 50 mm	1266.3 mW -EXEMPT-	382.3 mW -EXEMPT-	< 50 mm	< 50 mm	

Note(s):

1. According to KDB 447498, if the calculated Power threshold is less than the output power then SAR testing is required.

This report shall not be reproduced without the written approval of UL Verification Services Inc.

7.3. Required Test Configurations

The table below identifies the standalone test configurations required for this device according to the findings in Section 7.1:

Test Configurations	Rear	Edge 1 (Top Edge)	Edge 2 (Right Edge)	Edge 3 (Bottom Edge)	Edge 4 (Left Edge)
GSM850 Full Pow er	Yes	Yes	Yes	No	Yes
GSM850 w / Pow er Reduction	Yes	Yes	No	No	Yes
GSM1900 Full Pow er	Yes	Yes	Yes	No	Yes
GSM1900 w / Pow er Reduction	Yes	Yes	No	No	Yes
W-CDMA Band 2 Full Pow er	Yes	Yes	Yes	No	Yes
W-CDMA Band 2 w / Pow er Reduction	No	No	No	No	No
W-CDMA Band 5 Full Pow er	Yes	Yes	Yes	No	Yes
W-CDMA Band 5 w / Pow er Reduction	Yes	Yes	No	No	Yes
LTE Band 5 Full Pow er	Yes	Yes	Yes	No	Yes
LTE Band 5 w / Pow er Reduction	Yes	Yes	No	No	Yes
Wi-Fi 2.4 GHz Full Pow er	Yes	No	No	Yes	Yes
Wi-Fi 5 GHz Full Pow er	Yes	No	No	Yes	Yes
Bluetooth	No	No	No	No	No

Note(s):

1. Yes = Testing is required.
2. No = Testing is not required.

This report shall not be reproduced without the written approval of UL Verification Services Inc.

8. Dielectric Property Measurements & System Check

8.1. Dielectric Property Measurements

The temperature of the tissue-equivalent medium used during measurement must also be within 18°C to 25°C and within ± 2°C of the temperature when the tissue parameters are characterized.

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

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

Tissue Dielectric Parameters

FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz

Target Frequency (MHz)	Head		Body	
	ε_r	σ (S/m)	ε_r	σ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800 – 2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5000	36.2	4.45	49.3	5.07
5100	36.1	4.55	49.1	5.18
5200	36.0	4.66	49.0	5.30
5300	35.9	4.76	48.9	5.42
5400	35.8	4.86	48.7	5.53
5500	35.6	4.96	48.6	5.65
5600	35.5	5.07	48.5	5.77
5700	35.4	5.17	48.3	5.88
5800	35.3	5.27	48.2	6.00

IEEE Std 1528-2013

Refer to Table 3 within the IEEE Std 1528-2013

This report shall not be reproduced without the written approval of UL Verification Services Inc.

Dielectric Property Measurements Results:

SAR Lab F

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
1/26/2015	Body 835	e'	53.3100	Relative Permittivity (ε_r):	53.31	55.20	-3.42	5
		e''	21.6800	Conductivity (σ):	1.01	0.97	3.77	5
	Body 820	e'	53.4500	Relative Permittivity (ε_r):	53.45	55.28	-3.31	5
		e''	21.8800	Conductivity (σ):	1.00	0.97	3.01	5
	Body 850	e'	53.1700	Relative Permittivity (ε_r):	53.17	55.16	-3.60	5
		e''	21.6700	Conductivity (σ):	1.02	0.99	3.75	5
2/3/2015	Body 5180	e'	49.8900	Relative Permittivity (ε_r):	49.89	49.05	1.72	5
		e''	18.0900	Conductivity (σ):	5.21	5.27	-1.16	5
	Body 5200	e'	50.0900	Relative Permittivity (ε_r):	50.09	49.02	2.18	5
		e''	18.2200	Conductivity (σ):	5.27	5.29	-0.50	5
	Body 5600	e'	49.6600	Relative Permittivity (ε_r):	49.66	48.48	2.44	5
		e''	18.2400	Conductivity (σ):	5.68	5.76	-1.41	5
	Body 5800	e'	49.1500	Relative Permittivity (ε_r):	49.15	48.20	1.97	5
		e''	18.4100	Conductivity (σ):	5.94	6.00	-1.05	5
	Body 5825	e'	49.2700	Relative Permittivity (ε_r):	49.27	48.20	2.22	5
		e''	18.7100	Conductivity (σ):	6.06	6.00	1.00	5
2/4/2015	Head 5180	e'	36.1600	Relative Permittivity (ε_r):	36.16	36.01	0.41	5
		e''	16.1800	Conductivity (σ):	4.66	4.63	0.64	5
	Head 5200	e'	36.3700	Relative Permittivity (ε_r):	36.37	35.99	1.06	5
		e''	16.3400	Conductivity (σ):	4.72	4.65	1.58	5
	Head 5600	e'	35.9800	Relative Permittivity (ε_r):	35.98	35.53	1.26	5
		e''	16.3600	Conductivity (σ):	5.09	5.06	0.67	5
	Head 5800	e'	35.2500	Relative Permittivity (ε_r):	35.25	35.30	-0.14	5
		e''	16.3900	Conductivity (σ):	5.29	5.27	0.30	5
	Head 5825	e'	35.3500	Relative Permittivity (ε_r):	35.35	35.30	0.14	5
		e''	16.6100	Conductivity (σ):	5.38	5.27	2.08	5
2/10/2015	Head 835	e'	42.3700	Relative Permittivity (ε_r):	42.37	41.50	2.10	5
		e''	19.3400	Conductivity (σ):	0.90	0.90	-0.23	5
	Head 820	e'	42.5800	Relative Permittivity (ε_r):	42.58	41.60	2.35	5
		e''	19.4000	Conductivity (σ):	0.88	0.90	-1.55	5
	Head 850	e'	42.1600	Relative Permittivity (ε_r):	42.16	41.50	1.59	5
		e''	19.3100	Conductivity (σ):	0.91	0.92	-0.26	5
2/10/2015	Body 835	e'	54.2600	Relative Permittivity (ε_r):	54.26	55.20	-1.70	5
		e''	21.8000	Conductivity (σ):	1.01	0.97	4.34	5
	Body 820	e'	54.4500	Relative Permittivity (ε_r):	54.45	55.28	-1.50	5
		e''	21.8500	Conductivity (σ):	1.00	0.97	2.87	5
	Body 850	e'	54.0800	Relative Permittivity (ε_r):	54.08	55.16	-1.95	5
		e''	21.7300	Conductivity (σ):	1.03	0.99	4.04	5
3/2/2015	Body 835	e'	53.2900	Relative Permittivity (ε_r):	53.29	55.20	-3.46	5
		e''	21.8200	Conductivity (σ):	1.01	0.97	4.44	5
	Body 820	e'	53.4300	Relative Permittivity (ε_r):	53.43	55.28	-3.34	5
		e''	22.0100	Conductivity (σ):	1.00	0.97	3.62	5
	Body 850	e'	53.1200	Relative Permittivity (ε_r):	53.12	55.16	-3.69	5
		e''	21.6600	Conductivity (σ):	1.02	0.99	3.70	5
3/4/2015	Head 835	e'	40.5900	Relative Permittivity (ε_r):	40.59	41.50	-2.19	5
		e''	20.0700	Conductivity (σ):	0.93	0.90	3.54	5
	Head 820	e'	40.7100	Relative Permittivity (ε_r):	40.71	41.60	-2.15	5
		e''	20.0700	Conductivity (σ):	0.92	0.90	1.85	5
	Head 850	e'	40.4600	Relative Permittivity (ε_r):	40.46	41.50	-2.51	5
		e''	20.0900	Conductivity (σ):	0.95	0.92	3.77	5

This report shall not be reproduced without the written approval of UL Verification Services Inc.

SAR Lab H

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
1/26/2015	Body 1900	e'	52.8200	Relative Permittivity (ε_r):	52.82	53.30	-0.90	5
		e''	14.2500	Conductivity (σ):	1.51	1.52	-0.96	5
	Body 1850	e'	53.0400	Relative Permittivity (ε_r):	53.04	53.30	-0.49	5
		e''	14.1100	Conductivity (σ):	1.45	1.52	-4.51	5
	Body 1910	e'	52.8200	Relative Permittivity (ε_r):	52.82	53.30	-0.90	5
		e''	14.2400	Conductivity (σ):	1.51	1.52	-0.51	5
2/5/2015	Body 2450	e'	51.9300	Relative Permittivity (ε_r):	51.93	52.70	-1.46	5
		e''	14.1800	Conductivity (σ):	1.93	1.95	-0.94	5
	Body 2410	e'	52.1100	Relative Permittivity (ε_r):	52.11	52.76	-1.23	5
		e''	13.9900	Conductivity (σ):	1.87	1.91	-1.72	5
	Body 2475	e'	51.8500	Relative Permittivity (ε_r):	51.85	52.67	-1.55	5
		e''	14.2100	Conductivity (σ):	1.96	1.99	-1.49	5
2/6/2015	Head 2450	e'	38.5000	Relative Permittivity (ε_r):	38.50	39.20	-1.79	5
		e''	13.3900	Conductivity (σ):	1.82	1.80	1.34	5
	Head 2410	e'	38.5500	Relative Permittivity (ε_r):	38.55	39.28	-1.86	5
		e''	13.1600	Conductivity (σ):	1.76	1.76	0.17	5
	Head 2475	e'	38.4100	Relative Permittivity (ε_r):	38.41	39.17	-1.94	5
		e''	13.3900	Conductivity (σ):	1.84	1.83	0.86	5
2/8/2015	Head 1900	e'	39.6600	Relative Permittivity (ε_r):	39.66	40.00	-0.85	5
		e''	13.2200	Conductivity (σ):	1.40	1.40	-0.24	5
	Head 1850	e'	39.8400	Relative Permittivity (ε_r):	39.84	40.00	-0.40	5
		e''	13.0900	Conductivity (σ):	1.35	1.40	-3.82	5
	Head 1910	e'	39.6200	Relative Permittivity (ε_r):	39.62	40.00	-0.95	5
		e''	13.2200	Conductivity (σ):	1.40	1.40	0.28	5
2/8/2015	Body 1900	e'	51.5600	Relative Permittivity (ε_r):	51.56	53.30	-3.26	5
		e''	14.2400	Conductivity (σ):	1.50	1.52	-1.03	5
	Body 1850	e'	51.7600	Relative Permittivity (ε_r):	51.76	53.30	-2.89	5
		e''	14.1000	Conductivity (σ):	1.45	1.52	-4.58	5
	Body 1910	e'	51.5300	Relative Permittivity (ε_r):	51.53	53.30	-3.32	5
		e''	14.2900	Conductivity (σ):	1.52	1.52	-0.16	5

SAR Lab G

Date	Freq. (MHz)	Liquid Parameters			Measured	Target	Delta (%)	Limit ±(%)
2/11/2015	Body 1900	e'	52.1400	Relative Permittivity (ε_r):	52.14	53.30	-2.18	5
		e''	14.8400	Conductivity (σ):	1.57	1.52	3.14	5
	Body 1850	e'	52.3700	Relative Permittivity (ε_r):	52.37	53.30	-1.74	5
		e''	14.7300	Conductivity (σ):	1.52	1.52	-0.31	5
	Body 1910	e'	52.0800	Relative Permittivity (ε_r):	52.08	53.30	-2.29	5
		e''	14.8500	Conductivity (σ):	1.58	1.52	3.76	5

This report shall not be reproduced without the written approval of UL Verification Services Inc.

8.2. System Check

SAR system verification is required to confirm measurement accuracy, according to the tissue dielectric media, probe calibration points and other system operating parameters required for measuring the SAR of a test device. The system verification must be performed for each frequency band and within the valid range of each probe calibration point required for testing the device. The same SAR probe(s) and tissue-equivalent media combinations used with each specific SAR system for system verification must be used for device testing. When multiple probe calibration points are required to cover substantially large transmission bands, independent system verifications are required for each probe calibration point. A system verification must be performed before each series of SAR measurements using the same probe calibration point and tissue-equivalent medium. Additional system verification should be considered according to the conditions of the tissue-equivalent medium and measured tissue dielectric parameters, typically every three to four days when the liquid parameters are re-measured or sooner when marginal liquid parameters are used at the beginning of a series of measurements.

System Performance Check Measurement Conditions:

- The measurements were performed in the flat section of the TWIN SAM or ELI phantom, shell thickness: 2.0 ±0.2 mm (bottom plate) filled with Body or Head simulating liquid of the following parameters.
- The depth of tissue-equivalent liquid in a phantom must be ≥ 15.0 cm for SAR measurements ≤ 3 GHz and ≥ 10.0 cm for measurements > 3 GHz.
- The DASY system with an E-Field Probe was used for the measurements.
- The dipole was mounted on the small tripod so that the dipole feed point was positioned below the center marking of the flat phantom section and the dipole was oriented parallel to the body axis (the long side of the phantom). The standard measuring distance was 10 mm (above 1 GHz) and 15 mm (below 1 GHz) from dipole center to the simulating liquid surface.
- The coarse grid with a grid spacing of 15 mm was aligned with the dipole.
  For 5 GHz band - The coarse grid with a grid spacing of 10 mm was aligned with the dipole.
- Special 7x7x7 (below 3 GHz) and/or 8x8x7 (above 3 GHz) fine cube was chosen for the cube.
- Distance between probe sensors and phantom surface was set to 3 mm.
  For 5 GHz band - Distance between probe sensors and phantom surface was set to 2.5 mm
- The dipole input power (forward power) was 100 mW.
- The results are normalized to 1 W input power.

This report shall not be reproduced without the written approval of UL Verification Services Inc.

Reference Target SAR Values

The reference SAR values can be obtained from the calibration certificate of system validation dipoles

System Dipole	Serial No.	Cal. Date	Freq. (MHz)	Target SAR Values (W/kg)		
				1g/10g	Head	Body
D835V2	4d117	5/16/2014	835	1g	9.23	9.61
				10g	5.98	6.31
D1900V2	5d140	4/23/2014	1900	1g	40.1	40.2
				10g	21.0	21.3
D1900V2	5d043	11/7/2014	1900	1g	40.6	40.0
				10g	21.1	21.3
D2450V2	706	5/20/2014	2450	1g	53.0	50.2
				10g	24.5	23.4
D5GHzV2	1138	9/18/2014	5200	1g	81.4	75.4
				10g	23.3	21.0
			5600	1g	85.1	81.9
				10g	24.2	22.6
			5800	1g	80.6	75.2
				10g	23.0	20.8

This report shall not be reproduced without the written approval of UL Verification Services Inc.

System Check Results

The 1-g and 10-g SAR measured with a reference dipole, using the required tissue-equivalent medium at the test frequency, must be within 10% of the manufacturer calibrated dipole SAR target.

SAR Lab F

Date Tested	System Dipole		T.S. Liquid		Measured Results		Target (Ref. Value)	Delta ±10 %	Plot No.
	Type	Serial #			Zoom Scan to 100 mW	Normalize to 1 W			
1/26/2015	D835V2	4d117	Body	1g	1.00	10.0	9.61	4.06	
				10g	0.659	6.59	6.31	4.44	
2/3/2015	D5GHzV2 (5200)	1138	Body	1g	7.66	76.6	75.4	1.59	
				10g	2.19	21.9	21.0	4.29	
	D5GHzV2 (5600)			1g	7.99	79.9	81.9	-2.44	
				10g	2.25	22.5	22.6	-0.44	
	D5GHzV2 (5800)			1g	7.40	74.0	75.2	-1.60	
				10g	2.11	21.1	20.8	1.44	
2/4/2015	D5GHzV2 (5200)	1138	Head (ELI B)	1g	8.43	84.3	81.4	3.56	
				10g	2.44	24.4	23.3	4.72	
	D5GHzV2 (5600)			1g	8.67	86.7	85.1	1.88	
				10g	2.48	24.8	24.2	2.48	
	D5GHzV2 (5800)			1g	8.35	83.5	80.6	3.60	1,2
				10g	2.39	23.9	23.0	3.91	
2/10/2015	D835V2	4d117	Head	1g	0.975	9.75	9.23	5.63	3,4
				10g	0.636	6.36	5.98	6.35	
2/10/2015	D835V2	4d117	Body	1g	0.987	9.87	9.61	2.71	
				10g	0.649	6.49	6.31	2.85	
3/2/2015	D835V2	4d117	Body	1g	0.997	9.97	9.61	3.75	
				10g	0.654	6.54	6.31	3.65	
3/4/2015	D835V2	4d117	Head	1g	0.958	9.58	9.23	3.79	
				10g	0.627	6.27	5.98	4.85	

SAR Lab G

Date Tested	System Dipole		T.S. Liquid		Measured Results		Target (Ref. Value)	Delta ±10 %	Plot No.
	Type	Serial #			Zoom Scan to 100 mW	Normalize to 1 W			
2/11/2015	D1900V2	5d043	Body	1g	4.06	40.6	40.0	1.50	5,6
				10g	2.14	21.4	21.3	0.47	

SAR Lab H

Date Tested	System Dipole		T.S. Liquid		Measured Results		Target (Ref. Value)	Delta ±10 %	Plot No.
	Type	Serial #			Zoom Scan to 100 mW	Normalize to 1 W			
1/26/2015	D1900V2	5d140	Body	1g	4.08	40.8	40.2	1.49	
				10g	2.12	21.2	21.3	-0.47	
2/5/2015	D2450V2	706	Body	1g	4.80	48.0	50.2	-4.38	7,8
				10g	2.22	22.2	23.4	-5.13	
2/6/2015	D2450V2	706	Head (SAM A)	1g	5.47	54.7	53.0	3.21	
				10g	2.53	25.3	24.5	3.27	
2/6/2015	D2450V2	706	Head (ELI A)	1g	5.16	51.6	53.0	-2.64	
				10g	2.37	23.7	24.5	-3.27	
2/8/2015	D1900V2	5d140	Head	1g	3.82	38.2	40.1	-4.74	9,10
				10g	1.99	19.9	21.0	-5.24	
2/8/2015	D1900V2	5d140	Body	1g	4.03	40.3	40.2	0.25	
				10g	2.12	21.2	21.3	-0.47	

This report shall not be reproduced without the written approval of UL Verification Services Inc.

9. Conducted Output Power Measurements

9.1. GSM

GSM850 Measured Results

Band	Mode	Coding Scheme	Time Slots	Ch No.	Freq. (MHz)	Max Power		Reduce Power	
						Burst Pwr (dBm)	Frame Pwr (dBm)	Burst Pwr (dBm)	Frame Pwr (dBm)
850	GSM (Voice)	CS1	1	128	824.2	32.2	23.2	22.0	13.0
				190	836.6	32.3	23.3	22.0	13.0
				251	848.8	32.3	23.3	22.2	13.2
	GPRS (GMSK)	CS1	1	128	824.2	32.2	23.2	22.0	13.0
				190	836.6	32.3	23.3	22.0	13.0
				251	848.8	32.3	23.3	22.2	13.2
			2	128	824.2	30.7	24.7	22.0	16.0
				190	836.6	30.7	24.7	22.1	16.1
				251	848.8	30.9	24.9	22.2	16.2
			3	128	824.2	28.3	24.0	22.0	17.7
				190	836.6	28.4	24.1	22.1	17.8
				251	848.8	28.6	24.3	22.2	17.9
			4	128	824.2	26.2	23.2	20.9	17.9
				190	836.6	26.2	23.2	21.0	18.0
				251	848.8	26.5	23.5	21.2	18.2
	EGPRS (8PSK)	MCS5	1	128	824.2	26.0	17.0	14.5	5.5
				190	836.6	26.5	17.5	14.5	5.5
				251	848.8	26.5	17.5	14.5	5.5
			2	128	824.2	24.4	18.4	14.5	8.5
				190	836.6	25.0	19.0	14.5	8.5
				251	848.8	25.0	19.0	14.5	8.5
			3	128	824.2	22.5	18.2	14.5	10.2
				190	836.6	22.9	18.6	14.5	10.2
				251	848.8	22.9	18.6	14.5	10.2
			4	128	824.2	20.3	17.3	14.5	11.5
				190	836.6	20.9	17.9	14.5	11.5
				251	848.8	20.9	17.9	14.5	11.5

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 for Max Power and 4 time slots for Reduced power, 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

This report shall not be reproduced without the written approval of UL Verification Services Inc.

GSM1900 Measured Results

Band	Mode	Coding Scheme	Time Slots	Ch No.	Freq. (MHz)	Max Power		Reduce Power	
						Burst Pwr (dBm)	Frame Pwr (dBm)	Burst Pwr (dBm)	Frame Pwr (dBm)
1900	GSM (Voice)	CS1	1	512	1850.2	29.8	20.8	12.9	3.9
				661	1880.0	29.8	20.8	12.6	3.6
				810	1909.8	29.8	20.8	12.7	3.7
	GPRS (GMSK)	CS1	1	512	1850.2	29.8	20.8	12.9	3.9
				661	1880.0	29.8	20.8	12.6	3.6
				810	1909.8	29.8	20.8	12.7	3.7
			2	512	1850.2	28.3	22.3	12.8	6.8
				661	1880.0	28.3	22.3	12.6	6.6
				810	1909.8	28.3	22.3	12.7	6.7
			3	512	1850.2	26.3	22.0	12.8	8.5
				661	1880.0	26.3	22.0	12.5	8.2
				810	1909.8	26.2	21.9	12.6	8.3
			4	512	1850.2	24.0	21.0	12.8	9.8
				661	1880.0	24.0	21.0	12.5	9.5
				810	1909.8	23.9	20.9	12.6	9.6
	EGPRS (8PSK)	MCS5	1	512	1850.2	26.0	17.0	8.5	-0.5
				661	1880.0	25.9	16.9	8.6	-0.4
				810	1909.8	25.5	16.5	9.5	0.5
			2	512	1850.2	24.2	18.2	8.2	2.2
				661	1880.0	24.3	18.3	8.5	2.5
				810	1909.8	24.2	18.2	9.4	3.4
			3	512	1850.2	22.1	17.8	8.1	3.8
				661	1880.0	22.3	18.0	8.3	4.0
				810	1909.8	22.2	17.9	9.3	5.0
			4	512	1850.2	20.3	17.3	8.0	5.0
				661	1880.0	20.1	17.1	8.1	5.1
				810	1909.8	20.1	17.1	9.1	6.1

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 for Max Power and 4 time slots for Reduce Power, 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

This report shall not be reproduced without the written approval of UL Verification Services Inc.

9.2. W-CDMA

Release 99 Setup Procedures used to establish the test signals

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 2
	Rel99 RMC	12.2kbps RMC
	Power Control Algorithm	Algorithm2
	βc/βd	8/15

HSDPA Setup Procedures used to establish the test signals

The following 4 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	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-Set 1			
	Power Control Algorithm	Algorithm 2			
	βc	2/15	11/15	15/15	15/15
	βd	15/15	15/15	8/15	4/15
	Bd (SF)	64			
	βc/βd	2/15	12/15	15/8	15/4
	βhs	4/15	24/15	30/15	30/15
	MPR (dB)	0	0	0.5	0.5
HSDPA Specific Settings	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			
	Ahs=βhs/βc	30/15			

This report shall not be reproduced without the written approval of UL Verification Services Inc.

HSPA (HSDPA & HSUPA) Setup Procedures used to establish the test signals

The following 5 Sub-tests were completed according to Release 6 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	12.2 kbps RMC				
	HSDPA FRC	H-Set 1				
	HSUPA Test	HSPA				
	Power Control Algorithm	Algorithm 2				Algorithm 1
	βc	11/15	6/15	15/15	2/15	15/15
	βd	15/15	15/15	9/15	15/15	0
	βec	209/225	12/15	30/15	2/15	5/15
	βc/βd	11/15	6/15	15/9	2/15	15/1
	βhs	22/15	12/15	30/15	4/15	5/15
	βed	1309/225	94/75	47/15	56/75	47/15
	CM (dB)	1	3	2	3	1
	MPR (dB)	0	2	1	2	0
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				
	Ahs = βhs/βc	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

HSPA+

Since 16QAM is not used for uplink, the uplink Category and release is same as HSUPA, i.e., CAT 6 Rel 6. Therefore, the RF conducted power is not measured.

This report shall not be reproduced without the written approval of UL Verification Services Inc.

Measured Results

Band	Mode		UL Ch No.	Freq. (MHz)	MPR (dB)	Avg Pwr (dBm)	
						Max Pwr	Reduce Pwr
W-CDMA Band II	Rel 99	RMC, 12.2 kbps	9262	1852.4	N/A	23.0	7.3
			9400	1880.0	N/A	23.0	7.5
			9538	1907.6	N/A	23.0	7.3
	HSDPA	Subtest 1	9262	1852.4	0	22.0	6.4
			9400	1880.0	0	21.9	6.6
			9538	1907.6	0	21.9	6.4
		Subtest 2	9262	1852.4	0	20.5	6.2
			9400	1880.0	0	20.5	6.1
			9538	1907.6	0	20.6	6.0
		Subtest 3	9262	1852.4	0.5	20.2	5.8
			9400	1880.0	0.5	20.4	5.6
			9538	1907.6	0.5	20.5	5.7
		Subtest 4	9262	1852.4	0.5	20.7	5.6
			9400	1880.0	0.5	21.0	5.6
			9538	1907.6	0.5	20.6	5.7
	HSUPA	Subtest 1	9262	1852.4	0	21.0	6.0
			9400	1880.0	0	20.8	6.0
			9538	1907.6	0	20.6	6.0
		Subtest 2	9262	1852.4	2	20.0	4.0
			9400	1880.0	2	20.0	4.0
			9538	1907.6	2	20.0	4.0
		Subtest 3	9262	1852.4	1	20.3	5.0
			9400	1880.0	1	20.2	5.0
			9538	1907.6	1	20.4	5.0
		Subtest 4	9262	1852.4	2	20.0	4.0
			9400	1880.0	2	20.0	4.0
			9538	1907.6	2	20.0	4.0
		Subtest 5	9262	1852.4	0	21.5	6.0
			9400	1880.0	0	21.4	6.0
			9538	1907.6	0	21.6	6.0

This report shall not be reproduced without the written approval of UL Verification Services Inc.

Band	Mode		UL Ch No.	Freq. (MHz)	MPR (dB)	Avg Pwr (dBm)	
						Max Pwr	Reduce Pwr
W-CDMA Band V	Rel 99	RMC, 12.2 kbps	4132	826.4	N/A	23.4	18.8
			4183	836.6	N/A	23.3	18.7
			4233	846.6	N/A	23.4	18.7
	HSDPA	Subtest 1	4132	826.4	0	22.0	17.5
			4183	836.6	0	22.0	17.5
			4233	846.6	0	22.0	17.5
		Subtest 2	4132	826.4	0	21.3	16.2
			4183	836.6	0	21.6	16.2
			4233	846.6	0	21.4	16.3
		Subtest 3	4132	826.4	0.5	20.5	16.0
			4183	836.6	0.5	20.9	16.2
			4233	846.6	0.5	20.5	16.1
		Subtest 4	4132	826.4	0.5	20.6	16.3
			4183	836.6	0.5	20.7	16.2
			4233	846.6	0.5	20.8	16.0
	HSUPA	Subtest 1	4132	826.4	0	21.0	16.2
			4183	836.6	0	21.0	16.5
			4233	846.6	0	21.1	16.5
		Subtest 2	4132	826.4	2	20.0	14.0
			4183	836.6	2	20.0	14.0
			4233	846.6	2	20.0	14.0
		Subtest 3	4132	826.4	1	20.4	15.4
			4183	836.6	1	20.2	15.5
			4233	846.6	1	20.4	15.6
		Subtest 4	4132	826.4	2	20.0	14.0
			4183	836.6	2	20.0	14.0
			4233	846.6	2	20.0	14.0
		Subtest 5	4132	826.4	0	21.7	17.1
			4183	836.6	0	21.5	17.0
			4233	846.6	0	21.6	17.0

This report shall not be reproduced without the written approval of UL Verification Services Inc.

9.3. LTE

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

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

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

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

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

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

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

This report shall not be reproduced without the written approval of UL Verification Services Inc.

LTE Band 5 Max Power Measured Results

Band	BW (MHz)	Mode	RB Allocation	RB offset	Target MPR	Meas. MPR	Avg Pwr (dBm)		
							829 MHz	836.5 MHz	844 MHz
LTE Band 5	10	QPSK	1	0	0	0	22.7	22.7	22.7
			1	25	0	0	22.7	22.7	22.6
			1	49	0	0	22.7	22.6	22.6
			25	0	1	1	21.7	21.7	21.7
			25	12	1	1	21.7	21.7	21.6
			25	25	1	1	21.7	21.7	21.6
			50	0	1	1	21.7	21.7	21.6
		16QAM	1	0	1	1	22.0	22.0	21.8
			1	25	1	1	22.0	21.9	21.7
			1	49	1	1	22.0	22.0	21.7
			25	0	2	2	21.0	21.0	21.0
			25	12	2	2	21.0	21.0	21.0
			25	25	2	2	21.0	21.0	21.0
			50	0	2	2	21.0	21.0	21.0
Band	BW (MHz)	Mode	RB Allocation	RB offset	Target MPR	Meas. MPR	Avg Pwr (dBm)		
							826.5 MHz	836.5 MHz	846.5 MHz
LTE Band 5	5	QPSK	1	0	0	0	22.4	22.7	22.6
			1	12	0	0	22.5	22.7	22.5
			1	24	0	0	22.5	22.7	22.5
			12	0	1	1	21.7	21.8	21.7
			12	6	1	1	21.7	21.8	21.7
			12	11	1	1	21.7	21.8	21.6
			25	0	1	1	21.7	21.8	21.6
		16QAM	1	0	1	1	22.0	21.8	22.0
			1	12	1	1	22.0	21.8	22.0
			1	24	1	1	22.0	21.8	22.0
			12	0	2	2	21.0	21.0	21.0
			12	6	2	2	21.0	21.0	21.0
			12	11	2	2	21.0	21.0	21.0
			25	0	2	2	21.0	21.0	21.0
Band	BW (MHz)	Mode	RB Allocation	RB offset	Target MPR	Meas. MPR	Avg Pwr (dBm)		
							825.5 MHz	836.5 MHz	847.5 MHz
LTE Band 5	3	QPSK	1	0	0	0	22.6	22.6	22.6
			1	7	0	0	22.7	22.6	22.6
			1	14	0	0	22.7	22.6	22.6
			8	0	1	1	21.6	21.8	21.6
			8	4	1	1	21.7	21.8	21.6
			8	7	1	1	21.7	21.8	21.6
			15	0	1	1	21.7	21.8	21.6
		16QAM	1	0	1	1	22.0	22.0	21.8
			1	7	1	1	22.0	22.0	21.7
			1	14	1	1	22.0	22.0	21.7
			8	0	2	2	21.0	21.0	21.0
			8	4	2	2	21.0	21.0	21.0
			8	7	2	2	21.0	21.0	21.0
			15	0	2	2	21.0	21.0	20.9

This report shall not be reproduced without the written approval of UL Verification Services Inc.

LTE Band 5 Max Power Measured Results (continued)

Band	BW (MHz)	Mode	RB Allocation	RB offset	Target MPR	Meas. MPR	Avg Pwr (dBm)		
							824.7 MHz	836.5 MHz	848.3 MHz
LTE Band 5	1.4	QPSK	1	0	0	0	22.7	22.8	22.7
			1	2	0	0	22.7	22.8	22.7
			1	5	0	0	22.7	22.8	22.7
			3	0	0	0	22.7	22.8	22.7
			3	1	0	0	22.7	22.8	22.7
			3	2	0	0	22.7	22.9	22.7
			6	0	1	1	21.8	21.9	21.7
		16QAM	1	0	1	1	21.8	22.0	22.0
			1	2	1	1	21.8	22.0	22.0
			1	5	1	1	21.8	22.0	22.0
			3	0	1	1	22.0	22.0	22.0
			3	1	1	1	22.0	22.0	22.0
			3	2	1	1	22.0	22.0	22.0
			6	0	2	2	21.0	21.0	20.9

This report shall not be reproduced without the written approval of UL Verification Services Inc.

LTE Band 5 Reduce Power Measured Results

Band	BW (MHz)	Mode	RB Allocation	RB offset	Target MPR	Meas. MPR	Avg Pwr (dBm)		
							829 MHz	836.5 MHz	844 MHz
LTE Band 5	10	QPSK	1	0	0	0	16.8	16.8	16.5
			1	25	0	0	16.8	16.6	16.5
			1	49	0	0	16.5	16.5	16.5
			25	0	1	1	15.7	15.5	15.5
			25	12	1	1	15.8	15.6	15.5
			25	25	1	1	15.8	15.5	15.5
			50	0	1	1	15.8	15.5	15.6
		16QAM	1	0	1	1	15.8	16.3	15.6
			1	25	1	1	15.9	16.0	15.6
			1	49	1	1	15.6	15.8	15.6
			25	0	2	2	14.8	14.6	14.6
			25	12	2	2	14.9	14.7	14.7
			25	25	2	2	14.8	14.5	14.6
			50	0	2	2	14.8	14.6	14.6
Band	BW (MHz)	Mode	RB Allocation	RB offset	Target MPR	Meas. MPR	Avg Pwr (dBm)		
							826.5 MHz	836.5 MHz	846.5 MHz
LTE Band 5	5	QPSK	1	0	0	0	16.7	16.6	16.6
			1	12	0	0	16.7	16.6	16.6
			1	24	0	0	16.7	16.5	16.6
			12	0	1	1	15.8	15.6	15.5
			12	6	1	1	15.7	15.6	15.5
			12	11	1	1	15.8	15.5	15.5
			25	0	1	1	15.8	15.6	15.5
		16QAM	1	0	1	0	16.0	16.0	16.5
			1	12	1	0	15.8	16.0	16.4
			1	24	1	0	15.9	15.9	16.4
			12	0	2	2	14.8	14.8	14.6
			12	6	2	2	14.7	14.7	14.6
			12	11	2	2	14.8	14.6	14.6
			25	0	2	2	14.9	14.6	14.5
Band	BW (MHz)	Mode	RB Allocation	RB offset	Target MPR	Meas. MPR	Avg Pwr (dBm)		
							825.5 MHz	836.5 MHz	847.5 MHz
LTE Band 5	3	QPSK	1	0	0	0	16.7	16.7	16.5
			1	7	0	0	16.6	16.6	16.5
			1	14	0	0	16.7	16.5	16.5
			8	0	1	1	15.8	15.7	15.6
			8	4	1	1	15.7	15.7	15.6
			8	7	1	1	15.7	15.6	15.5
			15	0	1	1	15.7	15.6	15.5
		16QAM	1	0	1	1	15.9	16.2	15.7
			1	7	1	1	15.7	16.1	15.6
			1	14	1	1	15.7	16.0	15.7
			8	0	2	2	14.9	14.6	14.8
			8	4	2	2	14.8	14.6	14.8
			8	7	2	2	14.8	14.6	14.8
			15	0	2	2	14.8	14.7	14.5

This report shall not be reproduced without the written approval of UL Verification Services Inc.

LTE Band 5 Reduce Power Measured Results (continued)

Band	BW (MHz)	Mode	RB Allocation	RB offset	Target MPR	Meas. MPR	Avg Pwr (dBm)		
							824.7 MHz	836.5 MHz	848.3 MHz
LTE Band 5	1.4	QPSK	1	0	0	0	16.7	16.5	16.5
			1	2	0	0	16.7	16.5	16.5
			1	5	0	0	16.7	16.5	16.5
			3	0	0	0	16.8	16.5	16.5
			3	1	0	0	16.7	16.5	16.5
			3	2	0	0	16.7	16.5	16.5
			6	0	1	1	15.7	15.6	15.5
		16QAM	1	0	1	1	16.0	16.0	15.6
			1	2	1	1	15.9	16.0	15.6
			1	5	1	1	15.9	16.0	15.6
			3	0	1	1	15.9	15.8	15.8
			3	1	1	1	15.8	15.9	15.8
			3	2	1	1	15.8	15.8	15.8
			6	0	2	2	14.9	14.5	14.8

This report shall not be reproduced without the written approval of UL Verification Services Inc.

9.4. Wi-Fi 2.4GHz

Band (GHz)	Mode	Data Rate	Ch #	Freq. (MHz)	Avg Pwr (dBm)	Max Output Power (dBm)	SAR Test (Yes/No)	Note(s)
2.4	802.11b	1 Mbps	1	2412	11.9	12.5	Yes	
			6	2437	12.0			
			11	2462	11.7			
	802.11g	6 Mbps	1	2412	Not Required	11.5	No	1
			6	2437				
			11	2462				
	802.11n (HT20)	MCS0	1	2412		10.5	No	1
			6	2437				
			11	2462				

Note(s):

1. Output Power and SAR is not required for 802.11g/n HT20 channels when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.

This report shall not be reproduced without the written approval of UL Verification Services Inc.

9.5. Wi-Fi 5GHz

Band (GHz)	Mode	Data Rate	Ch #	Freq. (MHz)	Avg Pwr (dBm)	Max Output Power (dBm)	SAR Test (Yes/No)	Note(s)
5.2 (U-NII 1)	802.11a	6 Mbps	36	5180	9.2	9.5	No	2
			40	5200	9.1			
			44	5220	8.9			
			48	5240	9.5			
	802.11n (HT20)	6.5 Mbps	36-48	5180 - 5240	Not Required	8.5	No	1
	802.11n (HT40)	13.5 Mbps	38-46	5190 - 5230		8.5	No	1
5.3 (U-NII 2A)	802.11a	6 Mbps	52	5260	9.5	9.5	Yes	
			56	5280	9.4			
			60	5300	9.1			
			64	5320	9.2			
	802.11n (HT20)	6.5 Mbps	52-64	5260 - 5320	Not Required	8.5	No	1
	802.11n (HT40)	13.5 Mbps	54-62	5270 - 5310		8.5	No	1
5.5 (U-NII 2C)	802.11a	6 Mbps	100	5500	9.4	9.5	Yes	
			104	5520	9.4			
			108	5540	9.4			
			112	5560	9.2			
			116	5580	9.2			
			132	5660	8.9			
			136	5680	9.5			
			140	5700	9.4			
	802.11n (HT20)	6.5 Mbps	100-140	5500-5700	Not Required	8.5	No	1
	802.11n (HT40)	13.5 Mbps	102-134	5510-5670		8.5	No	1
5.8 (U-NII 3)	802.11a	6 Mbps	149	5745	9.4	9.5	Yes	
			153	5765	9.5			
			157	5785	9.5			
			161	5805	9.5			
			165	5825	9.5			
	802.11n (HT20)	6.5 Mbps	149-161	5745-5805	Not Required	8.5	No	1
	802.11n (HT40)	13.5 Mbps	151-159	5755-5795		8.5	No	1

Note(s):

1. Output Power and SAR measurement is not required for 802.11n HT20/HT40 channels when the specified tune-up tolerances for 802.11n HT20/HT40 are lower than 802.11a by more than ½ dB and the measured SAR is ≤ 1.2 W/Kg.
2. When the specified maximum output power is the same for both UNII band I and UNII band 2A, begin SAR measurement in UNII band 2A; and if the highest *reported* SAR for UNII band 2A is
   - ≤ 1.2 W/kg, SAR is not required for UNII band I
   - > 1.2 W/kg, both bands should be tested independently for SAR.

This report shall not be reproduced without the written approval of UL Verification Services Inc.

9.6. Bluetooth

Maximum tune-up tolerance limit is 7.50 dBm from the rated nominal maximum output power. This power level qualifies for exclusion of SAR testing.

This report shall not be reproduced without the written approval of UL Verification Services Inc.

10. Measured and Reported (Scaled) SAR Results

SAR Test Reduction criteria are as follows:

KDB 447498 D01 General RF Exposure Guidance:
Testing of other required channels within the operating mode of a frequency band is not required when the reported 1-g or 10-g SAR for the mid-band or highest output power channel is:

- ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
- ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
- ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz

KDB 648474 D04 Handset SAR:
With headset attached, when the reported SAR for body-worn accessory, measured without a headset connected to the handset, is > 1.2 W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a headset attached to the handset.

The normal tablet procedures in KDB 616217 are required when the over diagonal dimension of the device is > 20.0 cm. Hotspot mode SAR is not required when normal tablet procedures are applied. Extremity 10-g SAR is also not required for the front (top) surface of large form factor full size tablets. The more conservative tablet SAR results can be used to support the 10-g extremity SAR for phablet mode.

KDB 941225 D01 SAR test for 3G devices:
When the maximum output power and tune-up tolerance specified for production units in a secondary mode is ≤ ¼ dB higher than the primary mode or when the highest reported SAR of the primary mode is scaled by the ratio of specified maximum output power and tune-up tolerance of secondary to primary mode and the adjusted SAR is ≤ 1.2 W/kg, SAR measurement is not required for the secondary mode

KDB 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.

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

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

This report shall not be reproduced without the written approval of UL Verification Services Inc.

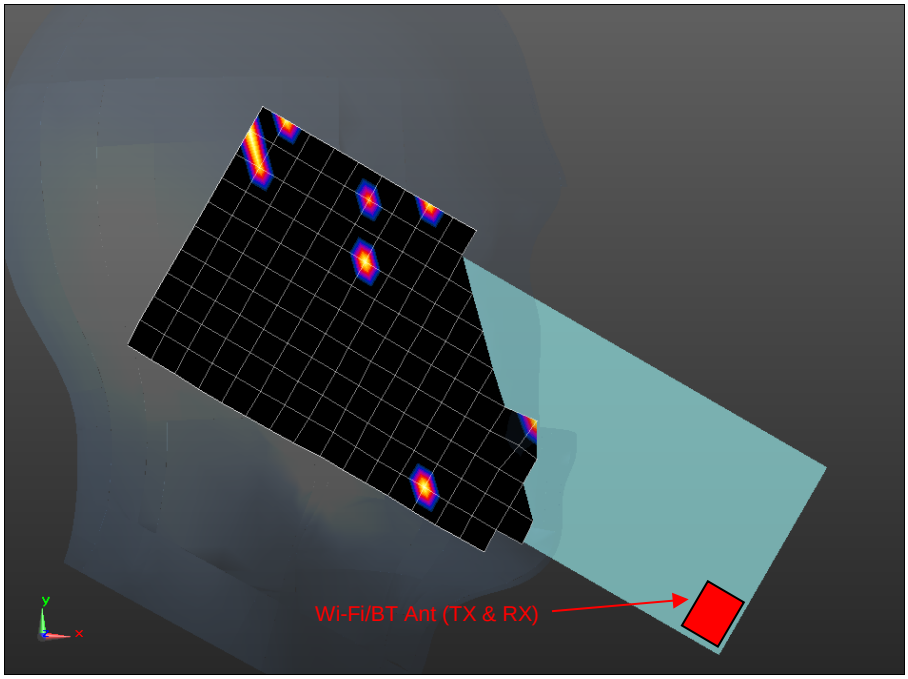
- ≤ 0.4 W/kg, further SAR measurement is not required for the other test positions in that exposure configuration and wireless mode combination within the frequency band or aggregated band. DSSS and OFDM configurations are considered separately according to the required SAR procedures.
- > 0.4 W/kg,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

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

This report shall not be reproduced without the written approval of UL Verification Services Inc.

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):

- 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.

This report shall not be reproduced without the written approval of UL Verification Services Inc.

10.1. GSM850

RF Exposure Conditions	Mode	Pwr Back Off	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		Plot No.
							Tune-up limit	Meas.	Meas.	Scaled	
Head	Voice	On	0	Left Touch	190	836.6	22.5	22.0	0.087	0.098	
				Left Tilt	190	836.6	22.5	22.0	0.070	0.079	
				Right Touch	190	836.6	22.5	22.0	0.115	0.129	
				Right Tilt	190	836.6	22.5	22.0	0.095	0.107	
Head VoIP	GPRS 4 Slots	On	0	Left Touch	190	836.6	21.5	21.0	0.245	0.275	
				Left Tilt	190	836.6	21.5	21.0	0.202	0.227	
				Right Touch	190	836.6	21.5	21.0	0.391	0.439	1
				Right Tilt	190	836.6	21.5	21.0	0.285	0.320	
Body	GPRS 4 Slots	On	0	Rear	128	824.2	21.5	20.9	0.915	1.051	
					190	836.6	21.5	21.0	0.974	1.093	2
					251	848.8	21.5	21.2	1.010	1.082	
				Edge 1	190	836.6	21.5	21.0	0.481	0.540	
				Edge 4	190	836.6	21.5	21.0	0.120	0.135	
	GPRS 2 Slots	Off	19	Rear	190	836.6	31.0	30.7	0.175	0.188	
			11	Edge 1	190	836.6	31.0	30.7	0.253	0.271	
			0	Edge 2	190	836.6	31.0	30.7	0.121	0.130	
			0	Edge 4	190	836.6	31.0	30.7	0.321	0.344	

10.2. GSM1900

RF Exposure Conditions	Mode	Pwr Back Off	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Power (dBm)		1-g SAR (W/kg)		Plot No.
							Tune-up limit	Meas.	Meas.	Scaled	
Head	Voice	On	0	Left Touch	661	1880.0	13.5	12.6	0.015	0.019	
				Left Tilt	661	1880.0	13.5	12.6	0.015	0.018	
				Right Touch	661	1880.0	13.5	12.6	0.050	0.062	
				Right Tilt	661	1880.0	13.5	12.6	0.044	0.054	
Head VoIP	GPRS 4 Slots	On	0	Left Touch	661	1880.0	13.5	12.5	0.057	0.072	
				Left Tilt	661	1880.0	13.5	12.5	0.054	0.068	
				Right Touch	661	1880.0	13.5	12.5	0.197	0.248	3
				Right Tilt	661	1880.0	13.5	12.5	0.161	0.203	
Body	GPRS 4 Slots	On	0	Rear	661	1880.0	13.5	12.5	0.523	0.658	4
				Edge 1	661	1880.0	13.5	12.5	0.281	0.354	
				Edge 4	661	1880.0	13.5	12.5	0.021	0.026	
	GPRS 2 Slots	Off	19	Rear	661	1880.0	28.5	28.3	0.484	0.507	
			11	Edge 1	661	1880.0	28.5	28.3	0.608	0.637	
			0	Edge 2	661	1880.0	28.5	28.3	0.083	0.087	
			0	Edge 4	661	1880.0	28.5	28.3	0.286	0.299	

This report shall not be reproduced without the written approval of UL Verification Services Inc.

10.3. W-CDMA Band V

RF Exposure Conditions	Mode	Pwr back Off	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	On	0	Left Touch	4183	836.6	19.0	18.7	0.274	0.294	
				Left Tilt	4183	836.6	19.0	18.7	0.233	0.250	
				Right Touch	4183	836.6	19.0	18.7	0.418	0.448	5
				Right Tilt	4183	836.6	19.0	18.7	0.324	0.347	
Body	Rel 99 RMC	On	0	Rear	4132	826.4	19.0	18.8	0.910	0.953	6
					4183	836.6	19.0	18.7	0.887	0.950	
					4233	846.6	19.0	18.7	0.887	0.950	
				Edge 1	4183	836.6	19.0	18.7	0.485	0.520	
				Edge 4	4183	836.6	19.0	18.7	0.133	0.143	
		Off	19	Rear	4183	836.6	23.5	23.3	0.189	0.198	
			11	Edge 1	4183	836.6	23.5	23.3	0.364	0.381	
			0	Edge 2	4183	836.6	23.5	23.3	0.138	0.145	
			0	Edge 4	4183	836.6	23.5	23.3	0.385	0.403	

10.4. W-CDMA Band II

RF Exposure Conditions	Mode	Pwr Back Off	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	On	0	Left Touch	9400	1880.0	8.0	7.5	0.022	0.025	
				Left Tilt	9400	1880.0	8.0	7.5	0.021	0.023	
				Right Touch	9400	1880.0	8.0	7.5	0.065	0.073	7
				Right Tilt	9400	1880.0	8.0	7.5	0.061	0.068	
Body	Rel 99 RMC	On	0	Rear	9400	1880.0	8.0	7.5	0.299	0.335	
				Edge 1	9400	1880.0	8.0	7.5	0.121	0.136	
				Edge 4	9400	1880.0	8.0	7.5	0.010	0.011	
		Off	19	Rear	9400	1880.0	23.0	23.0	0.536	0.536	
			11	Edge 1	9262	1852.4	23.0	23.0	0.798	0.798	
					9400	1880.0	23.0	23.0	0.832	0.832	8
					9538	1907.6	23.0	23.0	0.639	0.639	
			0	Edge 2	9400	1880.0	23.0	23.0	0.113	0.113	
			0	Edge 4	9400	1880.0	23.0	23.0	0.425	0.425	

This report shall not be reproduced without the written approval of UL Verification Services Inc.

10.5. LTE Band 5 (10MHz Bandwidth)

RF Exposure Conditions	Mode	Pwr Back Off	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	RB Allocation	RB offest	Power (dBm)		1-g SAR (W/kg)		Plot No.
									Tune-up limit	Meas.	Meas.	Scaled	
Head	QPSK	On	0	Left Touch	20525	836.5	1	0	18.0	16.8	0.180	0.238	
							25	12	17.0	15.6	0.104	0.144	
				Left Tilt	20525	836.5	1	0	18.0	16.8	0.157	0.208	
							25	12	17.0	15.6	0.091	0.126	
				Right Touch	20525	836.5	1	0	18.0	16.8	0.211	0.279	9
							25	12	17.0	15.6	0.120	0.166	
				Right Tilt	20525	836.5	1	0	18.0	16.8	0.201	0.266	
							25	12	17.0	15.6	0.122	0.168	
Body	QPSK	On	0	Rear	20525	836.5	1	0	18.0	16.8	0.504	0.667	
							25	12	17.0	15.6	0.490	0.676	10
				Edge 1	20525	836.5	1	0	18.0	16.8	0.290	0.384	
							25	12	17.0	15.6	0.275	0.380	
				Edge 4	20525	836.5	1	0	18.0	16.8	0.081	0.107	
							25	12	18.0	17.0	0.041	0.052	
		Off	19	Rear	20525	836.5	1	0	23.0	22.7	0.160	0.171	
							25	0	22.0	21.7	0.134	0.144	
			11	Edge 1	20525	836.5	1	0	23.0	22.7	0.227	0.243	
							25	0	22.0	21.7	0.189	0.203	
			0	Edge 2	20525	836.5	1	0	23.0	22.7	0.111	0.119	
							25	0	22.0	21.7	0.092	0.098	
			0	Edge 4	20525	836.5	1	0	23.0	22.7	0.310	0.332	
							25	0	22.0	21.7	0.259	0.278	

This report shall not be reproduced without the written approval of UL Verification Services Inc.

10.6. Wi-Fi (DTS Band)

Frequency Band	Mode	RF Exposure Conditions	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Area Scan Max. SAR (W/kg)	Power (dBm)		1-g SAR (W/kg)		Notes	Plot No.
								Tune-up limit	Meas.	Meas.	Scaled		
2.4GHz	802.11b 1 Mbps	Head	10	Flat	6	2437.0	0.048	12.5	12.0	0.033	0.037		11
		Body	0	Rear	6	2437.0	1.570	12.5	12.0	0.979	1.098		12
					11	2462.0		12.5	11.7	0.896	1.077	3	
				Edge 3	6	2437.0	0.757	12.5	12.0	0.631	0.708	2	
				Edge 4	6	2437.0	0.033						

Note(s):

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

10.7. Wi-Fi (U-NII Band)

Frequency Band	Mode	RF Exposure Conditions	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Area Scan Max. SAR (W/kg)	Power (dBm)		1-g SAR (W/kg)		Notes	Plot No.
								Tune-up limit	Meas.	Meas.	Scaled		
5.3 GHz U-NII 2A	802.11a 6 Mbps	Head	10	Flat	52	5260.0	0.137	9.5	9.5	0.075	0.075		13
		Body	0	Rear	52	5260.0	1.460	9.5	9.5	0.982	0.982		14
					56	5280.0		9.5	9.4	0.911	0.932	3	
				Edge 3	52	5260.0	0.595	9.5	9.5	0.307	0.307	2	
				Edge 4	52	5260.0	0.360						
Frequency Band	Mode	RF Exposure Conditions	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Area Scan Max. SAR (W/kg)	Power (dBm)		1-g SAR (W/kg)		Notes	Plot No.
								Tune-up limit	Meas.	Meas.	Scaled		
5.5 GHz U-NII 2C	802.11a 6 Mbps	Head	10	Flat	136	5680.0	0.065	9.5	9.5	0.044	0.044		15
		Body	0	Rear	136	5680.0	0.762	9.5	9.5	0.701	0.701		16
				Edge 3	136	5680.0	0.371	9.5	9.5	0.201	0.201	2	
				Edge 4	136	5680.0	0.164						
Frequency Band	Mode	RF Exposure Conditions	Dist. (mm)	Test Position	Ch #.	Freq. (MHz)	Area Scan Max. SAR (W/kg)	Power (dBm)		1-g SAR (W/kg)		Notes	Plot No.
								Tune-up limit	Meas.	Meas.	Scaled		
5.8 GHz U-NII 3	802.11a 6 Mbps	Head	10	Flat	157	5785.0	0.093	9.5	9.5	0.042	0.042		17
		Body	0	Rear	157	5785.0	1.150	9.5	9.5	0.811	0.811		
					161	5805.0		9.5	9.5	0.819	0.819	3	18
				Edge 3	157	5785.0	0.639	9.5	9.5	0.349	0.349	2	
				Edge 4	157	5785.0	0.151						

Note(s):

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

This report shall not be reproduced without the written approval of UL Verification Services Inc.

10.8. Bluetooth

Standalone SAR Test Exclusion Considerations & Estimated SAR

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

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

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

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

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

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

Body-worn Accessory Exposure Conditions

Max. tune-up tolerance limit		Min. test separation distance (mm)	Frequency (GHz)	SAR test exclusion Result*	Test Configuration	Estimated 1-g SAR (W/kg)
(dBm)	(mW)					
7.5	6	5	2.480	1.9	Rear/Front	0.252

Conclusion:

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

This report shall not be reproduced without the written approval of UL Verification Services Inc.

11. SAR Measurement Variability

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

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

Frequency Band	Air Interface	RF Exposure Conditions	Test Position	Repeated SAR	Highest Measured SAR	Repeated Measured SAR	Largest to Smallest
850	GSM 850	Body	Rear	Yes	1.010	1.010	1.00
	WCDMA Band V	Body	Rear	No	0.910	N/A	N/A
	LTE Band 5	Body	Rear	No	0.504	N/A	N/A
1900	GSM 1900	Body	Edge 1	No	0.608	N/A	N/A
	WCDMA Band II	Body	Rear	Yes	0.832	0.800	1.04
2400	Wi-Fi 802.11b/g/n	Body	Rear	Yes	0.979	0.949	1.03
5300	Wi-Fi 802.11a/n	Body	Rear	Yes	0.982	0.924	1.06
5500	Wi-Fi 802.11a/n	Body	Rear	No	0.701	N/A	N/A
5800	Wi-Fi 802.11a/n	Body	Rear	Yes	0.819	0.804	1.02

Note(s):

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

This report shall not be reproduced without the written approval of UL Verification Services Inc.

12. Simultaneous Transmission SAR Analysis

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

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

Where:

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

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

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

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

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

Simultaneous Transmission Condition

RF Exposure Condition	Item	Capable Transmit Configurations		
Head	1	GSM(Voice)	+	DTS
	2	GSM(Voice)	+	U-NII
	3	GSM(GPRS/EDGE)	+	DTS
	4	GSM(GPRS/EDGE)	+	U-NII
	5	W-CDMA	+	DTS
	6	W-CDMA	+	U-NII
	7	LTE	+	DTS
	8	LTE	+	U-NII
Standalone	9	GSM(GPRS/EDGE)	+	DTS
	10	GSM(GPRS/EDGE)	+	U-NII
	11	GSM(GPRS/EDGE)	+	BT
	12	W-CDMA	+	DTS
	13	W-CDMA	+	U-NII
	14	W-CDMA	+	BT
	15	LTE	+	DTS
	16	LTE	+	U-NII
	17	LTE	+	BT

Notes:

1. DTS and UNII-3 (5.8 GHz) supports Hotspot and Wi-Fi Direct.
2. GPRS/EDGE, W-CDMA, and LTE support Hotspot.
3. VoIP is supported in GPRS/EDGE, W-CDMA, and LTE.
4. DTS Radio cannot transmit simultaneously with Bluetooth Radio.
5. U-NII Radio cannot transmit simultaneously with Bluetooth Radio.

This report shall not be reproduced without the written approval of UL Verification Services Inc.

Estimated SAR for Simultaneous Transmission SAR Analysis

Considerations for SAR estimation

1. When standalone SAR test exclusion applies, standalone SAR must also be estimated to determine simultaneous transmission SAR test exclusion.
2. Dedicated Host Approach criteria for SAR test exclusion is likewise applied to SAR estimation, with certain distinctions between test exclusion and SAR estimation:
   - When the separation distance from the antenna to an adjacent edge is ≤ 5 mm, a distance of 5 mm is applied for SAR estimation; this is the same between test exclusion and SAR estimation calculations.
   - When the separation distance from the antenna to an adjacent edge is > 5 mm but ≤ 50 mm, the actual antenna-to-edge separation distance is applied for SAR estimation.
   - When the minimum test separation distance is > 50 mm, the estimated SAR value is 0.4 W/kg
3. Please refer to Estimated SAR Tables to see which test positions are inherently compliant as they consist of only estimated SAR values for all applicable transmitters and consequently will always have sum of SAR values < 1.2 W/kg. Simultaneous transmission SAR analysis was therefore not performed for these test positions.

Estimated SAR for WWAN

Antenna	Tx Interface	Frequency (MHz)	Output Power		Separation Distances (mm)						Estimated 1-g SAR Value (W/kg)					
			dBm	mW	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front
Full Power, Proximity Sensor Off. A test seperation distance of 19 mm is included for Rear, 12 mm for front and 11 mm for Edge 1																
Cellular	GPRS 2 Slots	848.8	31.00	315	19	15.1	49	172	5		-MEASURE-	-MEASURE-	-MEASURE-	0.400	-MEASURE-	
Cellular	GPRS 2 Slots	1909.8	28.50	177	19	15.1	49	172	5		-MEASURE-	-MEASURE-	-MEASURE-	0.400	-MEASURE-	
Cellular	W-CDMA 5	846.6	23.50	224	19	15.1	49	172	5		-MEASURE-	-MEASURE-	-MEASURE-	0.400	-MEASURE-	
Cellular	W-CDMA 2	1907.6	23.00	200	19	15.1	49	172	5		-MEASURE-	-MEASURE-	-MEASURE-	0.400	-MEASURE-	
Cellular	LTE Band 5	844	23.00	200	19	15.1	49	172	5		-MEASURE-	-MEASURE-	-MEASURE-	0.400	-MEASURE-	
Second Stage Power Back-off, Proximity Sensor On																
Cellular	GPRS 4 Slots	848.8	21.50	71	5	5	49	172	5		-MEASURE-	-MEASURE-	0.178	0.400	-MEASURE-	
Cellular	GPRS 4 Slots	1909.8	13.50	11	5	5	49	172	5		-MEASURE-	-MEASURE-	0.041	0.400	-MEASURE-	
Cellular	W-CDMA 5	846.6	19.00	79	5	5	49	172	5		-MEASURE-	-MEASURE-	0.198	0.400	-MEASURE-	
Cellular	W-CDMA 2	1907.6	8.00	6	5	5	49	172	5		0.221	0.221	0.023	0.400	0.221	
Cellular	LTE Band 5	844	18.00	63	5	5	49	172	5		-MEASURE-	-MEASURE-	0.157	0.400	-MEASURE-	

Estimated SAR for WLAN

Tx Interface	Frequency (MHz)	Output Power		Separation Distances (mm)						Estimated 1-g SAR Value (W/kg)					
		dBm	mW	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front	Rear	Edge 1	Edge 2	Edge 3	Edge 4	Front
Wi-Fi Main Antenna															
Wi-Fi 2.4 GHz	2462	12.50	18	5	167.1	78.7	5	5		-MEASURE-	0.400	0.400	-MEASURE-	-MEASURE-	
Wi-Fi 5.2 GHz	5240	9.50	9	5	167.1	78.7	5	5		-MEASURE-	0.400	0.400	-MEASURE-	-MEASURE-	
Wi-Fi 5.3 GHz	5320	9.50	9	5	167.1	78.7	5	5		-MEASURE-	0.400	0.400	-MEASURE-	-MEASURE-	
Wi-Fi 5.5 GHz	5700	9.50	9	5	167.1	78.7	5	5		-MEASURE-	0.400	0.400	-MEASURE-	-MEASURE-	
Wi-Fi 5.8 GHz	5825	9.50	9	5	167.1	78.7	5	5		-MEASURE-	0.400	0.400	-MEASURE-	-MEASURE-	
Bluetooth	2480	7.50	6	5	167.1	78.7	5	5		0.252	0.400	0.400	0.252	0.252	

This report shall not be reproduced without the written approval of UL Verification Services Inc.

12.1. Sum of the SAR for GSM850 & Wi-Fi & BT

RF Exposure conditions	Test Position	① WWAN	② DTS	③ U-NII	④ BT	① +② WWAN + DTS		① +③ WWAN + U-NII		① +④ WWAN + BT	
						∑ 1-g SAR (mW/g)	SPLSR (Yes/ No)	∑ 1-g SAR (mW/g)	SPLSR (Yes/ No)	∑ 1-g SAR (mW/g)	SPLSR (Yes/ No)
Head	Left Touch	0.275	0.037	0.075		0.312	No	0.350	No		
	Left Tilt	0.227	0.037	0.075		0.264	No	0.302	No		
	Right Touch	0.439	0.037	0.075		0.476	No	0.514	No		
	Right Tilt	0.320	0.037	0.075		0.357	No	0.395	No		
Body	Rear	1.093	1.098	0.982	0.252	2.191	Yes	2.075	Yes	1.345	No
	Edge 4	0.344	0.708	0.349		1.052	No	0.693	No		

SAR to Peak Location Separation Ratio (SPLSR)

Test Position	Worst-case combination		∑ 1-g SAR (mW/g)		Calculated distance (mm)	SPLSR (≤ 0.04)	Volume Scan (Yes/ No)	Figure
	① WWAN	② DTS						
Rear	1.093	1.098	① + ②	2.191	168.2	0.019	No	1

SAR to Peak Location Separation Ratio (SPLSR)

Test Position	Worst-case combination		∑ 1-g SAR (mW/g)		Calculated distance (mm)	SPLSR (≤ 0.04)	Volume Scan (Yes/ No)	Figure
	① WWAN	③ UNII						
Rear	1.093	0.982	① + ③	2.075	170.5	0.018	No	2

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

RF Exposure conditions	Test Position	① WWAN	② DTS	③ U-NII	④ BT	① +② WWAN + DTS		① +③ WWAN + U-NII		① +④ WWAN + BT	
						∑ 1-g SAR (mW/g)	SPLSR (Yes/ No)	∑ 1-g SAR (mW/g)	SPLSR (Yes/ No)	∑ 1-g SAR (mW/g)	SPLSR (Yes/ No)
Head	Left Touch	0.072	0.037	0.075		0.109	No	0.147	No		
	Left Tilt	0.068	0.037	0.075		0.105	No	0.143	No		
	Right Touch	0.248	0.037	0.075		0.285	No	0.323	No		
	Right Tilt	0.203	0.037	0.075		0.240	No	0.278	No		
Body	Rear	0.658	1.098	0.982	0.252	1.756	Yes	1.640	Yes	0.910	No
	Edge 4	0.299	0.708	0.349		1.007	No	0.648	No		

SAR to Peak Location Separation Ratio (SPLSR)

Test Position	Worst-case combination		∑ 1-g SAR (mW/g)		Calculated distance (mm)	SPLSR (≤ 0.04)	Volume Scan (Yes/ No)	Figure
	① WWAN	② DTS						
Rear	0.658	1.098	① + ②	1.756	172.1	0.014	No	3

SAR to Peak Location Separation Ratio (SPLSR)

Test Position	Worst-case combination		∑ 1-g SAR (mW/g)		Calculated distance (mm)	SPLSR (≤ 0.04)	Volume Scan (Yes/ No)	Figure
	① WWAN	③ UNII						
Rear	0.658	0.982	① + ③	1.640	174.8	0.012	No	4

This report shall not be reproduced without the written approval of UL Verification Services Inc.

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

RF Exposure conditions	Test Position	① WWAN	② DTS	③ U-NII	④ BT	① +② WWAN + DTS		① +③ WWAN + U-NII		① +④ WWAN + BT	
						∑ 1-g SAR (mW/g)	SPLSR (Yes/ No)	∑ 1-g SAR (mW/g)	SPLSR (Yes/ No)	∑ 1-g SAR (mW/g)	SPLSR (Yes/ No)
Head	Left Touch	0.294	0.037	0.075		0.331	No	0.369	No		
	Left Tilt	0.250	0.037	0.075		0.287	No	0.325	No		
	Right Touch	0.448	0.037	0.075		0.485	No	0.523	No		
	Right Tilt	0.347	0.037	0.075		0.384	No	0.422	No		
Body	Rear	0.953	1.098	0.982	0.252	2.051	**Yes**	1.935	**Yes**	1.205	No
	Edge 4	0.403	0.708	0.349		1.111	No	0.752	No		

SAR to Peak Location Separation Ratio (SPLSR)

Test Position	Worst-case combination		∑ 1-g SAR (mW/g)		Calculated distance (mm)	SPLSR (≤ 0.04)	Volume Scan (Yes/ No)	Figure
	① WWAN	② DTS						
Rear	0.953	1.098	① + ②	2.051	165.3	0.018	No	5

SAR to Peak Location Separation Ratio (SPLSR)

Test Position	Worst-case combination		∑ 1-g SAR (mW/g)		Calculated distance (mm)	SPLSR (≤ 0.04)	Volume Scan (Yes/ No)	Figure
	① WWAN	③ UNII						
Rear	0.953	0.982	① + ③	1.935	167.6	0.016	No	6

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

RF Exposure conditions	Test Position	① WWAN	② DTS	③ U-NII	④ BT	① +② WWAN + DTS		① +③ WWAN + U-NII		① +④ WWAN + BT	
						∑ 1-g SAR (mW/g)	SPLSR (Yes/ No)	∑ 1-g SAR (mW/g)	SPLSR (Yes/ No)	∑ 1-g SAR (mW/g)	SPLSR (Yes/ No)
Head	Left Touch	0.025	0.037	0.075		0.062	No	0.100	No		
	Left Tilt	0.023	0.037	0.075		0.060	No	0.098	No		
	Right Touch	0.073	0.037	0.075		0.110	No	0.148	No		
	Right Tilt	0.068	0.037	0.075		0.105	No	0.143	No		
Body	Rear	0.536	1.098	0.982	0.252	1.634	**Yes**	1.518	No	0.788	No
	Edge 4	0.425	0.708	0.349		1.133	No	0.774	No		

SAR to Peak Location Separation Ratio (SPLSR)

Test Position	Worst-case combination		∑ 1-g SAR (mW/g)		Calculated distance (mm)	SPLSR (≤ 0.04)	Volume Scan (Yes/ No)	Figure
	① WWAN	② DTS						
Rear	0.832	1.098	① + ②	1.930	174.2	0.015	No	7

This report shall not be reproduced without the written approval of UL Verification Services Inc.

12.5. Sum of the SAR for LTE Band 5 & Wi-Fi & BT

RF Exposure conditions	Test Position	① WWAN	② DTS	③ U-NII	④ BT	① +② WWAN + DTS		① +③ WWAN + U-NII		① +④ WWAN + BT	
						∑ 1-g SAR (mW/g)	SPLSR (Yes/ No)	∑ 1-g SAR (mW/g)	SPLSR (Yes/ No)	∑ 1-g SAR (mW/g)	SPLSR (Yes/ No)
Head	Left Touch	0.238	0.037	0.075		0.275	No	0.313	No		
	Left Tilt	0.208	0.037	0.075		0.245	No	0.283	No		
	Right Touch	0.279	0.037	0.075		0.316	No	0.354	No		
	Right Tilt	0.266	0.037	0.075		0.303	No	0.341	No		
Body	Rear	0.676	1.098	0.982	0.252	1.774	Yes	1.658	Yes	0.928	No
	Edge 4	0.332	0.708	0.349		1.040	No	0.681	No		

SAR to Peak Location Separation Ratio (SPLSR)

Test Position	Worst-case combination		∑ 1-g SAR (mW/g)		Calculated distance (mm)	SPLSR (≤ 0.04)	Volume Scan (Yes/ No)	Figure
	① WWAN	② DTS						
Rear	0.676	1.098	① + ②	1.774	167.3	0.014	No	8

SAR to Peak Location Separation Ratio (SPLSR)

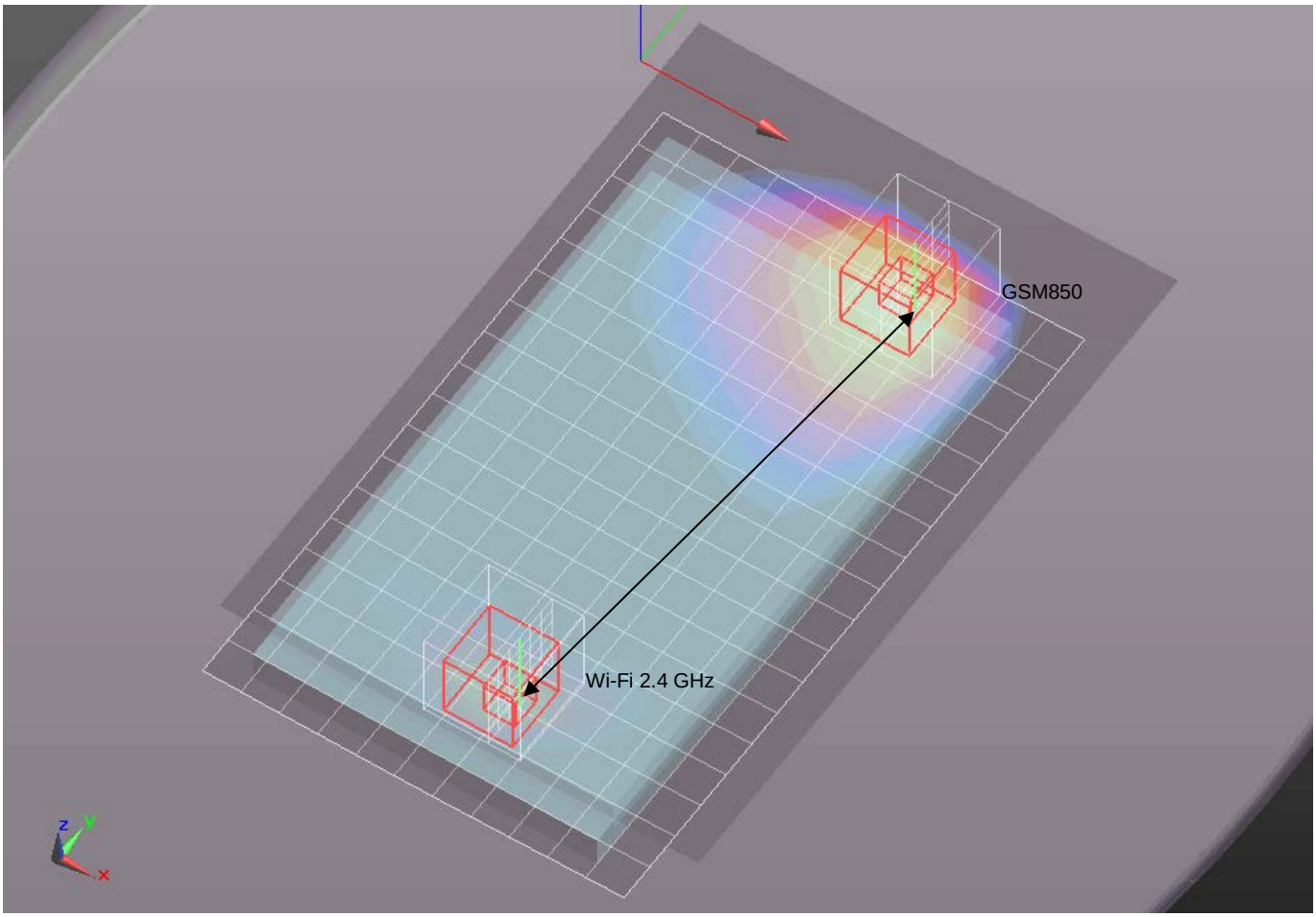
Test Position	Worst-case combination		∑ 1-g SAR (mW/g)		Calculated distance (mm)	SPLSR (≤ 0.04)	Volume Scan (Yes/ No)	Figure
	① WWAN	③ UNII						
Rear	0.676	0.982	① + ③	1.658	169.6	0.013	No	9

Conclusion:

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

This report shall not be reproduced without the written approval of UL Verification Services Inc.

Figure (1)



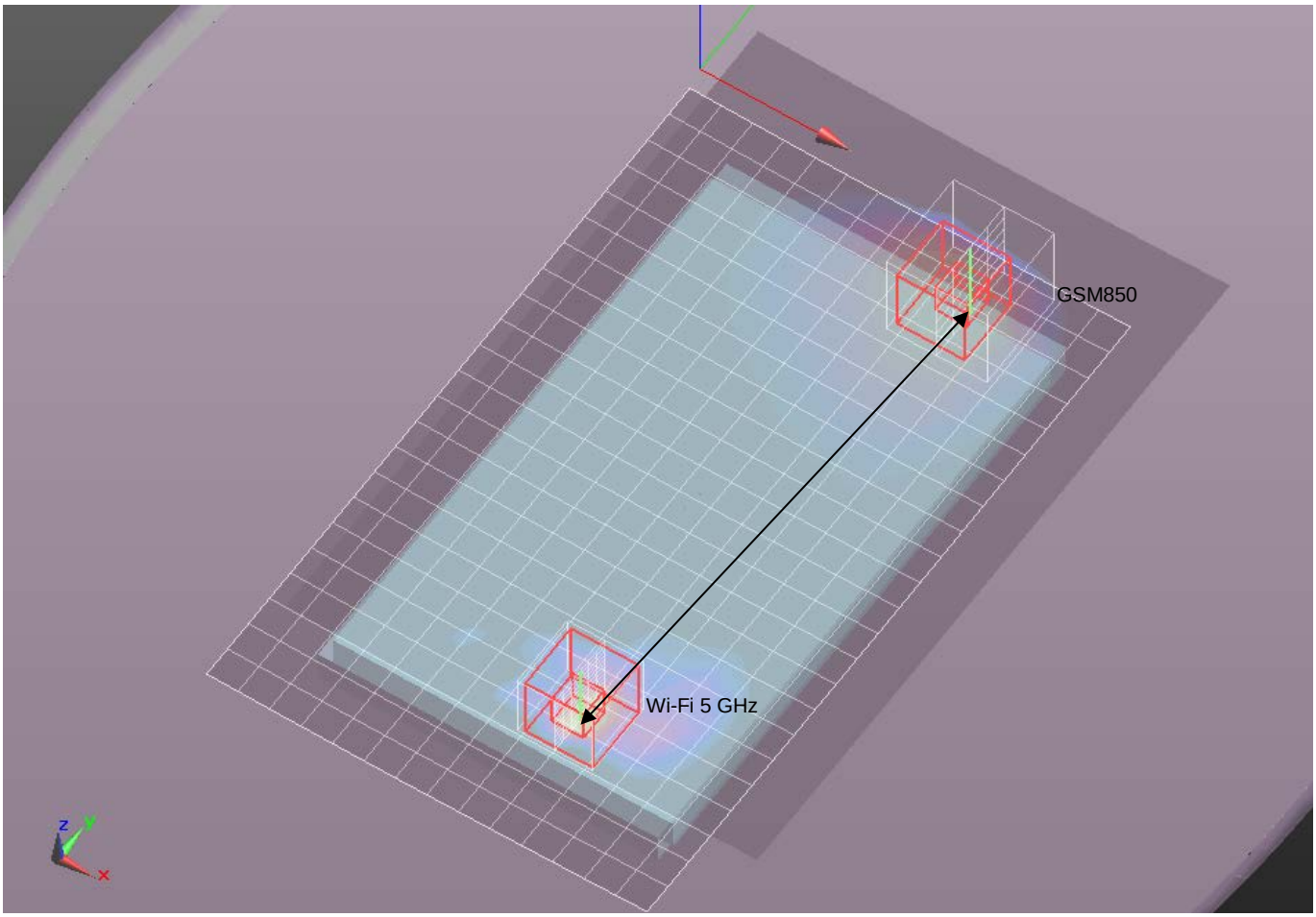
Mode		Peak SAR	X	Y	Z	d: Calculated distance (mm)	
		mW/g	m	m	m		
GSM 850	①	0.97	0.0277	0.0848	0.0037	① + ②	168.2
Wi-Fi 2.4 GHz	②	0.98	0.0166	-0.0828	-0.0054		

The Peak Location Separation Distance is computed by using the formula below:

SQRT((X1-X2)^2+(Y1-Y2)^2+(Z1-Z2)^2)

This report shall not be reproduced without the written approval of UL Verification Services Inc.

Figure (2)



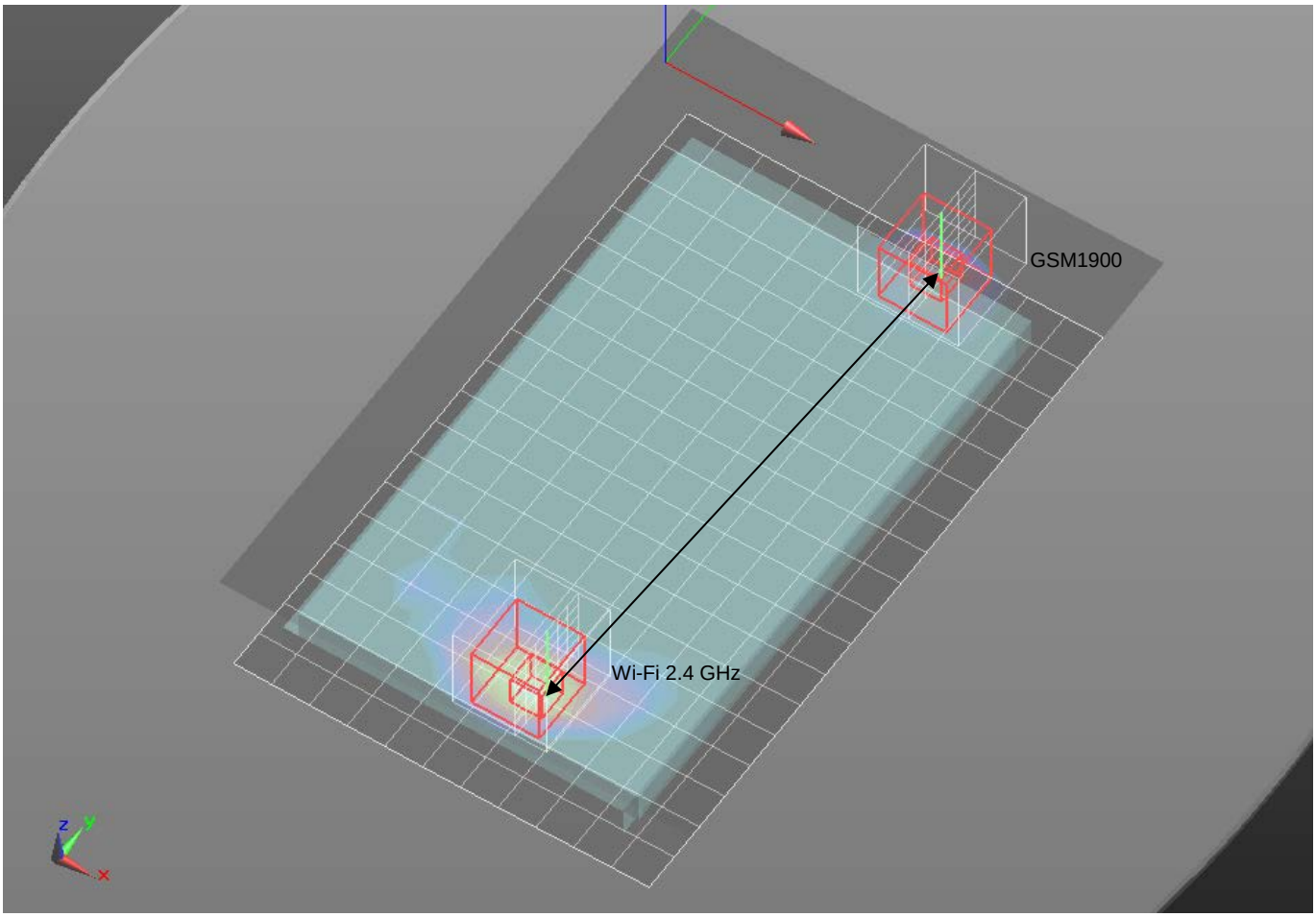
Mode		Peak SAR	X	Y	Z	d: Calculated distance (mm)	
		mW/g	m	m	m		
GSM 850	①	0.97	0.0277	0.0848	0.0037	① + ③	170.5
Wi-Fi 5 GHz	③	0.98	0.0184	-0.0854	0.0042		

The Peak Location Separation Distance is computed by using the formula below:

SQRT((X1-X2)^2+(Y1-Y2)^2+(Z1-Z2)^2)

This report shall not be reproduced without the written approval of UL Verification Services Inc.

Figure (3)



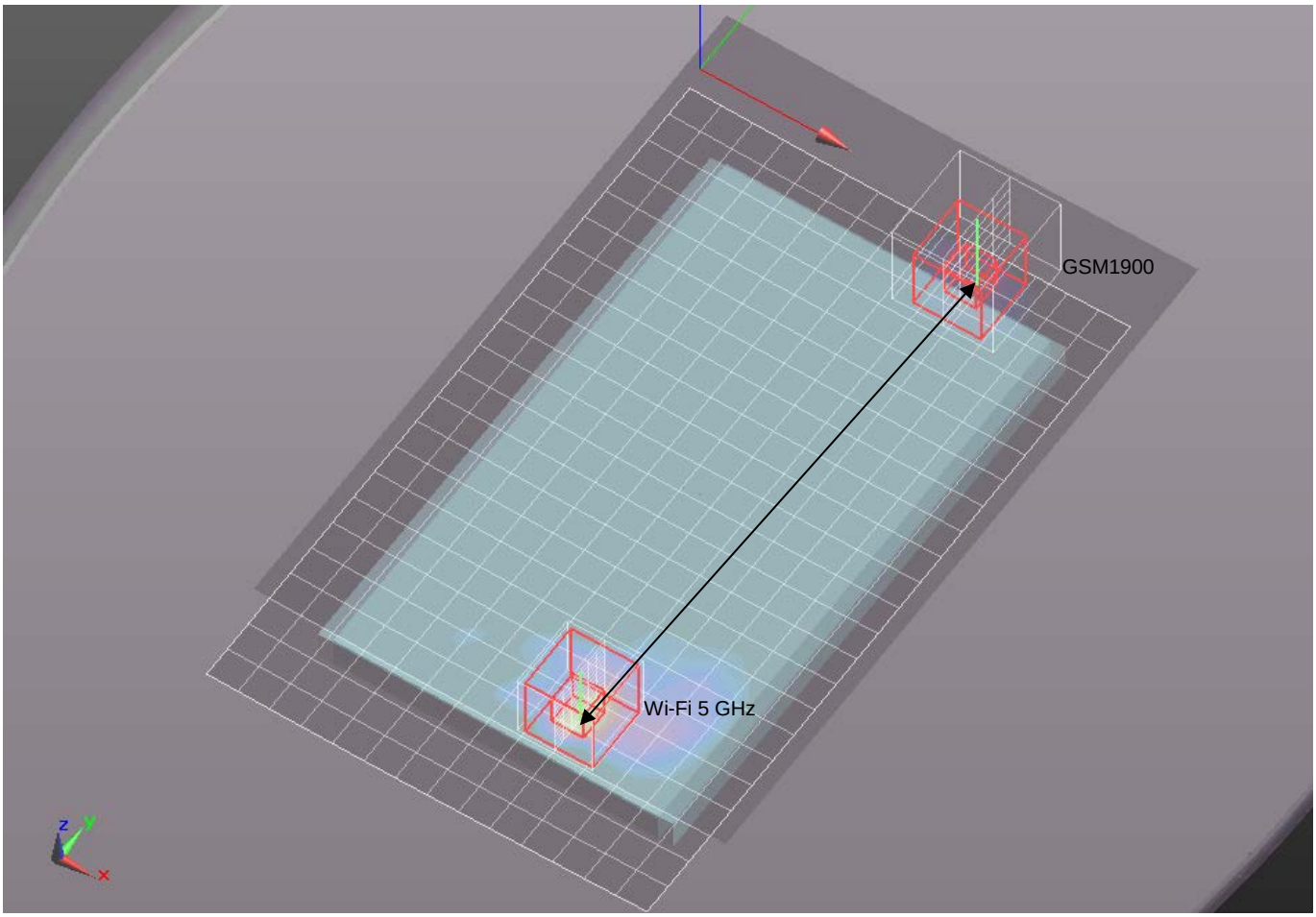
Mode		Peak SAR	X	Y	Z	d: Calculated distance (mm)	
		mW/g	m	m	m		
GSM 1900	①	0.52	0.0269	0.0890	-0.0038	① + ②	172.1
Wi-Fi 2.4 GHz	②	0.98	0.0166	-0.0828	-0.0054		

The Peak Location Separation Distance is computed by using the formula below:

SQRT((X1-X2)^2+(Y1-Y2)^2+(Z1-Z2)^2)

This report shall not be reproduced without the written approval of UL Verification Services Inc.

Figure (4)



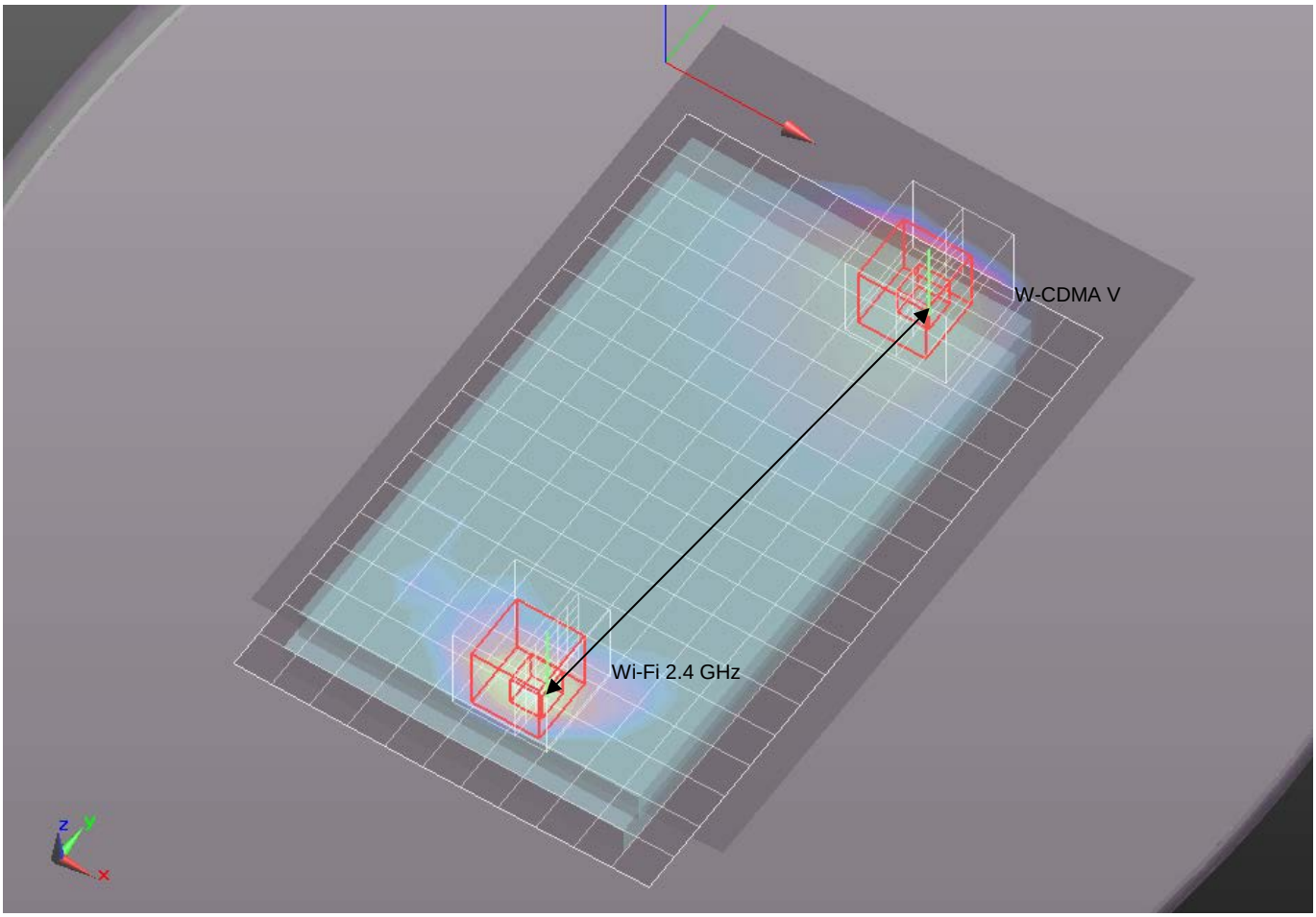
Mode		Peak SAR	X	Y	Z	d: Calculated distance (mm)	
		mW/g	m	m	m		
GSM 1900	①	0.52	0.0269	0.0890	-0.0038	① + ③	174.8
Wi-Fi 5 GHz	③	0.98	0.0184	-0.0854	0.0042		

The Peak Location Separation Distance is computed by using the formula below:

SQRT((X1-X2)^2+(Y1-Y2)^2+(Z1-Z2)^2)

This report shall not be reproduced without the written approval of UL Verification Services Inc.

Figure (5)



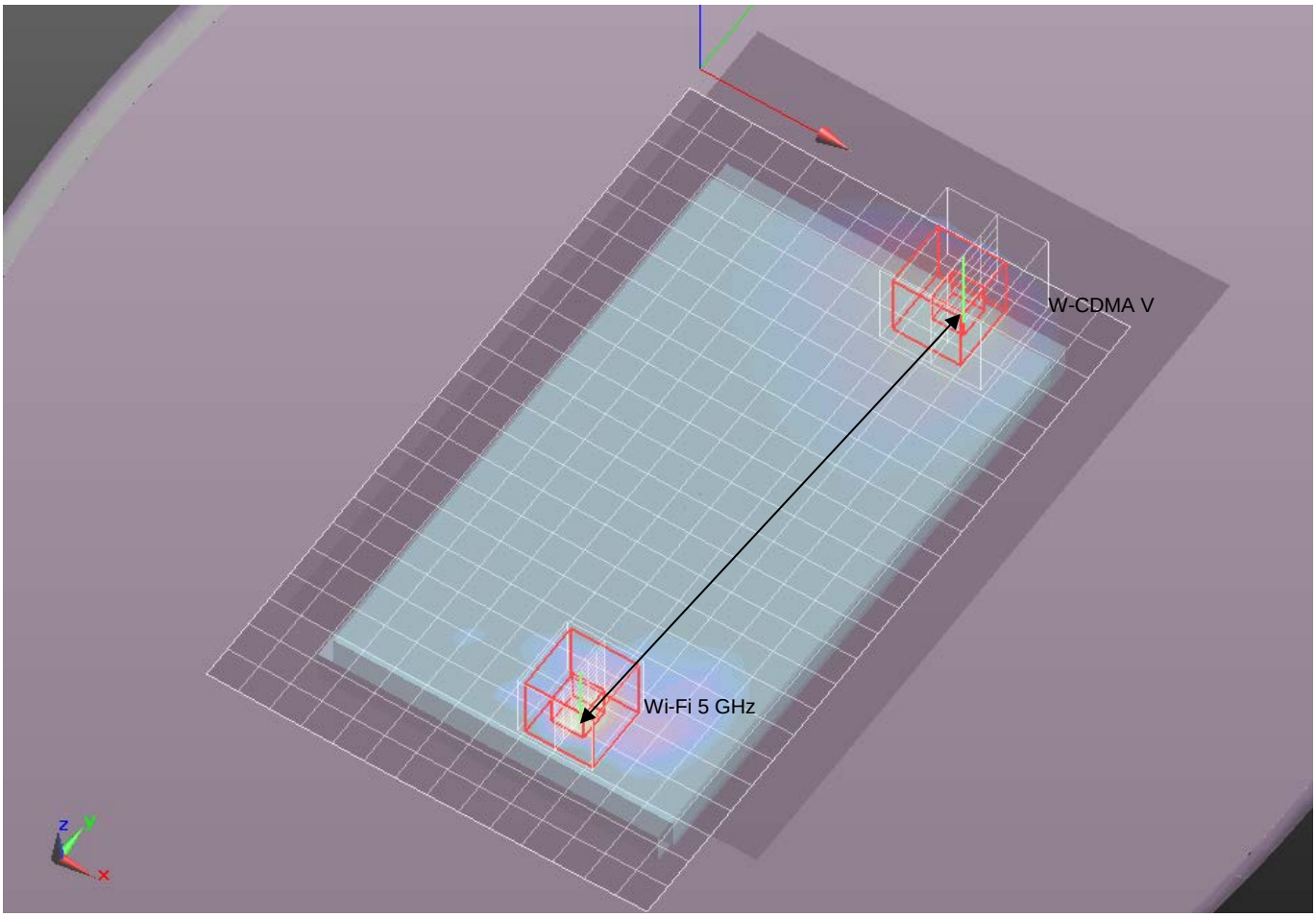
Mode		Peak SAR	X	Y	Z	d: Calculated distance (mm)	
		mW/g	m	m	m		
W-CDMA V	①	0.91	0.0293	0.0818	0.0034	① + ②	165.3
Wi-Fi 2.4 GHz	②	0.98	0.0166	-0.0828	-0.0054		

The Peak Location Separation Distance is computed by using the formula below:

SQRT((X1-X2)^2+(Y1-Y2)^2+(Z1-Z2)^2)

This report shall not be reproduced without the written approval of UL Verification Services Inc.

Figure (6)



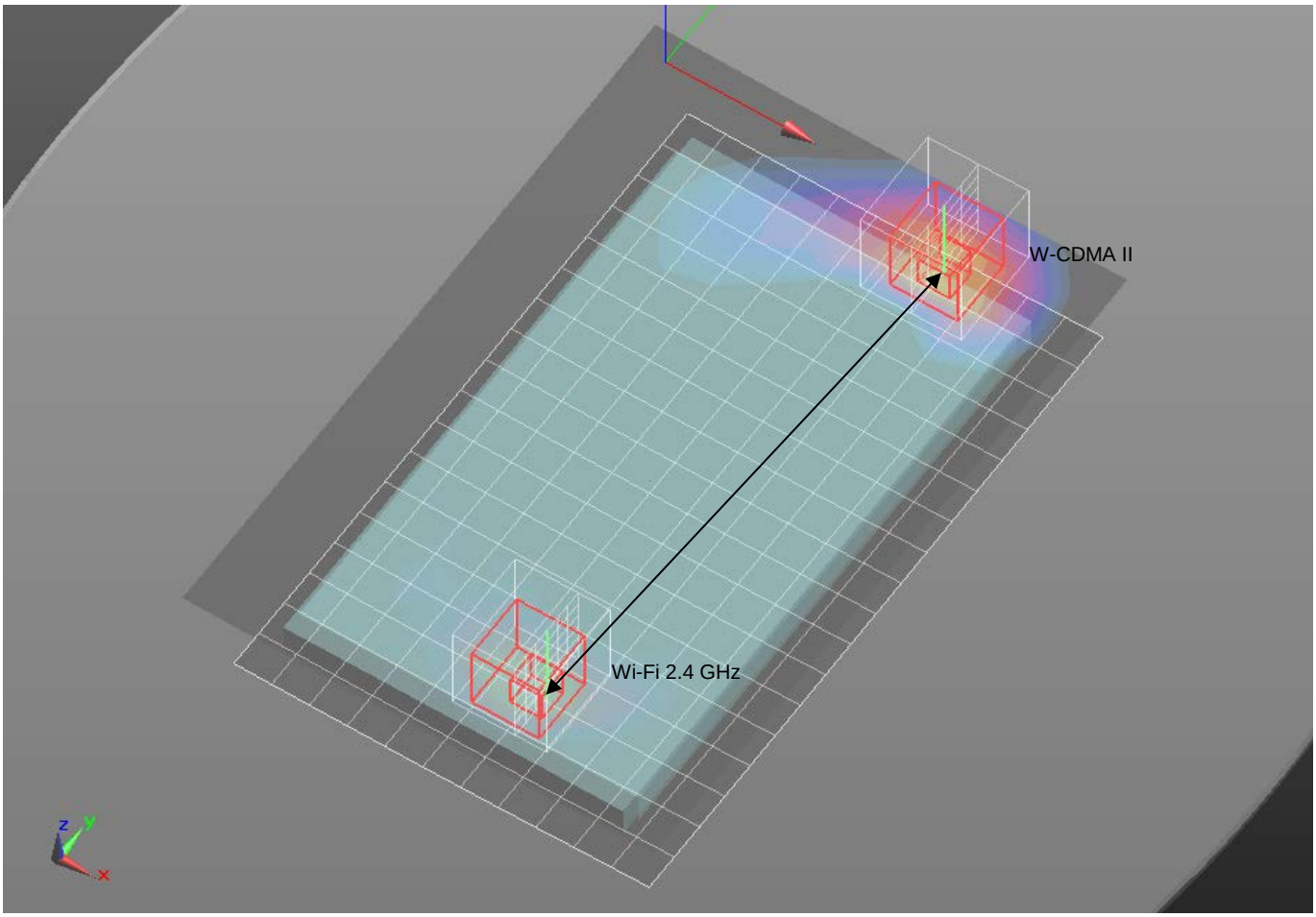
Mode		Peak SAR	X	Y	Z	d: Calculated distance (mm)	
		mW/g	m	m	m		
W-CDMA V	①	0.91	0.0293	0.0818	0.0034	① + ③	167.6
Wi-Fi 5 GHz	③	0.98	0.0184	-0.0854	0.0042		

The Peak Location Separation Distance is computed by using the formula below:

SQRT((X1-X2)^2+(Y1-Y2)^2+(Z1-Z2)^2)

This report shall not be reproduced without the written approval of UL Verification Services Inc.

Figure (7)



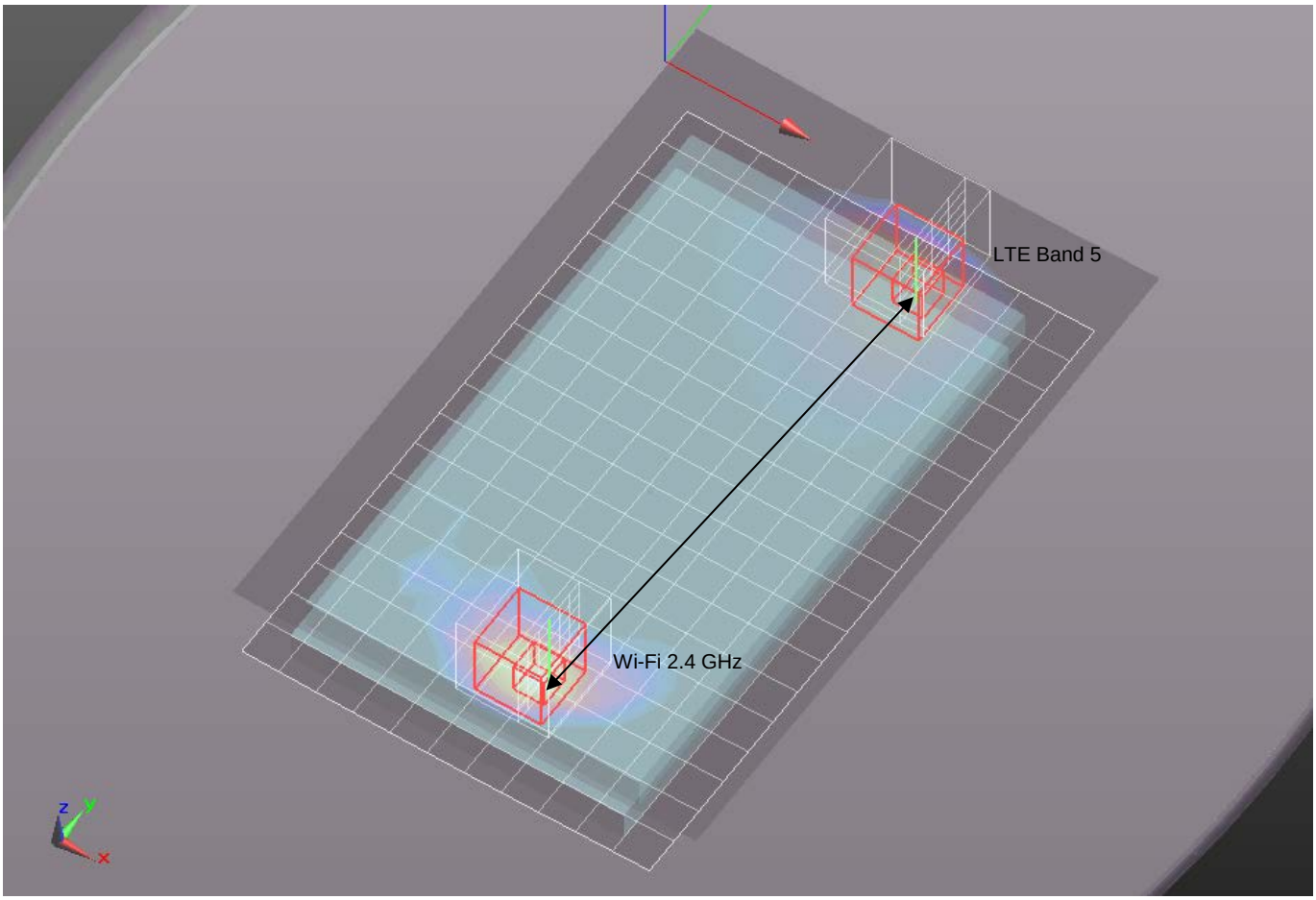
Mode		Peak SAR	X	Y	Z	d: Calculated distance (mm)	
		mW/g	m	m	m		
W-CDMA II	①	0.54	0.0280	0.0910	-0.0044	① + ②	174.2
Wi-Fi 2.4 GHz	②	0.98	0.0166	-0.0828	-0.0054		

The Peak Location Separation Distance is computed by using the formula below:

SQRT((X1-X2)^2+(Y1-Y2)^2+(Z1-Z2)^2)

This report shall not be reproduced without the written approval of UL Verification Services Inc.

Figure (8)



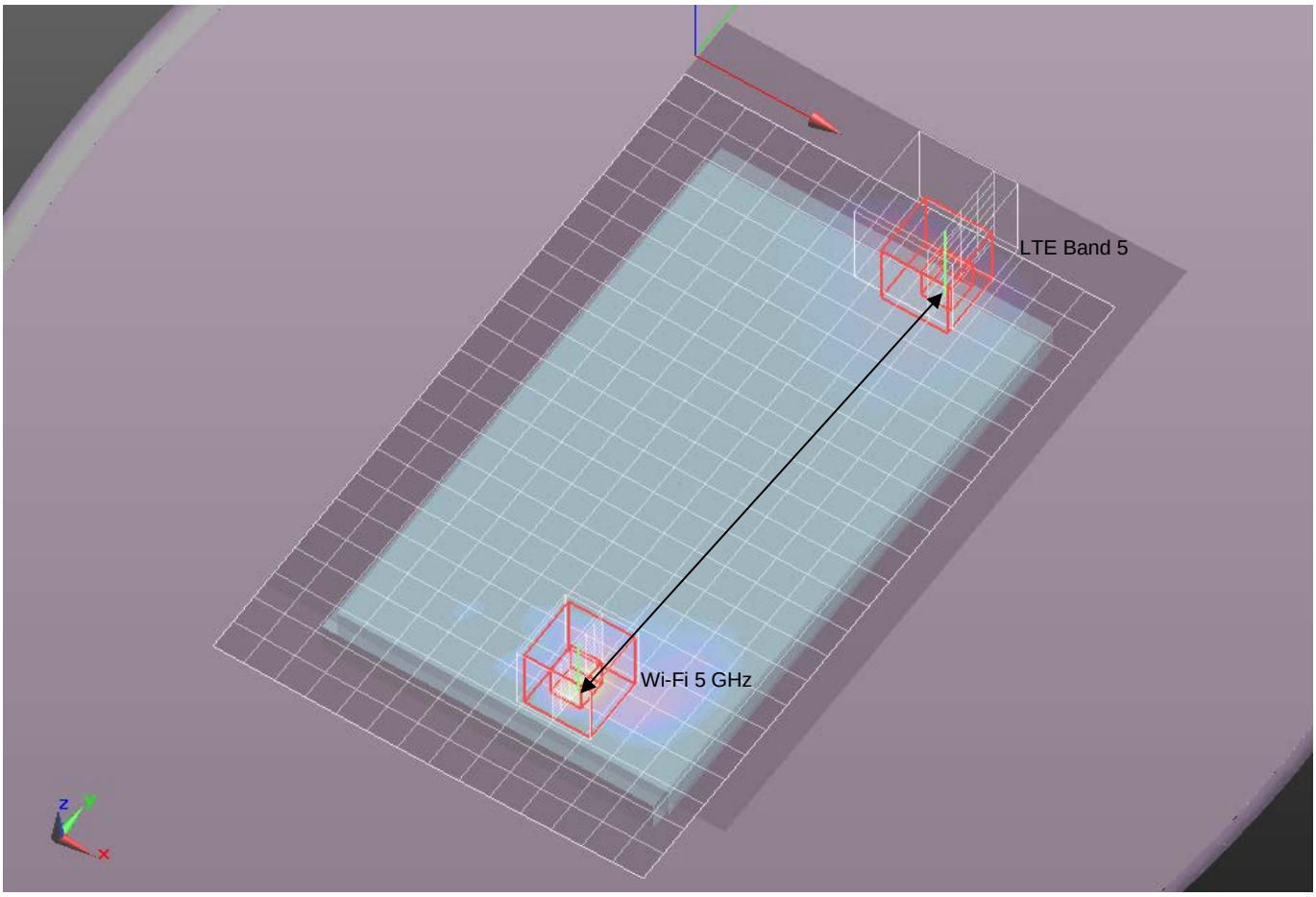
Mode		Peak SAR	X	Y	Z	d: Calculated distance (mm)	
		mW/g	m	m	m		
LTE Band 5	①	0.49	0.0279	0.0839	0.0029	① + ②	167.3
Wi-Fi 2.4 GHz	②	0.98	0.0166	-0.0828	-0.0054		

The Peak Location Separation Distance is computed by using the formula below:

SQRT((X1-X2)^2+(Y1-Y2)^2+(Z1-Z2)^2)

This report shall not be reproduced without the written approval of UL Verification Services Inc.

Figure (9)



Mode		Peak SAR	X	Y	Z	d: Calculated distance (mm)	
		mW/g	m	m	m		
LTE Band 5	①	0.49	0.0279	0.0839	0.0029	① + ③	169.6
Wi-Fi 5 GHz	③	0.98	0.0184	-0.0854	0.0042		

The Peak Location Separation Distance is computed by using the formula below:

SQRT((X1-X2)^2+(Y1-Y2)^2+(Z1-Z2)^2)

This report shall not be reproduced without the written approval of UL Verification Services Inc.

Appendixes

Refer to separated files for the following appendixes.

A_15I19878v1 SAR Photos & Ant. Locations

B_15I19878v0 SAR System Check Plots

C_15I19878v1 SAR Highest Test Plots

D_15I19878v0 SAR Tissue Ingredients

E_15I19878v0 SAR Probe Cal. Certificates

F_15I19878v0 SAR Dipole Cal. Certificates

END OF REPORT

This report shall not be reproduced without the written approval of UL Verification Services Inc.