TEST REPORT

No. I18D00006-SAR01

For

Client:	**Lenovo (Shanghai) Electronics Technology Co., Ltd**
Production:	**Portable Tablet Computer**
Brand ：	**Lenovo**
Model Name:	**Lenovo TB-8504X**
Standard:	**ANSI C95.1-1999** **FCC 47 CFR Part 2 (2.1093)**
FCC ID:	**O57TB8504X**
Hardware Version:	**Lenovo Tablet TB-8504X**
Software Version:	**TB-8504X_RF01_170520**
Issued date:	**2018-2-05**

Note:

The test results in this test report relate only to the devices specified in this report. This report shall not be reproduced except in full without the written approval of ECIT Shanghai.

Test Laboratory:

ECIT Shanghai, East China Institute of Telecommunications
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Revision Version

Report Number	Revision	Date	Memo
I18D00006-SAR01	00	2018-1-31	Initial creation of test report
I18D00006-SAR01	01	2018-2-05	Second creation of test report

CONTENTS

1. Test Laboratory

1.1. Testing Location

Company Name:	ECIT Shanghai, East China Institute of Telecommunications
Address:	7-8F, G Area,No. 668, Beijing East Road, Huangpu District, Shanghai, P. R. China
Postal Code:	200001
Telephone:	(+86)-021-63843300
Fax:	(+86)-021-63843301

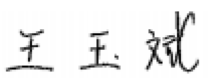
1.2. Testing Environment

Normal Temperature:	18-25℃
Relative Humidity:	10-90%
Ambient noise & Reflection:	< 0.012 W/kg

1.3. Project Data

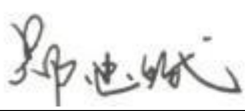
Project Leader:	Xu Yuting
Testing Start Date:	2018-01-15
Testing End Date:	2018-01-18

1.4. Signature



Wang Yubin
(Prepared this test report)

Fu Erliang
(Reviewed this test report)



Zheng Zhongbin
(Approved this test report)

2. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for **Lenovo TB-8504X** are as follows

Table 2.1: Max. Reported SAR (1g)

Band	Position	SAR 1g (W/Kg)
GSM850	Head	0.121
GSM1900	Head	0.046
WCDMA Band2	Head	0.154
WCDMA Band5	Head	0.141
LTE Band5	Head	0.089
LTE Band7	Head	0.152
Wi-Fi 2.4GHz	Head	0.579
GSM850	Body	0.679
GSM1900	Body	1.121
WCDMA Band2	Body	0.927
WCDMA Band5	Body	0.594
LTE Band5	Body	0.629
LTE Band7	Body	1.086
Wi-Fi 2.4GHz	Body	0.409

The SAR values found for the Mobile Phone are below the maximum recommended levels of 1.6 W/Kg as averaged over any 1g tissue according to the ANSI C95.1-1999 .

For body worn operation, this device has been tested and meets FCC RF exposure guidelines when used with any accessory that contains no metal. Use of other accessories may not ensure compliance with FCC RF exposure guidelines.

Table 2.2: Simultaneous SAR (1g)

Transmission SAR(W/Kg)					
Test Position		WWAN	WIFI 2.4GHz	BT	SUM
Head	Left Touch	0.141	0.224	0.209	0.365
	Left Tilt	0.085	0.249	0.209	0.334
	Right Touch	0.154	0.579	0.209	0.733
	Right Tilt	0.078	0.443	0.209	0.521
Body 14mm	Ground Side	0.704	0.139	0.209	0.843
	Left Side	--	0.075	0.209	0.209
	Right Side	--	--	0.209	0.209
	Bottom Side	0.795	--	0.209	1.004
	Top Side	--	0.094	0.209	0.209
Body 0 mm	Ground Side	1.121	0.409	0.209	1.530
	Left Side	--	0.168	0.209	0.209
	Right Side	1.086	--	0.209	1.295
	Bottom Side	0.664	--	0.209	0.873
	Top Side	--	0.200	0.209	0.209

According to the above table, the maximum sum of reported SAR values for WCDMA/LTE and WiFi is **1.530 W/kg** (1g).

3. Client Information

3.1. Applicant Information

Company Name:	Lenovo (Shanghai) Electronics Technology Co., Ltd
Address:	NO.68 BUILDING, 199 FENJU RD, China (Shanghai) Pilot Free Trade Zone, 200131, CHINA
Telephone:	18116117205

3.2. Manufacturer Information

Company Name:	Lenovo PC HK Limited
Address:	23/F, Lincoln House, Taikoo Place 979 King's Road, Quarry Bay, Hong Kong
Telephone:	18116117205

4. Equipment Under Test (EUT) and Ancillary Equipment (AE)

4.1. About EUT

Description:	Portable Tablet Computer
Model name:	Lenovo TB-8504X
Operation Model(s):	GSM900/1800/850/1900 WCDMA Band I/II/V/VIII LTE Band 1/3/5/7/8/20,WIFI2450,BT
Tx Frequency:	824 MHz - 849 MHz (GSM850) 1850 MHz -1910 MHz (GSM1900) 1852.4 MHz -1907.6 MHz (WCDMA Band II) 826.4 MHz -846.6MHz (WCDMA Band V) 824 MHz -849 MHz (LTE Band 5) 2500 MHz - 2570 MHz (LTE Band 7) 2412- 2462 MHz (Wi-Fi) 2400-2483.5 MHz (BT)
Test device Production information: GPRS/EGPRS Class Mode: GPRS/ EGPRS Multislot Class:	Production unit 12 12
Device type:	Portable device
UE category:	3
Antenna type:	Inner antenna
Accessories/Body-worn configurations:	Headset
Dimensions: Hotspot Mode:	21cm × 12.5 cm x 0.9 cm Support simultaneous transmission of hotspot and voice (or data)
FCC ID:	O57TB8504X
The device employs proximity sensors that detect the presence of the user's body at the back faces or Top side or Left side of the device for WLAN and back faces or Bottom side of the device for WWAN. when back body worn and Top or Left side condition is detected, WIFI 2.4GHz reduced power will be active; when back body worn and Bottom side condition is detected, WWAN reduced power will be active	

4.2. Internal Identification of EUT used during the test

EUT ID*	SN or IMEI	HW Version	SW Version	Receive Date
N06	SIM1:863768030010621 SIM2:863768030012601	Lenovo Tablet TB-8504X	TB-8504X_RF01_170520	2018-1-8

*EUT ID: is used to identify the test sample in the lab internally.

4.3. Internal Identification of AE used during the test

AE ID*	Description	Model	SN	Manufacturer
N/A	N/A	N/A	N/A	N/A

*AE ID: is used to identify the test sample in the lab internally.

5. TEST METHODOLOGY

5.1. Applicable Limit Regulations

ANSI C95.1–1999:IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz.

FCC 47 CFR Part 2 (2.1093)：Radiofrequency radiation exposure evaluation: portable devices.

It specifies the maximum exposure limit of **1.6 W/kg** as averaged over any 1 gram of tissue for portable devices being used within 20 cm of the user in the uncontrolled environment.

5.2. Applicable Measurement Standards

IEEE 1528:2013: Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Body Due to Wireless Communications Devices:
Experimental Techniques.

KDB 616217 D04 SAR for laptop and tablets v01r02: SAR evaluation considerations for laptop, notebook, netbook and tablet computers.

KDB248227 D01 802 11 Wi-Fi SAR v02r02: SAR measurement procedures for 802.112abg transmitters.

KDB447498 D01 General RF Exposure Guidance v06: Mobile and Portable Devices RF Exposure Procedures and Equipment Authorization Policies.

KDB865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04:SAR Measurement Requirements for 100 MHz to 6 GHz

KDB865664 D02 RF Exposure Reporting v01r02:provides general reporting requirements as well as certain specific information required to support MPE and SAR compliance.

KDB941225 D01 3G SAR Procedures v03r01: 3G SAR Measurement Procedures.

KDB941225 D05 SAR for LTE Devices v02r04: SAR Evaluation Considerations for LTE Devices.

KDB941225 D06 hotspot SAR v02r01:SAR Evaluation Procedures for Portable Devices with Wireless Router Capabilities.

NOTE: KDB is not in A2LA Scope List.

6. Specific Absorption Rate (SAR)

6.1. Introduction

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational/controlled and general population/uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.

6.2. SAR Definition

The SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density (ρ) . The equation description is as below:

$$SAR = \frac{d}{dt}\left(\frac{dW}{dm}\right) = \frac{d}{dt}\left(\frac{dW}{\rho dv}\right)$$

SAR is expressed in units of Watts per kilogram (W/kg)

SAR measurement can be either related to the temperature elevation in tissue by

$$SAR = c\left(\frac{\delta T}{\delta t}\right)$$

Where: C is the specific head capacity, δT is the temperature rise and δt is the exposure duration, or related to the electrical field in the tissue by

$$SAR = \frac{\sigma |E|^2}{\rho}$$

Where: σ is the conductivity of the tissue, ρ is the mass density of tissue and E is the RMS electrical field strength.

However for evaluating SAR of low power transmitter, electrical field measurement is typically applied.

7. Tissue Simulating Liquids

7.1. Targets for tissue simulating liquid

Table 7.1: Targets for tissue simulating liquid

Frequency (MHz)	Liquid Type	Conductivity(σ)	± 5% Range	Permittivity(ε)	± 5% Range
835	Head	0.90	0.86～0.95	41.5	39.4～43.6
835	Body	0.97	0.92～1.02	55.2	52.4～58.0
1800	Head	1.40	1.33～1.47	40.0	38.0～42.0
1800	Body	1.52	1.44～1.60	53.3	50.6～56.0
1900	Head	1.40	1.33～1.47	40.0	38.0～42.0
1900	Body	1.52	1.44～1.60	53.3	50.6～56.0
2450	Head	1.80	1.71～1.89	39.2	37.2～41.2
2450	Body	1.95	1.85～2.05	52.7	50.1～55.3
2600	Head	1.96	1.86~2.06	39	37.05~40.95
2600	Body	2.16	2.05~2.27	52.5	59.88~55.13

7.2. Dielectric Performance

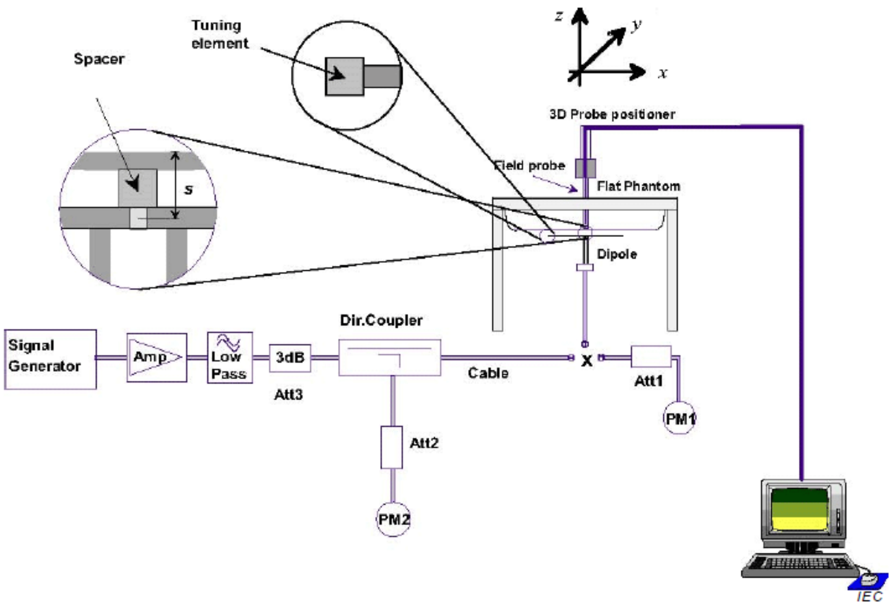
Table 7.2: Dielectric Performance of Tissue Simulating Liquid

Measurement Value						
Liquid Temperature: 22.5 ℃						
Type	**Frequency**	**Permittivity ε**	**Drift (%)**	**Conductivity σ**	**Drift (%)**	Test Date
Head	835 MHz	41.039	-1.11%	0.917	1.89%	2018-1-15
Head	1900 MHz	41.157	2.89%	1.307	-6.64%	2018-1-16
Head	2450 MHz	40.742	3.93%	1.808	0.44%	2018-1-17
Head	2600 MHz	38.249	-1.93%	2.035	3.83%	2018-1-18
Body	835 MHz	57.108	3.46%	1.001	3.20%	2018-1-15
Body	1900 MHz	54.595	2.43%	1.576	3.68%	2018-1-16
Body	2450 MHz	53.369	1.27%	1.907	-2.21%	2018-1-17
Body	2600 MHz	52.857	0.68%	2.083	-3.56%	2018-1-18

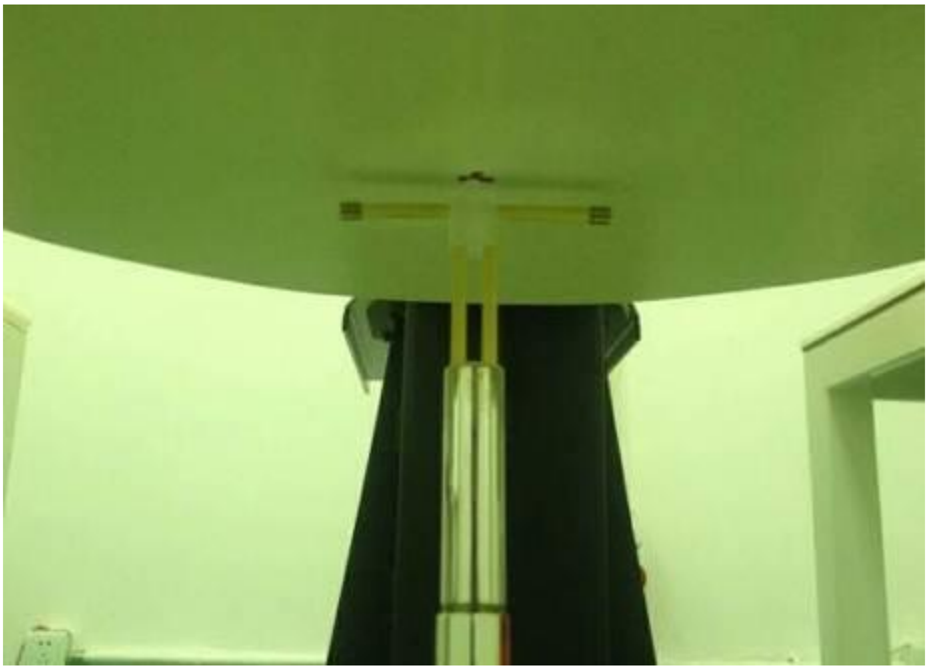
8. System verification

8.1. System Setup

In the simplified setup for system evaluation, the DUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom section of the SAM twin phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The equipment setup is shown below:



Picture 8.1 System Setup for System Evaluation



Picture 8.2 Photo of Dipole Setup

8.2. System Verification

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 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.

Table 8.1: System Verification of Head

Verification Results							
Input power level: 1W							
Frequency	**Target value (W/kg)**		**Measured value (W/kg)**		**Deviation**		**Test date**
	10 g Average	**1 g Average**	**10 g Average**	**1 g Average**	**10 g Average**	**1 g Average**	
835 MHz	6.03	9.22	6.28	9.6	4.15%	4.12%	2018-1-15
1900 MHz	21	40.8	20.64	39.08	-1.71%	-4.22%	2018-1-16
2450 MHz	24.3	52.9	23.64	51.6	-2.72%	-2.46%	2018-1-17
2600 MHz	25.5	58	24.72	55.6	-3.06%	-4.14%	2018-1-18

Table 8.2: System Verification of Body

Verification Results							
Input power level: 1W							
Frequency	**Target value (W/kg)**		**Measured value (W/kg)**		**Deviation**		**Test date**
	10 g Average	**1 g Average**	**10 g Average**	**1 g Average**	**10 g Average**	**1 g Average**	
835 MHz	6.29	9.57	6.44	9.92	2.38%	3.66%	2018-1-15
1900 MHz	21.3	41.1	22.04	42.8	3.47%	4.14%	2018-1-16
2450 MHz	24.7	53.1	24.8	52.4	0.40%	-1.32%	2018-1-17
2600 MHz	25.4	57.1	24.52	54.4	-3.46%	-4.73%	2018-1-18

9. Measurement Procedures

9.1. Tests to be performed

In order to determine the highest value of the peak spatial-average SAR of a handset, all device positions, configurations and operational modes shall be tested for each frequency band according to steps 1 to 3 below. A flowchart of the test process is shown in Picture 11.1.

Step 1: The tests described in 11.2 shall be performed at the channel that is closest to the centre of the transmit frequency band (f_c) for:

a) all device positions (cheek and tilt, for both left and right sides of the SAM phantom, as described in Chapter 8),

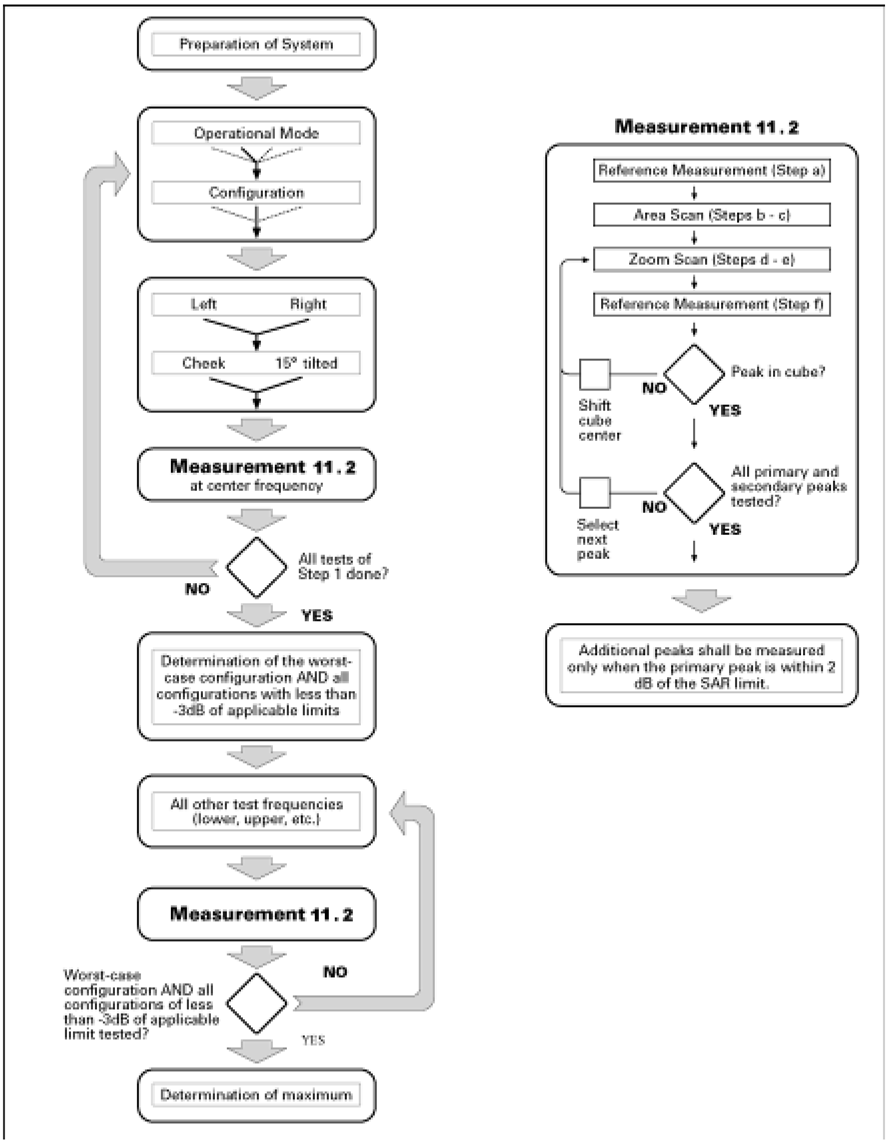
b) all configurations for each device position in a), e.g., antenna extended and retracted, and

c) all operational modes, e.g., analogue and digital, for each device position in a) and configuration in b) in each frequency band.

If more than three frequencies need to be tested according to 11.1 (i.e., N_c > 3), then all frequencies, configurations and modes shall be tested for all of the above test conditions.

Step 2: For the condition providing highest peak spatial-average SAR determined in Step 1, perform all tests described in 11.2 at all other test frequencies, i.e., lowest and highest frequencies. In addition, for all other conditions (device position, configuration and operational mode) where the peak spatial-average SAR value determined in Step 1 is within 3 dB of the applicable SAR limit, it is recommended that all other test frequencies shall be tested as well.

Step 3: Examine all data to determine the highest value of the peak spatial-average SAR found in Steps 1 to 2.



Picture 9.1Block diagram of the tests to be performed

9.2. General Measurement Procedure

The following procedure shall be performed for each of the test conditions (see Picture 11.1) described in 11.1:

a) Measure the local SAR at a test point within 8 mm or less in the normal direction from the inner surface of the phantom.

b) Measure the two-dimensional SAR distribution within the phantom (area scan procedure). The boundary of the measurement area shall not be closer than 20 mm from the phantom side walls. The distance between the measurement points should enable the detection of the location of local maximum with an accuracy of better than half the linear dimension of the tissue cube after interpolation. A maximum grip spacing of 20 mm for frequencies below 3 GHz and (60/f [GHz]) mm for frequencies of 3GHz and greater is recommended. The maximum distance between the geometrical centre of the probe detectors and the inner surface of the phantom shall be 5 mm for frequencies below 3 GHz andδln(2)/2 mm for frequencies of 3 GHz and greater, whereδis the plane wave skin depth and ln(x) is the natural logarithm. The maximum variation of the sensor-phantom surface shall be ±1 mm for frequencies below 3 GHz and ±0.5 mm for frequencies of 3 GHz and greater. At all measurement points the angle of the probe with respect to the line normal to the surface should be less than 5°. If this cannot be achieved for a measurement distance to the phantom inner surface shorter than the probe diameter, additional uncertainty evaluation is needed.

c) From the scanned SAR distribution, identify the position of the maximum SAR value, in addition identify the positions of any local maxima with SAR values within 2 dB of the maximum value that are not within the zoom-scan volume; additional peaks shall be measured only when the primary peak is within 2 dB of the SAR limit. This is consistent with the 2 dB threshold already stated;

d) Measure the three-dimensional SAR distribution at the local maxima locations identified in step c). The horizontal grid step shall be (24/f[GHz]) mm or less but not more than 8 mm. The minimum zoom size of 30 mm by 30 mm and 30 mm for frequencies below 3 GHz. For higher frequencies, the minimum zoom size of 22 mm by 22 mm and 22 mm. The grip step in the vertical direction shall be (8-f[GHz]) mm or less but not more than 5 mm, if uniform spacing is used. If variable spacing is used in the vertical direction, the maximum spacing between the two closest measured points to the phantom shell shall be (12 / f[GHz]) mm or less but not more than 4 mm, and the spacing between father points shall increase by an incremental factor not exceeding 1.5. When variable spacing is used, extrapolation routines shall be tested with the same spacing as used in measurements. The maximum distance between the geometrical centre of the probe detectors and the inner surface of the phantom shall be 5 mm for frequencies below 3 GHz andδIn(2)/2 mm for frequencies of 3 GHz and greater, where δis the plane wave skin depth and In(x) is the natural logarithm. Separate grids shall be centered on each of the local SAR maxima found in step c). Uncertainties due to field distortion between the media boundary and the dielectric enclosure of the probe should also be minimized, which is achieved is the distance between the phantom surface and physical tip of the probe is larger than probe tip diameter. Other methods may utilize correction procedures for these boundary effects that enable high precision measurements closer than half the probe diameter. For all measurement points, the angle of the probe with respect to the flat phantom surface shall be less than 5°. If this cannot be achieved an additional uncertainty evaluation is needed.

e) Use post processing(e.g. interpolation and extrapolation) procedures to determine the local SAR values at the spatial resolution needed for mass averaging.

9.3. WCDMA Measurement Procedures for SAR

The following procedures are applicable to WCDMA handsets operating under 3GPP Release99, Release 5 and Release 6. The default test configuration is to measure SAR with an established radio link between the DUT and a communication test set using a 12.2kbps RMC (reference measurement channel) configured in Test Loop Mode 1. SAR is selectively confirmed for other physical channel configurations (DPCCH &$DPDCH_n$), HSDPA and HSPA (HSUPA/HSDPA) modes according to output power, exposure conditions and device operating capabilities. Both uplink and downlink should be configured with the same RMC or AMR, when required. SAR for Release 5 HSDPA and Release 6 HSPA are measured using the applicable FRC (fixed reference channel) and E-DCH reference channel configurations. Maximum output power is verified according to applicable versions of 3GPP TS 34.121 and SAR must be measured according to these maximum output conditions. When Maximum Power Reduction (MPR) is not implemented according to Cubic Metric (CM) requirements for Release 6 HSPA, the following procedures do not apply.

For Release 5 HSDPA Data Devices:

Sub-test	β_c	β_d	β_d (SF)	β_c/β_d	β_{hs}	CM/dB	MPR/dB
1	2/15	15/15	64	2/15	4/15	2.0	0.0

2	12/15	15/15	64	12/15	24/25	2.0	0.0
3	15/15	8/15	64	15/8	30/15	2.0	0.0
4	15/15	4/15	64	15/4	30/15	2.0	0.0

For Release 6 HSUPA Data Devices

Sub-test	β_c	β_d	β_d (SF)	β_c / β_d	β_{hs}	β_{ec}	β_{ed}	β_{ed} (SF)	β_{ed} (codes)	CM (dB)	MPR (dB)	AG Index	E-TFCI
1	11/15	15/15	64	11/15	22/15	209/225	1039/225	4	1	2.0	1.0	20	75
2	6/15	15/15	64	6/15	12/15	12/15	12/15	4	1	2.0	1.0	12	67
3	15/15	9/15	64	15/9	30/15	30/15	β_{ed1}:47/15 β_{ed2}:47/15	4	2	2.0	1.0	15	92
4	2/15	15/15	64	2/15	4/15	4/15	56/75	4	1	2.0	1.0	17	71
5	15/15	15/15	64	15/15	24/15	30/15	134/15	4	1	2.0	1.0	21	81

9.4. SAR Measurement for LTE

SAR tests for LTE are performed with a base station simulator, Anritsu 8820. Closed loop power control was used so the UE transmits with maximum output power during SAR testing. All powers were measured with the Anritsu 8820

It is performed for conducted power and SAR based on the KDB941225 D05.

SAR is evaluated separately according to the following procedures for the different test positions in each exposure condition – head, body, body-worn accessories and other use conditions. The procedures in the following subsections are applied separately to test each LTE frequency band

1) QPSK with 1 RB allocation

Start with the largest channel bandwidth and measure SAR for QPSK with 1 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 of the remaining RB offset configurations and required test channels is not required for 1 RB allocation; otherwise, SAR is required for the remaining required test channels and only for the RB offset configuration with the highest output power for that channel. When the reported SAR of a required test channel is > 1.45 W/kg, SAR is required for all three RB offset configurations for that required test channel.

2) QPSK with 50% RB allocation

The procedures required for 1 RB allocation in 1) are applied to measure the SAR for QPSK with 50% RB allocation.

3) QPSK with 100% RB allocation

For QPSK with 100% RB allocation, SAR is not required when the highest maximum output power for 100 % RB allocation is less than the highest maximum output power in 50% and 1 RB allocations and the highest reported SAR for 1 RB and 50% RB allocation in 1) and 2) are ≤ 0.8W/kg. Otherwise, SAR is measured for the highest output power channel; and if the reported SAR is > 1.45 W/kg, the remaining required test channels must also be tested.

9.5. Bluetooth & Wi-Fi Measurement Procedures for SAR

Normal network operating configurations are not suitable for measuring the SAR of 802.11 transmitters in general. Unpredictable fluctuations in network traffic and antenna diversity conditions can introduce undesirable variations in SAR results. The SAR for these devices should be measured using chipset based test mode software to ensure that the results are consistent and reliable.

Chipset based test mode software is hardware dependent and generally varies among manufacturers. The device operating parameters established in a test mode for SAR measurements must be identical to those programmed in production units, including output power levels, amplifier gain settings and other RF performance tuning parameters. The test frequencies should correspond to actual channel frequencies defined for domestic use. SAR for devices with switched diversity should be measured with only one antenna transmitting at a time during each SAR measurement, according to a fixed modulation and data rate. The same data pattern should be used for all measurements.

9.6. Power Drift

To control the output power stability during the SAR test, DASY5 system calculates the power drift by measuring the E-field at the same location at the beginning and at the end of the measurement for each test position. These drift values can be found in Section 14 labeled as: (Power Drift [dB]). This ensures that the power drift during one measurement is within 5%.

10. Area Scan Based 1-g SAR

10.1 Requirement of KDB

According to the KDB447498 D01 v06, when the implementation is based the specific polynomial fit algorithm as presented at the 29th Bioelectromagnetics Society meeting (2007) and the estimated 1-g SAR is ≤ 1.2 W/kg, a zoom scan measurement is not required provided it is also not needed for any other purpose; for example, if the peak SAR location required fo simultaneous transmission SAR test exclusion can be determined accurately by the SAR system or manually to discriminate between distinctive peaks and scattered noisy SAR distributions from area scans.

There must not be any warning or alert messages due to various measurement concerns identified by the SAR system; for example, noise in measurements, peaks too close to scan boundary, peaks are too sharp, spatial resolution and uncertainty issues etc. The SAR system verification must also demonstrate that the area scan estimated 1-g SAR is within 3% of the zoom scan 1-g SAR (See Annex B). When all the SAR results for each exposure condition in a frequency band and wireless mode are based on estimated 1-g SAR, the 1-g SAR for the highest SAR configuration must be determined by a zoom scan.

10.2 Fast SAR Algorithms

The approach is based on the area scan measurement applying a frequency dependent attenuation parameter. This attenuation parameter was empirically determined by analyzing a large number of phones. The MOTOROLA FAST SAR was developed and validated by the MOTOROLA Research Group in Ft. Lauderdale.

In the initial study, an approximation algorithm based on Linear fit was developed. The accuracy of the algorithm has been demonstrated across a broad frequency range (136-2450 MHz) and for both 1- and 10-g averaged SAR using a sample of 264 SAR measurements from 55 wireless handsets. For the sample size studied, the root-mean-squared errors of the algorithm are 1.2% and 5.8% for 1- and 10-g averaged SAR, respectively. The paper describing the algorithm in detail is expected to be published in August 2004 within the Special Issue of Transactions on MTT.

In the second step, the same research group optimized the fitting algorithm to an Polynomial fit whereby the frequency validity was extended to cover the range 30-6000MHz. Details of this study can be found in the BEMS 2007 Proceedings.

Both algorithms are implemented in DASY software.

11. Conducted Output Power

11.1. Manufacturing tolerance

Table 11.1: GSM （Sensor off）

GSM 850				
Channel		Channel 128	Channel 190	Channel 251
Maximum Target Value (dBm)		33.5	33.5	33.5
GSM 1900				
Channel		Channel 512	Channel 661	Channel 810
Maximum Target Value (dBm)		30.5	30.5	30.5
GSM 850 GPRS/EGPRS(GMSK)				
Channel		128	190	251
1 Txslot	Maximum Target Value (dBm)	34.0	34.0	34.0
2 Txslots	Maximum Target Value (dBm)	32	32	32
3Txslots	Maximum Target Value (dBm)	31	31	31
4 Txslots	Maximum Target Value (dBm)	29	29	29
GSM 1900 GPRS/EGPRS(GMSK)				
Channel		512	661	810
1 Txslot	Maximum Target Value (dBm)	31	31	31
2 Txslots	Maximum Target Value (dBm)	29.5	29.5	29.5
3Txslots	Maximum Target Value (dBm)	28	28	28
4 Txslots	Maximum Target Value (dBm)	27	27	27
GSM 850 EGPRS(8PSK)				
Channel		128	190	251
1 Txslot	Maximum Target Value (dBm)	27.5	27.5	27.5
2 Txslots	Maximum Target Value (dBm)	27	27	27
3Txslots	Maximum Target Value (dBm)	25	25	25
4 Txslots	Maximum Target Value (dBm)	24	24	24

GSM 1900 EGPRS(8PSK)				
Channel		512	661	810
1 Txslot	Maximum Target Value (dBm)	26	26	26
2 Txslots	Maximum Target Value (dBm)	25	25	25
3Txslots	Maximum Target Value (dBm)	23	23	23
4 Txslots	Maximum Target Value (dBm)	22	22	22

Table 11.2: GSM （Sensor on）

GSM 850			
Channel	Channel 128	Channel 190	Channel 251
Maximum Target Value (dBm)	23	23	23
GSM 1900			
Channel	Channel 512	Channel 661	Channel 810
Maximum Target Value (dBm)	21	21	21

GSM 850 GPRS/EGPRS(GMSK)				
Channel		128	190	251
1 Txslot	Maximum Target Value (dBm)	23	23	23
2 Txslots	Maximum Target Value (dBm)	22	22	22
3Txslots	Maximum Target Value (dBm)	21	21	21
4 Txslots	Maximum Target Value (dBm)	21	21	21
GSM 1900 GPRS/EGPRS(GMSK)				
Channel		512	661	810
1 Txslot	Maximum Target Value (dBm)	21	21	21
2 Txslots	Maximum Target Value (dBm)	21	21	21
3Txslots	Maximum Target Value (dBm)	19	19	19
4 Txslots	Maximum Target Value (dBm)	19	19	19
GSM 850 EGPRS(8PSK)				

Channel		128	190	251
1 Txslot	Maximum Target Value (dBm)	21	21	21
2 Txslots	Maximum Target Value (dBm)	20	20	20
3Txslots	Maximum Target Value (dBm)	19	19	19
4 Txslots	Maximum Target Value (dBm)	19	19	19
GSM 1900 EGPRS(8PSK)				
Channel		512	661	810
1 Txslot	Maximum Target Value (dBm)	18	18	18
2 Txslots	Maximum Target Value (dBm)	17	17	17
3Txslots	Maximum Target Value (dBm)	16	16	16
4 Txslots	Maximum Target Value (dBm)	16	16	16

Table 11.3: WCDMA

WCDMA Band II Sensor off			
Channel	Channel 9262	Channel 9400	Channel 9538
Maximum Target Value (dBm)	23	23	23
WCDMA Band II Sensor on			
Channel	Channel 9262	Channel 9400	Channel 9538
Maximum Target Value (dBm)	14.5	14.5	14.5

Table 11.4: HSDPA

WCDMA Band II				
Channel		9262	9400	9538
1	Maximum Target Value (dBm)	23	23	23
2	Maximum Target Value (dBm)	23	23	23
3	Maximum Target Value (dBm)	23	23	23
4	Maximum Target Value (dBm)	23	23	23

Table 11.5: HSUPA

WCDMA Band II				
Channel		9262	9400	9538
1	Maximum Target Value (dBm)	23	23	23
2	Maximum Target Value (dBm)	23	23	23
3	Maximum Target Value (dBm)	23	23	23
4	Maximum Target Value (dBm)	23	23	23
5	Maximum Target Value (dBm)	23	23	23

Table 11.6: WCDMA

WCDMA Band V Sensor off			
Channel	4132	4182	4233
Maximum Target Value (dBm)	24	24	24
WCDMA Band V Sensor on			
Channel	4132	4182	4233
Maximum Target Value (dBm)	20	20	20

Table 11.7: HSDPA

WCDMA Band V				
Channel		4132	4182	4233
1	Maximum Target Value (dBm)	24	24	24
2	Maximum Target Value (dBm)	24	24	24
3	Maximum Target Value (dBm)	24	24	24
4	Maximum Target Value (dBm)	24	24	24

Table 11.8: HSUPA

WCDMA Band V				
Channel		4132	4182	4233
1	Maximum Target Value (dBm)	24	24	24

2	Maximum Target Value (dBm)	24	24	24
3	Maximum Target Value (dBm)	24	24	24
4	Maximum Target Value (dBm)	24	24	24
5	Maximum Target Value (dBm)	24	24	24

Table 11.9: LTE

LTE Band5 Sensor off			
RB Size	1	50%	100%
Maximum Target Value (dBm)	24	24	24
LTE Band7 Sensor off			
RB Size	1	50%	100%
Maximum Target Value (dBm)	24	24	24
LTE Band5 Sensor on			
RB Size	1	50%	100%
Maximum Target Value (dBm)	22	21	21
LTE Band7 Sensor on			
RB Size	1	50%	100%
Maximum Target Value (dBm)	12.5	11	11

Table 11.10: WiFi

WiFi 802.11b Sensor off			
Channel	Channel 1	Channel 6	Channel 11
Maximum Target Value (dBm)	16	16	16
WiFi 802.11g Sensor off			
Channel	Channel 1	Channel 6	Channel 11
Maximum Target Value (dBm)	15.5	15	15
WiFi 802.11n 20M Sensor off			
Channel	Channel 1	Channel 6	Channel 11
Maximum Target Value (dBm)	15	14	14
WiFi 802.11b Sensor on			
Channel	Channel 1	Channel 6	Channel 11
Maximum Target Value (dBm)	14	14	14
WiFi 802.11g Sensor on			
Channel	Channel 1	Channel 6	Channel 11
Maximum Target Value (dBm)	13	13	13
WiFi 802.11n 20M Sensor on			
Channel	Channel 1	Channel 6	Channel 11
Maximum Target Value (dBm)	13	13	13

Table 11.11: Bluetooth

Bluetooth 2.1			
Channel	Channel 0	Channel 39	Channel 78
Maximum Target Value (dBm)	7	7	5
Bluetooth 4.0			
Channel	Channel 0	Channel 19	Channel 39
Maximum Target Value (dBm)	-1	-1	-1

11.2. GSM Measurement result

Table 11.12: The conducted Power for GSM Sensor off

The conducted power measurement results for GSM850/GSM1900

GSM 850MHZ	Conducted Power (dBm)		
	Channel 128(824.2MHz)	Channel 190(826.6MHz)	Channel 251(848.8MHz)
	33.34	33.24	33.22
GSM 1900MHZ	Conducted Power(dBm)		
	Channel 512(1850.2MHz)	Channel 661(1880 MHz)	Channel 810(1909.8MHz)
	29.71	30.3	29.88

GSM 850 MHz							
GPRS/E GPRS(GMSK)	**128**	**190**	**251**	Calculation	**128**	**190**	**251**
1 Txslot	33.37	33.3	33.25	-9.03dB	24.34	24.27	24.22
2 Txslots	31.34	31.26	31.38	-6.02dB	25.32	25.24	25.36
3Txslots	29.68	29.61	29.71	-4.26dB	25.42	25.35	25.45
4 Txslots	28.63	28.67	28.63	-3.01dB	25.62	25.66	25.62
GSM 1900 MHz							
GPRS/E GPRS (GMSK)	**512**	**661**	**810**	Calculation	**512**	**661**	**810**
1 Txslot	29.77	30.32	29.9	-9.03dB	20.74	21.29	20.87
2 Txslots	29.01	28.91	28.74	-6.02dB	22.99	22.89	22.72
3Txslots	27.69	27.61	27.88	-4.26dB	23.43	23.35	23.62
4 Txslots	26.76	26.73	26.61	-3.01dB	23.75	23.72	23.6

The conducted power measurement results for E-GPRS(8PSK)

GSM 850 MHz							
E-GPRS(8PSK)	**128**	**190**	**251**	Calculation	**128**	**190**	**251**
1 Txslot	27.2	26.86	26.93	-9.03dB	18.17	17.83	17.9
2 Txslots	26.5	26.37	26.31	-6.02dB	20.48	20.35	20.29
3Txslots	24.45	24.22	24.26	-4.26dB	20.19	19.96	20
4 Txslots	23.36	23.21	23.28	-3.01dB	20.35	20.2	20.27
GSM 1900 MHz							
E-GPRS (8PSK)	**512**	**661**	**810**	Calculation	**512**	**661**	**810**
1 Txslot	25.13	25.43	24.98	-9.03dB	16.1	16.4	15.95
2 Txslots	24.91	24.82	24.61	-6.02dB	18.89	18.8	18.59
3Txslots	22.78	22.64	22.46	-4.26dB	18.52	18.38	18.2
4 Txslots	21.52	21.51	21.42	-3.01dB	18.51	18.5	18.41

Table 11.13: The conducted Power for GSM Sensor on

The conducted power measurement results for GSM850/GSM1900

GSM 850MHZ	Conducted Power (dBm)		
	Channel 128(824.2MHz)	Channel 190(826.6MHz)	Channel 251(848.8MHz)
	22.43	22.50	22.55
GSM 1900MHZ	Conducted Power(dBm)		
	Channel 512(1850.2MHz)	Channel 661(1880 MHz)	Channel 810(1909.8MHz)
	20.59	20.53	20.86

GSM 850 MHz							
GPRS/E GPRS(GMSK)	**128**	**190**	**251**	Calculation	**128**	**190**	**251**
1 Txslot	22.43	22.51	22.55	-9.03dB	13.4	13.48	13.52
2 Txslots	22.15	22.34	22.33	-6.02dB	16.13	16.32	16.31
3Txslots	20.81	20.91	20.94	-4.26dB	16.55	16.65	16.68
4 Txslots	20.47	20.52	20.38	-3.01dB	17.46	17.51	17.37
GSM 1900 MHz							
GPRS/E GPRS (GMSK)	**512**	**661**	**810**	Calculation	**512**	**661**	**810**
1 Txslot	20.59	20.53	20.86	-9.03dB	11.56	11.5	11.83
2 Txslots	19.7	19.6	20.56	-6.02dB	13.68	13.58	14.54
3Txslots	18.39	18.26	18.73	-4.26dB	14.13	14	14.47
4 Txslots	18.32	18.48	18.59	-3.01dB	15.31	15.47	15.58

The conducted power measurement results for E-GPRS(8PSK)

GSM 850 MHz							
E-GPRS (8PSK)	**128**	**190**	**251**	Calculation	**128**	**190**	**251**
1 Txslot	22.43	22.51	22.55	-9.03dB	13.4	13.48	13.52
2 Txslots	22.15	22.34	22.33	-6.02dB	16.13	16.32	16.31
3Txslots	20.81	20.91	20.94	-4.26dB	16.55	16.65	16.68
4 Txslots	20.47	20.52	20.38	-3.01dB	17.46	17.51	17.37
GSM 1900 MHz							
E-GPRS (8PSK)	**512**	**661**	**810**	Calculation	**512**	**661**	**810**
1 Txslot	20.59	20.53	20.86	-9.03dB	11.56	11.5	11.83
2 Txslots	19.7	19.6	20.56	-6.02dB	13.68	13.58	14.54
3Txslots	18.39	18.26	18.73	-4.26dB	14.13	14	14.47
4 Txslots	18.32	18.48	18.59	-3.01dB	15.31	15.47	15.58

1) Division Factors

To average the power, the division factor is as follows:

1TX-slot = 1 transmit time slot out of 8 time slots=> conducted power divided by (8/1) => -9.03dB

2TX-slots = 2 transmit time slots out of 8 time slots=> conducted power divided by (8/2) => -6.02dB

3TX-slots = 3 transmit time slots out of 8 time slots=> conducted power divided by (8/3) => -4.26dB

4TX-slots = 4 transmit time slots out of 8 time slots=> conducted power divided by (8/4) => -3.01dB

According to the conducted power as above, the body measurements are performed with GPRS 4Txslots for GSM850 and GSM1900.

11.3. WCDMA Measurement result

Table 11.14: The conducted Power for WCDMA Sensor off

Item	band	WCDMA BAND II result(dBm)		
	ARFCN	2712 (1852.4MHz)	2788 (1880.0MHz)	2863 (1907.6MHz)
WCDMA	\	22.82	22.89	22.93
HSDPA	1	22.59	22.41	22.47
	2	22.37	22.21	22.29
	3	22.04	21.91	22
	4	21.96	21.81	21.87
HSUPA	1	21.94	21.81	21.86
	2	20.99	20.75	20.9
	3	20.98	20.89	20.83
	4	21.79	21.59	21.74
	5	21.59	21.49	21.63
HSPA+		21.72	21.53	21.71
Item	band	WCDMA BAND V result(dBm)		
	ARFCN	Channel 4132 (826.4MHz)	Channel 4183 (836.6MHz)	Channel 4233 (846.6MHz)
WCDMA	\	23.43	23.39	23.34
HSDPA	1	22.98	22.93	22.92
	2	22.38	22.35	22.28
	3	22.11	22.04	22.03
	4	22.01	21.97	21.93
HSUPA	1	22.01	21.94	21.86
	2	21.58	21.55	21.87
	3	21.58	21.49	21.91
	4	21.91	21.77	21.79
	5	21.62	21.6	21.62
HSPA+		21.51	21.42	21.83

Table 11.15: The conducted Power for WCDMA Sensor on

Item	band	WCDMA BAND II result(dBm)		
	ARFCN	9262 (1852.4MHz)	9400 (1880.0MHz)	9538 (1907.6MHz)
WCDMA	\	14.38	14.41	14.45
HSDPA	1	13.66	13.68	13.71
	2	13.44	13.48	13.53
	3	13.11	13.18	13.24
	4	13.03	13.08	13.11
HSUPA	1	13.01	13.08	13.1
	2	12.06	12.02	12.14
	3	12.05	12.16	12.07
	4	12.86	12.86	12.98
	5	12.66	12.76	12.87
HSPA+		12.39	12.4	12.45
Item	band	WCDMA BAND V result(dBm)		
	ARFCN	Channel 4132 (826.4MHz)	Channel 4183 (836.6MHz)	Channel 4233 (846.6MHz)
WCDMA	\	19.9	19.9	19.96
HSDPA	1	19.15	19.16	19.24
	2	18.95	18.98	19
	3	18.68	18.67	18.75
	4	18.58	18.6	18.65
HSUPA	1	18.58	18.57	18.58
	2	17.55	17.58	17.59
	3	17.55	17.63	17.63
	4	18.48	18.4	18.51
	5	18.19	18.23	18.34
HSPA+		17.52	17.68	17.64

11.4. LTE Measurement result

Table 11.16: The conducted Power for LTE BAND 5/7 Sensor off

Band5						
Bandwidth	Mode	RB Size	RB Offset	Actual output power(dBm)		
				Channel 20425 826.5MHz	Channel 20525 836.5MHz	Channel 20625 846.5MHz
5MHz	QPSK	1	0	23.2	23.3	23.39
		1	13	23.44	23.54	23.57
		1	24	23.38	23.59	23.68
		12	0	23.2	23.3	23.4
		12	6	23.51	23.58	23.66
		12	13	23.39	23.46	23.53
		25	0	22.41	22.49	22.56
	16QAM	1	0	22.2	22.29	22.41
		1	13	22.42	22.55	22.55
		1	24	22.27	22.52	22.55
		12	0	22.26	22.22	22.41
		12	6	22.44	22.55	22.73
		12	13	22.41	22.48	22.41
		25	0	23.31	23.45	23.54
Bandwidth	Mode	RB Size	RB Offset	Actual output power(dBm)		
				Channel 20450 829MHz	Channel 20525 836.5MHz	Channel 20600 844MHz
10MHz	QPSK	1	0	23.33	23.45	23.49
		1	25	23.53	23.66	23.74
		1	49	23.24	23.34	23.38
		25	0	23.52	23.62	23.66
		25	13	23.49	23.52	23.54
		25	25	23.41	23.43	23.46
		50	0	22.41	22.45	22.49
	16QAM	1	0	22.33	22.44	22.51
		1	25	22.51	22.67	22.72
		1	49	22.13	22.27	22.25
		25	0	22.58	22.54	22.67
		25	13	22.42	22.49	22.61
		25	25	22.43	22.45	22.34
		50	0	23.31	23.41	23.47
Bandwidth	Mode	RB Size	RB Offset	Actual output power(dBm)		
				Channel 20415	Channel	Channel 20635

				825.5MHz	20525 836.5MHz	847.5MHz
3MHz	QPSK	1	0	23.32	23.37	23.45
		1	8	23.34	23.4	23.47
		1	14	23.25	23.35	23.43
		8	0	23.26	23.36	23.51
		8	4	23.38	23.51	23.62
		8	7	23.39	23.49	23.42
		15	0	22.34	22.44	22.48
	16QAM	1	0	22.28	22.36	22.47
		1	8	22.32	22.41	22.45
		1	15	22.14	22.28	22.3
		8	0	22.22	22.28	22.52
		8	4	22.31	22.48	22.69
		8	7	22.41	22.51	22.3
		15	0	23.24	23.4	23.46
Bandwidth	Mode	RB Size	RB Offset	Actual output power(dBm)		
				Channel 20407 824.7MHz	Channel 20525 836.5MHz	Channel 20643 848.3MHz
1.4MHz	QPSK	1	0	23.2	23.4	23.33
		1	2	23.37	23.4	23.41
		1	5	23.26	23.36	23.39
		3	0	23.39	23.49	23.52
		3	1	23.28	23.46	23.31
		3	2	23.31	23.47	23.39
		6	0	22.51	22.61	22.63
	16QAM	1	0	22.16	22.39	22.35
		1	2	22.35	22.41	22.39
		1	5	22.15	22.29	22.26
		3	0	22.35	22.41	22.53
		3	1	22.21	22.43	22.38
		3	2	22.33	22.49	22.27
		6	0	23.41	23.57	23.61

Band7						
Bandwidth	Mode	RB Size	RB Offset	Actual output power(dBm)		
				Channel 20775 2502.5MHz	Channel 21100 2535MHz	Channel 21425 2567.5MHz
5MHz	QPSK	1	0	22.79	22.98	22.65
		1	13	23.08	23.25	23.11

		1	24	22.9	23	22.92
		12	0	22.81	23.11	22.89
		12	6	23.03	23.23	22.93
		12	13	22.98	23.18	22.88
		25	0	23.48	23.18	23.21
	16QAM	1	0	22.84	22.95	22.67
		1	13	22.07	22.32	22.99
		1	24	22.89	22.94	22.72
		12	0	22.88	22.03	22.29
		12	6	22.96	22.29	22
		12	13	22.9	22.2	22.8
		25	0	22.98	23.34	23.09

Bandwidth	Mode	RB Size	RB Offset	Actual output power(dBm)		
				Channel 20800 2505MHz	Channel 21100 2535MHz	Channel 21400 2565MHz
10MHz	QPSK	1	0	23.1	23.3	23.12
		1	25	23.16	23.38	23.38
		1	49	23.12	23.32	23.11
		25	0	23.15	23.32	23.17
		25	13	23.19	23.37	23.21
		25	25	23.01	23.29	23.02
		50	0	22.22	22.4	22.25
	16QAM	1	0	22.15	22.27	22.14
		1	25	22.15	22.45	22.26
		1	49	22.11	22.26	21.91
		25	0	22.22	22.24	21.57
		25	13	22.12	22.43	22.28
		25	25	21.93	22.31	21.94
		50	0	22.32	22.56	22.43

Bandwidth	Mode	RB Size	RB Offset	Actual output power(dBm)		
				Channel 20825 2507.5MHz	Channel 21100 2535MHz	Channel 21375 2562.5MHz
15MHz	QPSK	1	0	22.82	23	22.89
		1	38	23.21	23.4	23.25
		1	74	22.85	23.05	22.91
		36	0	22.93	23.29	22.95
		36	18	23.15	23.11	23.18
		36	39	23.08	23.28	23.11
		75	0	23	23.2	23.02
	16QAM	1	0	22.78	21.99	21.91
		1	38	22.19	22.41	22.23

		1	74	22.74	21.98	21.78
		36	0	21.89	22.21	21.96
		36	18	22.48	22.58	22.65
		36	39	22.1	22.3	21.99
		75	0	22.1	22.36	22.2
Bandwidth	Mode	RB Size	RB Offset	Actual output power(dBm)		
				Channel 20850 2510MHz	Channel 21100 2535MHz	Channel 21350 2560MHz
20MHz	QPSK	1	0	23.12	23.32	23.19
		1	50	23.65	**23.81**	23.64
		1	99	23.13	23.23	23.11
		50	0	23.31	**23.42**	23.21
		50	25	23.15	23.35	23.11
		50	50	23.1	23.3	23.05
		100	0	23.34	23.5	23.24
	16QAM	1	0	22.12	22.31	22.21
		1	50	22.63	22.82	22.62
		1	99	22.02	22.16	21.98
		50	0	22.37	22.34	22.22
		50	25	22.08	22.32	22.18
		50	50	22.12	22.32	21.93
		100	0	22.44	22.66	22.42

Table 11.17: The conducted Power for LTE BAND 5/7 Sensor on

Band5						
Bandwidth	Mode	RB Size	RB Offset	Actual output power(dBm)		
				Channel 20425 826.5MHz	Channel 20525 836.5MHz	Channel 20625 846.5MHz
5MHz	QPSK	1	0	21.45	21.33	21.29
		1	12	21.52	21.40	21.49
		1	24	21.46	21.28	21.30
		12	0	20.58	20.57	20.53
		12	6	20.61	20.56	20.52
		12	13	20.61	20.39	20.56
		25	0	20.53	20.45	20.56
	16QAM	1	0	20.04	20.11	20.62
		1	12	20.73	20.17	20.77
		1	24	20.11	19.95	20.62

		12	0	19.49	19.59	19.60
		12	6	19.60	19.67	19.68
		12	13	19.53	19.59	19.63
		25	0	19.53	19.71	19.61
Bandwidth	Mode	RB Size	RB Offset	Actual output power(dBm)		
				Channel 20450 829MHz	Channel 20525 836.5MHz	Channel 20600 844MHz
10MHz	QPSK	1	0	21.33	21.39	21.59
		1	25	21.59	21.53	21.65
		1	49	21.21	21.28	21.26
		25	0	20.61	20.62	20.64
		25	13	20.64	20.63	20.62
		25	25	20.60	20.53	20.60
		50	0	20.59	20.55	20.59
	16QAM	1	0	20.03	20.14	20.00
		1	25	20.08	20.16	20.07
		1	49	19.93	20.08	20.06
		25	0	19.57	19.60	19.52
		25	13	19.68	19.71	19.58
		25	25	19.64	19.60	19.54
		50	0	19.66	19.62	19.64
Bandwidth	Mode	RB Size	RB Offset	Channel 20415 825.5MHz		
				Channel 20415 825.5MHz	Channel 20525 836.5MHz	Channel 20635 847.5MHz
3MHz	QPSK	1	0	21.60	21.34	21.60
		1	7	21.58	21.40	21.50
		1	14	21.25	21.41	21.45
		8	0	21.58	21.56	21.46
		8	4	21.52	21.57	21.49
		8	7	21.45	21.64	21.51
		15	0	20.65	20.61	20.60
	16QAM	1	0	19.09	20.04	20.77
		1	7	19.27	20.00	20.77
		1	14	18.78	20.02	20.11
		8	0	19.87	20.41	20.38
		8	4	19.92	20.42	20.41
		8	7	19.07	20.68	20.52
		15	0	19.22	19.61	19.58
Bandwidth	Mode	RB Size	RB Offset	Actual output power(dBm)		
				Channel 20407 824.7MHz	Channel 20525	Channel 20643 848.3MHz

					836.5MHz	
1.4MHz	QPSK	1	0	21.12	21.51	21.46
		1	2	21.31	21.70	21.65
		1	5	18.78	21.54	21.60
		3	0	20.27	21.50	21.50
		3	2	21.07	21.62	21.52
		3	3	21.61	21.61	21.67
		6	0	20.12	20.64	20.66
	16QAM	1	0	19.82	20.01	19.85
		1	2	18.87	20.74	19.99
		1	5	19.35	20.21	19.93
		3	0	19.97	20.25	20.32
		3	2	20.43	20.54	20.54
		3	3	20.82	20.62	20.50
		6	0	19.53	19.63	19.62

Band7						
Bandwidth	Mode	RB Size	RB Offset	Actual output power(dBm)		
				Channel 20775 2502.5MHz	Channel 21100 2535MHz	Channel 21425 2567.5MHz
5MHz	QPSK	1	0	11.67	11.73	11.33
		1	13	11.75	11.75	11.43
		1	24	11.76	11.68	11.35
		12	0	10.61	10.75	10.58
		12	6	10.78	10.82	10.6
		12	13	10.8	10.78	10.56
		25	0	10.71	10.76	10.63
	16QAM	1	0	10.27	10.83	9.96
		1	13	10.41	10.82	9.96
		1	24	10.77	10.84	10.16
		12	0	9.61	9.87	9.78
		12	6	9.79	9.69	9.6
		12	13	9.66	9.84	9.67
		25	0	9.73	9.71	9.72
Bandwidth	Mode	RB Size	RB Offset	Actual output power(dBm)		
				Channel 20800 2505MHz	Channel 21100 2535MHz	Channel 21400 2565MHz
10MHz	QPSK	1	0	11.54	11.79	11.71
		1	25	12.04	11.89	12.08

		1	49	11.63	11.69	11.64
		25	0	10.92	11.01	10.87
		25	13	11.1	11	10.91
		25	25	10.96	10.96	10.77
		50	0	11.04	10.94	10.87
	16QAM	1	0	10.25	10.28	10.13
		1	25	10.58	11.04	10.21
		1	49	10	10.5	10.29
		25	0	9.88	9.7	9.95
		25	13	9.96	9.9	9.99
		25	25	10.12	9.81	9.84
		50	0	9.99	9.78	9.94

Bandwidth	Mode	RB Size	RB Offset	Actual output power(dBm)		
				Channel 20825 2507.5MHz	Channel 21100 2535MHz	Channel 21375 2562.5MHz
15MHz	QPSK	1	0	11.54	11.79	11.71
		1	38	12.04	11.89	12.08
		1	74	11.63	11.69	11.64
		36	0	10.86	10.88	10.88
		36	18	10.94	10.89	10.76
		36	39	10.97	10.82	10.72
		75	0	10.93	10.8	10.76
	16QAM	1	0	10.28	10.62	10.39
		1	38	10.4	11.03	10.93
		1	74	10.15	10.63	10.4
		36	0	9.83	9.85	10
		36	18	10	9.97	9.78
		36	39	9.94	9.91	9.94
		75	0	9.9	9.89	9.98

Bandwidth	Mode	RB Size	RB Offset	Actual output power(dBm)		
				Channel 20850 2510MHz	Channel 21100 2535MHz	Channel 21350 2560MHz
20MHz	QPSK	1	0	11.83	11.94	11.53
		1	50	12.13	12.2	12.06
		1	99	11.9	11.92	11.79
		50	0	10.93	10.83	10.83
		50	25	10.89	10.84	10.74
		50	50	10.84	10.8	10.69
		100	0	10.77	10.76	10.67
	16QAM	1	0	10.23	10.35	10.3
		1	50	10.79	10.82	10.94

		1	99	10.34	10.41	10.24
		50	0	9.86	9.77	9.87
		50	25	9.82	9.87	9.77
		50	50	9.87	9.95	9.73
		100	0	9.79	9.8	9.7

11.5. Wi-Fi and BT Measurement result

Table 11.18: The conducted power for Bluetooth

GFSK			
Channel	Ch0 (2402 MHz)	Ch39 (2441MHz)	CH78 (2480MHz)
Conducted Output Power (dBm)	5.2	6.3	3.9
π/4 DQPSK			
Channel	Ch0 (2402 MHz)	Ch39 (2441MHz)	CH78 (2480MHz)
Conducted Output Power (dBm)	6.2	6.7	4.6
8DPSK			
Channel	Ch0 (2402 MHz)	Ch39 (2441MHz)	CH78 (2480MHz)
Conducted Output Power (dBm)	6.3	6.8	4.3

Table 11.19: The conducted power for Bluetooth 4.0

GFSK			
Channel	Ch0 2402 MHz	Ch19 2440 MHz	CH39 2480 MHz
Conducted Output Power (dBm)	-2.4	-1.6	-1.7

NOTE: According to KDB447498 D01 BT standalone SAR are not required, because maximum average output power is less than 10mW.

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 the 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.

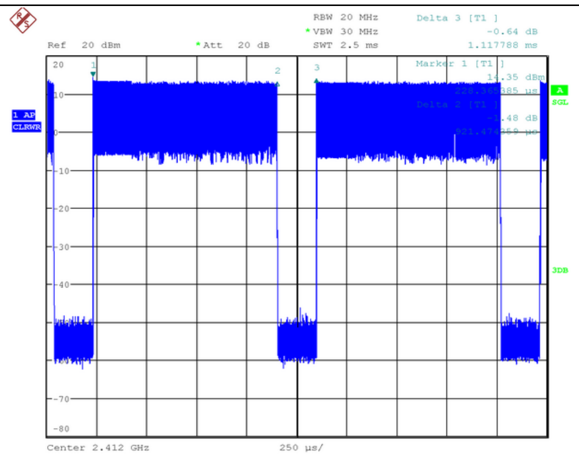
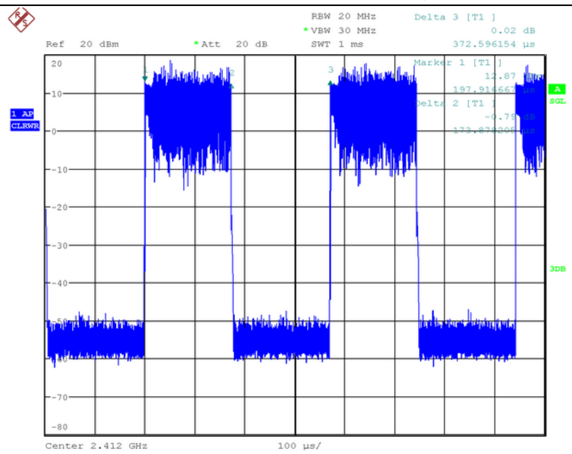
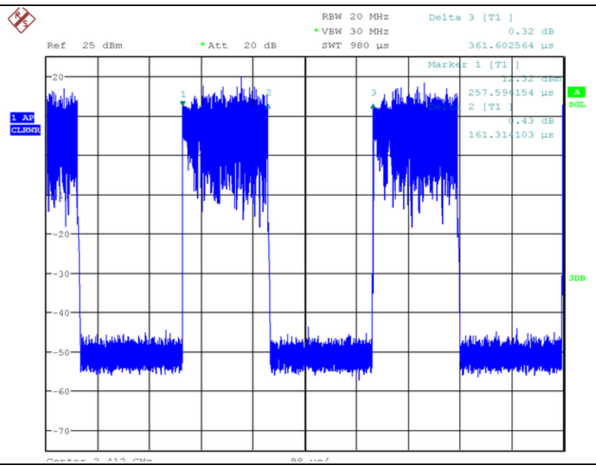
SAR body value of BT is 0.209 W/Kg.

The default power measurement procedures are:

a) Power must be measured at each transmit antenna port according to the DSSS and OFDM transmission configurations in each standalone and aggregated frequency band.

b) Power measurement is required for the transmission mode configuration with the highest maximum output power specified for production units.

1) When the same highest maximum output power specification applies to multiple transmission modes, the largest channel bandwidth configuration with the lowest order modulation and lowest data rate is measured.

Duty Cycle 82.4% for 802.11b mode	Duty Cycle 46.7% for 802.11g mode
	
Duty Cycle 44.6% for 802.11 20n mode	
	

2) When the same highest maximum output power is specified for multiple largest channel bandwidth configurations with the same lowest order modulation or lowest order modulation and lowest data rate, power measurement is required for all equivalent 802.11 configurations with the same maximum output power.

c) For each transmission mode configuration, power must be measured for the highest and lowest channels; and at the mid-band channel(s) when there are at least 3 channels. For configurations with multiple mid-band channels, due to an even number of channels, both channels should be measured.

During WLAN SAR testing EUT is configured with the WLAN continuous TX tool, and the transmission duty factor was monitored on the spectrum analyzer with zero-span setting.

Table 11.19: The average conducted power for WiFi

Mode	Channel	Frequence	Average power(dBm)
802.11 b Sensor off	1	2412 MHZ	15.67
	6	2437 MHZ	15.73
	11	2462 MHZ	15.77
802.11 g Sensor off	1	2412 MHZ	15.22
	6	2437 MHZ	14.97
	11	2462 MHZ	14.49
802.11 n 20M Sensor off	1	2412 MHZ	Not required
	6	2437 MHZ	
	11	2462 MHZ	
802.11 b Sensor on	1	2412 MHZ	13.97
	6	2437 MHZ	13.91
	11	2462 MHZ	13.81
802.11 g Sensor on	1	2412 MHZ	Not required
	6	2437 MHZ	
	11	2462 MHZ	
802.11 n 20M Sensor on	1	2412 MHZ	
	6	2437 MHZ	
	11	2462 MHZ	

2.4 GHz 802.11g/n OFDM SAR Test Exclusion Requirements

When SAR measurement is required for 2.4 GHz 802.11g/n OFDM configurations, the measurement and test reduction procedures for OFDM are applied. SAR is not required for the following 2.4 GHz OFDM conditions.

a) When KDB Publication 447498 D01 SAR test exclusion applies to the OFDM configuration.

b) 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.

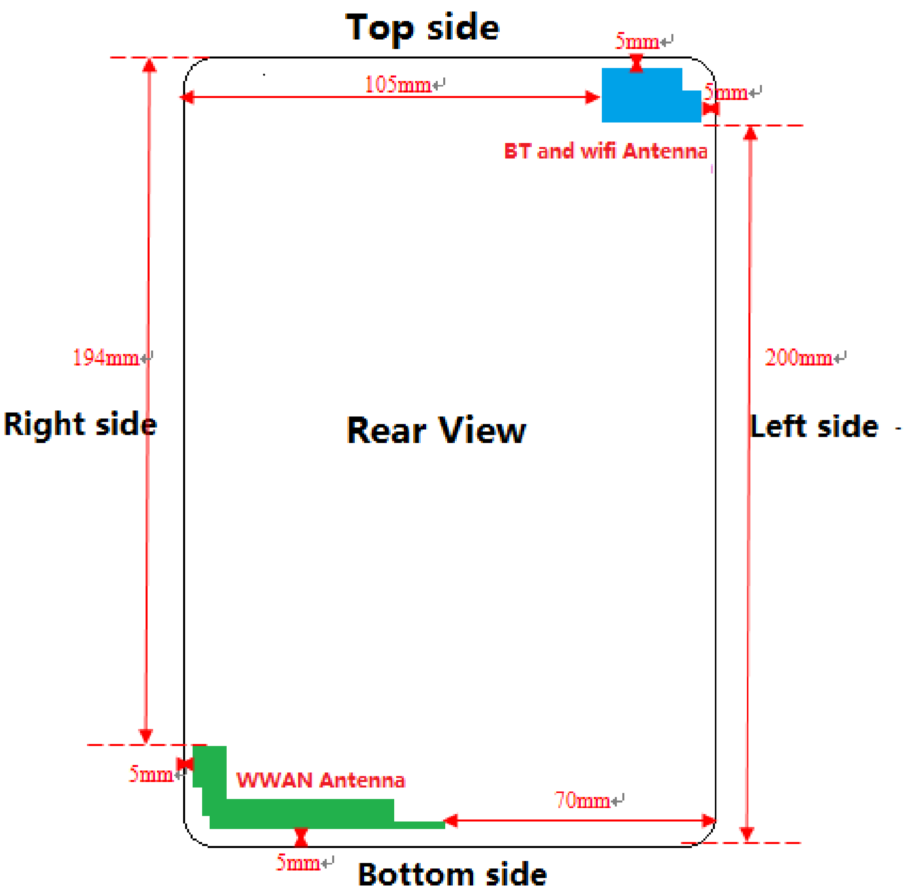
12. Simultaneous TX SAR Considerations

12.1. Introduction

The following procedures adopted from “FCC SAR Considerations for Cell Phones with Multiple Transmitters” are applicable to handsets with built-in unlicensed transmitters such as 802.11 a/b/g and Bluetooth devices which may simultaneously transmit with the licensed transmitter.

For this device, the BT and Wi-Fi 2.4GHz can transmit simultaneous with other transmitters.

12.2. Transmit Antenna Separation Distances



Picture 12.1 Antenna Locations

12.3. Standalone SAR Test Exclusion Considerations

Standalone 1-g head or body SAR evaluation by measurement or numerical simulation is not required when the corresponding SAR Exclusion Threshold condition, listed below, is satisfied.

The 1-g SAR test exclusion threshold 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, 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

According to the KDB447498 appendix A, the SAR test exclusion threshold for 2450MHz at 5mm test separation distances is 10mW.

$$\frac{\text{(max. power of channel, including tune-up tolerance, mW)}}{\text{(min. test separation distance, mm)}} * \sqrt{\text{Frequency (GHz)}} \leq 3.0$$

Based on the above equation, Bluetooth SAR was not required:

Evaluation=1.565＜3.0

Based on the above equation, WiFi SAR was required:

Evaluation=12.43>3.0

12.4. SAR Measurement Positions

The following SAR test exclusion Thresholds based on KDB 447498 D01 General RF Exposure Guidance v06 4.3.1

Exposure Position	Wireless Interface	GSM		WCDMA		LTE		WLAN
		850	**1900**	**Band5**	**Band2**	**Band5**	**Band7**	**802.11 b**
	Maximum power	33.5	30.5	24	23	24	24	16
	Maximum rated power(mW)	2238.72	1122.02	251.19	199.53	251.19	251.19	39.81
Rear view	Antenna to user (mm)	5	5	5	5	5	5	5
	SAR exclusion threshold	16.27	10.88	16.27	10.88	16.27	9.30	9.58
	SAR testing required?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Top	Antenna to user (mm)	194	194	194	194	194	194	5
	SAR exclusion threshold	980.00	1549.00	980.00	1549.00	980.00	1536.00	9.58
	SAR testing required?	**Yes**	**No**	**No**	**No**	**No**	**No**	**Yes**
Left	Antenna to user (mm)	70	70	70	70	70	70	5
	SAR exclusion threshold	277.33	309.00	277.33	309.00	277.33	296.00	9.58
	SAR testing required?	**Yes**	**Yes**	**No**	**No**	**No**	**No**	**Yes**
Bottom	Antenna to user (mm)	5	5	5	5	5	5	200
	SAR exclusion threshold	16.27	10.88	16.27	10.88	16.27	9.30	1596
	SAR testing required?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**No**
Right	Antenna to user (mm)	5	5	5	5	5	5	105
	SAR exclusion threshold	16.27	10.88	16.27	10.88	16.27	9.30	646
	SAR testing required?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**No**

13. Power Reduction by Proximity Sensing

A proximity sensor for power reduction is implemented in this device to address RF exposure compliance when the cellular antenna is positioned close to the user's body. The sensor's mechanical structure is designed to fit within the enclosure design used in this device and also extended around the edge and top of the antenna element in order to optimize sensitivity in these orientations. This design combines the antenna printed directly on a plastic part and proximity sensor FPC (Flexible Printed Circuit) bonded together into one piece. According to KDB 616217 D04 SAR for laptop and tablets v01r02 6)

13.1. Procedures for determining proximity sensor triggering distances

The following procedures should be applied to determine proximity sensor triggering distances for the back surface and individual edges of a tablet. Conducted power is monitored qualitatively to identify the general triggering characteristics and recorded quantitatively, versus spacing, as required by the procedures. Unless there is built-in test software that reports the triggering conditions and enables the power levels to be confirmed separately, monitoring of conducted power during the triggering tests typically requires internal access to the antenna ports inside the tablet, which may interfere with the triggering tests.

(1) The relevant transmitter should be set to operate at its normal maximum output power.
(2) The entire back surface or edge of the tablet is positioned below a flat phantom filled with the required tissue-equivalent medium, and positioned at least 20 mm further than the distance that triggers power reduction.
(3) It should be ensured that the cables required for power measurements are not interfering with the proximity sensor. Cable losses should be properly compensated to report the measured power results.
(4) The back surface or edge is moved toward the phantom in 3 mm steps until the sensor triggers.
(5) The back surface or edge is then moved back (further away) from the phantom by at least 5 mm or until maximum output power is returned to the normal maximum level.
(6) The back surface or edge is again moved toward the phantom, but in 1 mm steps, until it is at least 5 mm past the triggering point or touching the phantom. If 1 mm resolution is not suitable for the sensor triggering sensitivity, a KDB inquiry should be submitted to determine alternative test configurations.
(7) If the tablet is not touching the phantom, it is moved in 3 mm steps until it touches the phantom to confirm that the sensor remains triggered and the maximum power stays reduced.
(8) The process is then reversed by moving the tablet away from the phantom according to steps 4) to 7), to determine triggering release, until it is at least 10 mm beyond the point that triggers the return of normal maximum power.
(9) The measured output power within ± 5 mm of the triggering points, or until the tablet is

touching the phantom, for movements to and from the phantom should be tabulated in the SAR report.

(10) If the sensor design and implementation allow additional variations for triggering distance tolerances, multiple samples should be tested to determine the most conservative distance required for SAR evaluation.
(11) To ensure all production units are compliant, it is generally necessary to reduce the triggering distance determined from the triggering tests by 1 mm, or more if it is necessary, and use the smallest distance for movements to and from the phantom, minus 1 mm, as the sensor triggering distance for determining the SAR measurement distance.

13.2. Procedures for determining antenna and proximity sensor coverage

The sensing regions are usually limited to areas near the sensor element. If a sensor is spatially offset from the antenna(s), it is necessary to verify sensor triggering for conditions where the antenna is next to the user but the sensor is laterally further away to ensure sensor coverage is sufficient for reducing the power to maintain compliance. The following are used to determine if additional SAR measurements may be necessary due to sensor and antenna offset. 25 These procedures do not apply and are not required for configurations where the antenna and sensor are collocated and the peak SAR location is overlapping with the sensor.

(1) The back surface or edge of the tablet is positioned at a test separation distance less than or equal to the distance required for back surface or edge triggering, with both the antenna and sensor pad located at least 20 mm laterally outside the edge (boundary) of the phantom, along the direction of maximum antenna and sensor offset. For the back surface, if the direction of maximum offset is not aligned with the tablet coordinates (physical edges) the tablet test position would not be aligned with the phantom coordinates (orientations). Each applicable tablet edge should be positioned perpendicularly to the phantom to determine sensor coverage. For antennas and/or sensors located near the corner of a tablet, both adjacent edges must be considered.
(2) The similar sequence of steps applied to determine sensor triggering distance in section 6.2 are used to verify back surface and edge sensor coverage by moving the tablet (sensor and antenna) horizontally toward the phantom while maintaining the same vertical separation between the back surface or edge and the phantom.
(3) After the exact location where triggering of power reduction is determined, with respect to the sensor and antenna, the tablet movement should be continued, in 3 mm increments, until both the sensor and antenna(s) are fully under the phantom and at least 20 mm inside the phantom edge.
(4) The process is then repeated from the opposite direction, starting at the other end of the maximum antenna and sensor offset, by rotating the tablet 180° along the vertical axis.
(5) The triggering points should be documented graphically, with the antenna and sensor

clearly identified, along with all relevant dimensions.

(6) If the subsequently measured peak SAR location for the antenna is not between the triggering points, established by the sensor coverage tests from opposite ends of the antenna and sensor, additional SAR tests may be required for conditions where only part of the back surface or edge of a tablet corresponding to the antenna is in proximity to the user and the sensor may not be triggering as desired. A KDB inquiry must be submitted by the test lab to determine if additional tests are required and the proper test configurations to use for testing. This may include situations where the sensor coverage region is too small for the antenna, the sensor is located too far away from the antenna, the sensor location is insufficient to cover multiple antennas or the antenna is at the corner of a tablet etc.