FCC SAR Compliance Test Report

Product Name: Mobile WiFi

Model: R227h

Report No.: SYBH(Z-SAR)009052017-2

FCC ID: QISR227H

	APPROVED (Lab Manager)	PREPARED (Test Engineer)
BY	Wei Huanbin	Sun Shanbin
DATE	2017-07-07	2017-07-07

Reliability Laboratory of Huawei Technologies Co., Ltd.

(Global Compliance and Testing Center of Huawei Technologies Co., Ltd)

Administration Building, Headquarters of Huawei Technologies Co., Ltd., Bantian, Longgang District, Shenzhen, 518129, P.R.C
Tel: +86 755 28780808 Fax: +86 755 89652518

※ ※ Notice ※ ※

1. The laboratory has passed the accreditation by China National Accreditation Service for Conformity Assessment (CNAS). The accreditation number is L0310.

2. The laboratory has passed the accreditation by The American Association for Laboratory Accreditation (A2LA). The accreditation number is 2174.01 & 2174.02 & 2174.03

3. The laboratory (Reliability Lab of Huawei Technologies Co., Ltd) is also named “Global Compliance and Testing Center of Huawei Technologies Co., Ltd”, the both names have coexisted since 2009.

4. The test report is invalid if not marked with the signatures of the persons responsible for preparing and approving the test report.

5. The test report is invalid if there is any evidence of erasure and/or falsification.

6. The test report is only valid for the test samples.

7. Content of the test report, in part or in full, cannot be used for publicity and/or promotional purposes without prior written approval from the laboratory.

Table of Contents

1 General Information ... 6
1.1 Statement of Compliance ... 6
1.2 RF exposure limits ... 7
1.3 EUT Description ... 8
1.3.1 General Description ... 10
1.3.1 Downlink LTE CA specification ... 11
1.4 Test specification(s) ... 14
1.5 Testing laboratory ... 14
1.6 Applicant and Manufacturer ... 14
1.7 Application details ... 14
1.8 Ambient Condition ... 14
2 SAR Measurement System ... 15
2.1 SAR Measurement Set-up ... 15
2.2 Test environment ... 16
2.3 Data Acquisition Electronics description ... 16
2.4 Probe description ... 17
2.5 Phantom description ... 18
2.6 Device holder description ... 19
2.7 Test Equipment List ... 20
3 SAR Measurement Procedure ... 21
3.1 Scanning procedure ... 21
3.2 Spatial Peak SAR Evaluation ... 22
3.3 Data Storage and Evaluation ... 23
4 System Verification Procedure ... 25
4.1 Tissue Verification ... 25
4.2 System Check ... 27
4.3 System check Procedure ... 28
5 SAR measurement variability and uncertainty ... 29
5.1 SAR measurement variability ... 29
5.2 SAR measurement uncertainty ... 29
6 SAR Test Configuration ... 30
6.1 Test Positions Configuration ... 30
6.2 3G SAR Test Reduction Procedure ... 30
6.3 GSM Test Configuration ... 30
6.4 UMTS Test Configuration ... 31
6.5 LTE Test Configuration ... 36
6.6 WiFi Test Configuration ... 40
6.6.1 Initial Test Position Procedure ... 40
6.6.2 Initial Test Configuration Procedure ... 40
6.6.3 Sub Test Configuration Procedure ... 40
6.6.4 WiFi 2.4G SAR Test Procedures ... 41
6.6.5 WiFi 5G SAR Test Procedures ... 42
6.6.6 MIMO SAR Considerations ... 42
7 SAR Measurement Results ... 43
7.1 Conducted power measurements ... 43
7.1.1 Conducted power measurements of GSM850 ... 44
7.1.2 Conducted power measurements of GSM1900 ... 45
7.1.1 Conducted power measurements of UMTS Band II ... 46
7.1.2 Conducted power measurements of UMTS Band V ... 47
7.1.3 Conducted power measurements of LTE Band V ... 48
7.1.1 Conducted power measurements of LTE Band VII ... 49
7.1.1 Conducted power measurements of LTE Band XXXVIII ... 51
7.1.1 Conducted power measurements of Downlink LTE CA ... 53
7.1.2 Conducted power measurements of WiFi 2.4G ... 54
7.1.3 Conducted power measurements of WiFi 5G ... 55
7.2 SAR measurement Results ... 59
7.2.1 SAR measurement Result of GSM850 ... 61
7.2.2 SAR measurement Result of GSM1900 ... 61
7.2.1 SAR measurement Result of UMTS Band II ... 62

7.2.2 SAR measurement Result of UMTS Band V 62
7.2.3 SAR measurement Result of LTE Band V 63
7.2.4 SAR measurement Result of LTE Band VII 64
7.2.5 SAR measurement Result of LTE Band XXXVIII 65
7.2.6 SAR measurement Result of WiFi 2.4G 66
7.2.1 SAR measurement Result of WiFi 5G 68
7.3 Multiple Transmitter Evaluation 70
7.3.1 Simultaneous Transmission Possibilities 71
7.3.2 SAR Summation Scenario 71
7.3.3 Simultaneous Transmission Conlcusion 71
Appendix A. System Check Plots 72
Appendix B. SAR Measurement Plots 72
Appendix C. Calibration Certificate 72
Appendix D. Photo documentation 72

※ ※ Modified History ※ ※

REV.	DESCRIPTION	ISSUED DATE	REMARK
Rev.1.0	Initial Test Report Release	2017-07-07	Sun Shanbin

1 General Information

1.1 Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for R227h are as below Table 1.

Band	Max Reported SAR(W/kg)
	1-g Body/Hotspot(10mm)
GSM850	0.74
GSM1900	0.43
UMTS Band II	0.74
UMTS Band V	0.55
LTE B5	0.78
LTE B7	**1.26**
LTE B38	0.49
WiFi 2.4G	0.27
WiFi 5G	0.34
The highest reported SAR for body and simultaneous transmission exposure conditions are 1.26W/kg and 1.59 W/kg respectively per KDB690783 D01.	

Table 1:Summary of test result

Note:

The device is in compliance with Specific Absorption Rate（SAR）for general population/uncontraolled exposure limits according to the FCC rule §2.1093, the ANSI C95.1:1992/IEEE C95.1:1991, the NCRP Report Number 86 for uncontrolled environment, according to the Industry Canada Radio Standards Specification RSS-102 for General Population/Uncontrolled exposure, and had been tested in accordance with the measurement methods and procedures specified in IEEE Std 1528-2013.

1.2 RF exposure limits

Human Exposure	Uncontrolled Environment General Population	Controlled Environment Occupational
Spatial Peak SAR* (Brain/Body/Arms/Legs)	**1.60 W/kg**	8.00 W/kg
Spatial Average SAR** (Whole Body)	0.08 W/kg	0.40 W/kg
Spatial Peak SAR*** (Hands/Feet/Ankle/Wrist)	4.00 W/kg	20.00 W/kg

Table 2: RF exposure limits

The limit applied in this test report is shown in **bold** letters

Notes:

* The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

** The Spatial Average value of the SAR averaged over the whole body.

*** The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation.

1.3 EUT Description

<table>
<tr><td colspan="4">Device Information:</td></tr>
<tr><td>Product Name:</td><td colspan="3">Mobile WiFi</td></tr>
<tr><td>Model:</td><td colspan="3">R227h</td></tr>
<tr><td>FCC ID :</td><td colspan="3">QISR227H</td></tr>
<tr><td>SN No.:</td><td colspan="3">THY0117424000077
THY0117424000132</td></tr>
<tr><td>Device Type :</td><td colspan="3">Portable device</td></tr>
<tr><td>Device Phase:</td><td colspan="3">Identical Prototype</td></tr>
<tr><td>Exposure Category:</td><td colspan="3">Uncontrolled environment / general population</td></tr>
<tr><td>Hardware Version :</td><td colspan="3">CL1E5785SM06</td></tr>
<tr><td>Software Version :</td><td colspan="3">21.130.00.00.00</td></tr>
<tr><td>Antenna Type :</td><td colspan="3">Internal antenna</td></tr>
<tr><td colspan="4">Device Operating Configurations:</td></tr>
<tr><td>Supporting Mode(s)</td><td colspan="3">GSM850/1900, UMTS Band II/V,
LTE Band V/VII/XXXVIII, WiFi 2.4G/5G</td></tr>
<tr><td>Test Modulation</td><td colspan="3">GSM(GMSK/8PSK),UMTS(QPSK),LTE(QPSK/16QAM),
WiFi(DSSS/OFDM)</td></tr>
<tr><td>Device Class</td><td colspan="3">B</td></tr>
<tr><td rowspan="10">Operating Frequency Range(s)</td><td>Band</td><td>Tx (MHz)</td><td>Rx (MHz)</td></tr>
<tr><td>GSM850</td><td>824-849</td><td>869-894</td></tr>
<tr><td>GSM1900</td><td>1850-1910</td><td>1930-1990</td></tr>
<tr><td>UMTS Band II</td><td>1850-1910</td><td>1930-1990</td></tr>
<tr><td>UMTS Band V</td><td>824-849</td><td>869-894</td></tr>
<tr><td>LTE Band V</td><td>824-849</td><td>869-894</td></tr>
<tr><td>LTE Band VII</td><td>2500-2570</td><td>2620-2690</td></tr>
<tr><td>LTE Band XXXVIII</td><td>2570-2620</td><td>2570-2620</td></tr>
<tr><td>WiFi 2.4G</td><td colspan="2">2412-2457</td></tr>
<tr><td>WiFi 5G</td><td colspan="2">5150-5250
5725-5850</td></tr>
<tr><td rowspan="3">GPRS Multislot Class(12)</td><td colspan="2">Max Number of Timeslots in Uplink:</td><td>4</td></tr>
<tr><td colspan="2">Max Number of Timeslots in Downlink:</td><td>4</td></tr>
<tr><td colspan="2">Max Total Timeslot:</td><td>5</td></tr>
<tr><td rowspan="3">EGPRS Multislot Class(12)</td><td colspan="2">Max Number of Timeslots in Uplink:</td><td>4</td></tr>
<tr><td colspan="2">Max Number of Timeslots in Downlink:</td><td>4</td></tr>
<tr><td colspan="2">Max Total Timeslot:</td><td>5</td></tr>
<tr><td>HSDPA UE Category</td><td colspan="3">14</td></tr>
<tr><td>HSUPA UE Category</td><td colspan="3">6</td></tr>
<tr><td>DC-HSDPA UE Category</td><td colspan="3">24</td></tr>
<tr><td rowspan="7">Power Class:</td><td colspan="3">4,tested with power level 5(GSM850)</td></tr>
<tr><td colspan="3">1,tested with power level 0(GSM1900)</td></tr>
<tr><td colspan="3">3, tested with power control “all 1”(UMTS Band II)</td></tr>
<tr><td colspan="3">3, tested with power control “all 1”(UMTS Band V)</td></tr>
<tr><td colspan="3">3, tested with power control all Max.(LTE Band V)</td></tr>
<tr><td colspan="3">3, tested with power control all Max.(LTE Band VII)</td></tr>
<tr><td colspan="3">3, tested with power control all Max.(LTE Band XXXVIII)</td></tr>
</table>

Test Channels (low-mid-high):	128-190-251(GSM850)
	512-661-810(GSM1900)
	9262-9400-9538(UMTS Band II)
	4132-4182-4233(UMTS Band V)
	20425-20525-20625(LTE Band V BW=5MHz)
	20450-20525-20600(LTE Band V BW=10MHz)
	20775-21100-21425(LTE Band VII BW=5MHz)
	20800-21100-21400(LTE Band VII BW=10MHz)
	20825-21100-21375(LTE Band VII BW=15MHz)
	20850-21100-21350(LTE Band VII BW=20MHz)
	37775-38000-38225(LTE Band XXXVIII BW=5MHz)
	37800-38000-38200(LTE Band XXXVIII BW=10MHz)
	37825-38000-38175(LTE Band XXXVIII BW=15MHz)
	37850-38000-38150(LTE Band XXXVIII BW=20MHz)
	WiFi 2.4G : 802.11b/g/n 20M:1-5-10 802.11n 40M:3-5-8
	WiFi 5G : 802.11a/802.11n 20M/802.11ac 20M:36-40-44-48-149-153-157-161-165 802.11n 40M/802.11ac 40M:38-46-151-159 802.11ac 80M:42-155

Table 3:Device information and operating configuration

1.3.1 General Description

R227h is a LTE/UMTS/GSM mode and 2*2 WiFi Wireless mobile WiFi; it can be used as a WiFi hotspot based on standard of IEEE802.11a/b/g/n/ac. It supports 2G GPRS 3G WCDMA and 4G FDD/TDD LTE wireless internet accessing function. About 2G GSM wireless mode,it supports GPRS and EDGE,operating in Band2,Band5;About 3G WCDMA wireless mode, it supports WCDMA and HSDPA/HSUPA/HSPA+/DC-HSPA+, operating in Band2,Band5; and the 4G LTE, operating in Band5,Band7,Band38.The WiFi is 2X2 and the frequency are 2.4GHz/5GHz. R227h supports 1Tx2Rx for 3G WCDMA and 4G LTE, WiFi only.
R227h supports 1Tx2Rx for 3G WCDMA and 4G LTE.

Battery information:

Name	Manufacture	Serials number	Description
Li-Polymer Battery	Sunwoda	NA	Rechargeable Battery,Li-polymer Battery,H824666RBC,3.8V,3000mAh, Battery Group,8.2*46.0*65.4mm

1.3.1 Downlink LTE CA specification

The device supports downlink LTE Carrier Aggregation (CA). Other Release 10 or higher features are not supported, including Uplink Carrier Aggregation, Enhanced SC-FDMA and Uplink MIMO or other antenna diversity configurations etc. All uplink communications are identical to the Release 8 Specifications.
The possible downlink LTE CA combinations supported by this device are as below tables per 3GPP TS 36.101 V14.3.0. The conducted power measurement results of downlink LTE CA are provided in Section 7 of this report per 3GPP TS 36.521-1 V14.2.0. According to KDB 941225 D05A, the downlink LTE CA SAR test is not required and PAG requirements can be excluded.

Table: contiguous intra-band CA

E-UTRA CA configuration / Bandwidth combination set						
E-UTRA CA configuration	**Uplink CA configurations (NOTE 3)**	**Component carriers in order of increasing carrier frequency**			**Maximum aggregated bandwidth [MHz]**	**Bandwidth combination set**
		Channel bandwidths for carrier [MHz]	**Channel bandwidths for carrier [MHz]**	**Channel bandwidths for carrier [MHz]**		
CA_7C	NA	15	15		40	0
		20	20			
		10	20		40	1
		15	15, 20			
		20	10, 15, 20			
CA_38C	NA	15	15		40	0
		20	20			
		10	15, 20	20		
		15	20	10, 15		
		15	10, 15, 20	20		
		20	15, 20	10		
		20	10, 15, 20	15, 20		

Table: Test frequencies for CA_7C

Range	CC-Combo / NRB_agg [RB]	CC1 Note1					CC2 Note1				
		BW [RB]	N_{UL}	f_{UL} [MHz]	N_{DL}	f_{DL} [MHz]	BW [RB]	N_{UL}	f_{UL} [MHz]	N_{DL}	f_{DL} [MHz]
Low	50+100	50	20805	2505.5	2805	2625.5	100	20949	2519.9	2949	2639.9
		100	20850	2510	2850	2630	50	20994	2524.4	2994	2644.4
	75+75	75	20825	2507.5	2825	2627.5	75	20975	2522.5	2975	2642.5
	75+100	75	20828	2507.8	2828	2627.8	100	20999	2524.9	2999	2644.9
		100	20850	2510	2850	2630	75	21021	2527.1	3021	2647.1
	100+100	100	20850	2510	2850	2630	100	21048	2529.8	3048	2649.8
Mid	50+100	50	21006	2525.6	3006	2645.6	100	21150	2540	3150	2660
		100	21051	2530.1	3051	2650.1	50	21195	2544.5	3195	2664.5
	75+75	75	21025	2527.5	3025	2647.5	75	21175	2542.5	3175	2662.5
	75+100	75	21003	2525.3	3003	2645.3	100	21174	2542.4	3174	2662.4
		100	21026	2527.6	3026	2647.6	75	21197	2544.7	3197	2664.7
	100+100	100	21001	2525.1	3001	2645.1	100	21199	2544.9	3199	2664.9
High	50+100	50	21206	2545.6	3206	2665.6	100	21350	2560	3350	2680
		100	21251	2550.1	3251	2670.1	50	21395	2564.5	3395	2684.5
	75+75	75	21225	2547.5	3225	2667.5	75	21375	2562.5	3375	2682.5
	75+100	75	21179	2542.9	3179	2662.9	100	21350	2560	3350	2680
		100	21201	2545.1	3201	2665.1	75	21372	2562.2	3372	2682.2
	100+100	100	21152	2540.2	3152	2660.2	100	21350	2560	3350	2680
Note 1: Carriers in increasing frequency order.											

Table: Test frequencies for CA_38C

Range	CC-Combo / N_{RB_agg} [RB]	CC1 Note1			CC2 Note1		
		BW [RB]	$N_{UL/DL}$	$f_{UL/DL}$ [MHz]	BW [RB]	$N_{UL/DL}$	$f_{UL/DL}$ [MHz]
Low	75+75	75	37825	2577.5	75	37975	2592.5
	100+100	100	37850	2580	100	38048	2599.8
Mid	75+75	75	37925	2587.5	75	38075	2602.5
	100+100	100	37901	2585.1	100	38099	2604.9
High	75+75	75	38025	2597.5	75	38175	2612.5
	100+100	100	37952	2590.2	100	38150	2610
Note 1: Carriers in increasing frequency order.							

Table: Inter-band CA(two bands)

E-UTRA CA configuration / Bandwidth combination set									
E-UTRA CA Configuration	**E-UTRA Bands**	**1.4 MHz**	**3 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	**Maximum aggregated bandwidth [MHz]**	**Bandwidth combination set**
CA_3A-5A	3				Yes	Yes	Yes	30	0
	5			Yes	Yes				
	3				Yes			20	1
	5			Yes	Yes				
	3			Yes	Yes	Yes	Yes	30	2
	5			Yes	Yes				
CA_3A-7A	3			Yes	Yes	Yes	Yes	40	0
	7				Yes	Yes	Yes		
CA_7A-20A	7				Yes	Yes	Yes	30	0
	20			Yes	Yes				
	7				Yes	Yes	Yes	40	1
	20			Yes	Yes	Yes	Yes		
NOTE 1: The CA Configuration refers to a combination of an operating band and a CA bandwidth class specified in Table 5.4.2A-1 (the indexing letter). Absence of a CA bandwidth class for an operating band implies support of all classes. NOTE 2: For each band combination, all combinations of indicated bandwidths belong to the set NOTE 3: For the supported CC bandwidth combinations, the CC downlink and uplink bandwidths are equal									

Note:

1）For the inter-band CA combinations above, all the listed bands above can be used as PCC or SCC.

2) The channel spacing and aggregated channel bandwidth for CA are identical to the associated specification in 3GPP TS 36.101 V14.3.0.

3) The reference test frequencies for CA refers to 3GPP TS 36.508 V14.1.0

1.4 Test specification(s)

ANSI C95.1:1992 /IEEE C95.1:1991	Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz – 300 GHz.
IEEE Std 1528-2013	Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques
KDB941225 D01	3G SAR Procedures v03r01
KDB941225 D05	SAR for LTE Devices v02r05
KDB941225 D05A	LTE Rel.10 KDB Inquiry Sheet v01r02
KDB941225 D06	Hotspot SAR v02r01
KDB447498 D01	General RF Exposure Guidance v06
KDB248227 D01	SAR Guidance for IEEE 802 11 Wi-Fi SAR v02r01
KDB865664 D01	SAR measurement 100 MHz to 6 GHz v01r04
KDB865664 D02	SAR Reporting v01r02
KDB690783 D01	SAR Listings on Grants v01r03

1.5 Testing laboratory

Test Site	The Reliability Laboratory of Huawei Technologies Co., Ltd.
Test Location	Section G1,Huawei Base Bantian, Longgang District, Shenzhen 518129, P.R. China
Telephone	+86 755 28780808
Fax	+86 755 89652518
State of accreditation	The Test laboratory (area of testing) is accredited according to ISO/IEC 17025. CNAS Registration number: L0310 A2LA TESTING CERT #2174.01 & 2174.02 & 2174.03

1.6 Applicant and Manufacturer

Company Name	HUAWEI TECHNOLOGIES CO., LTD
Address	Administration Building, Headquarters of Huawei Technologies Co., Ltd., Bantian, Longgang District, Shenzhen, 518129, P.R.C

1.7 Application details

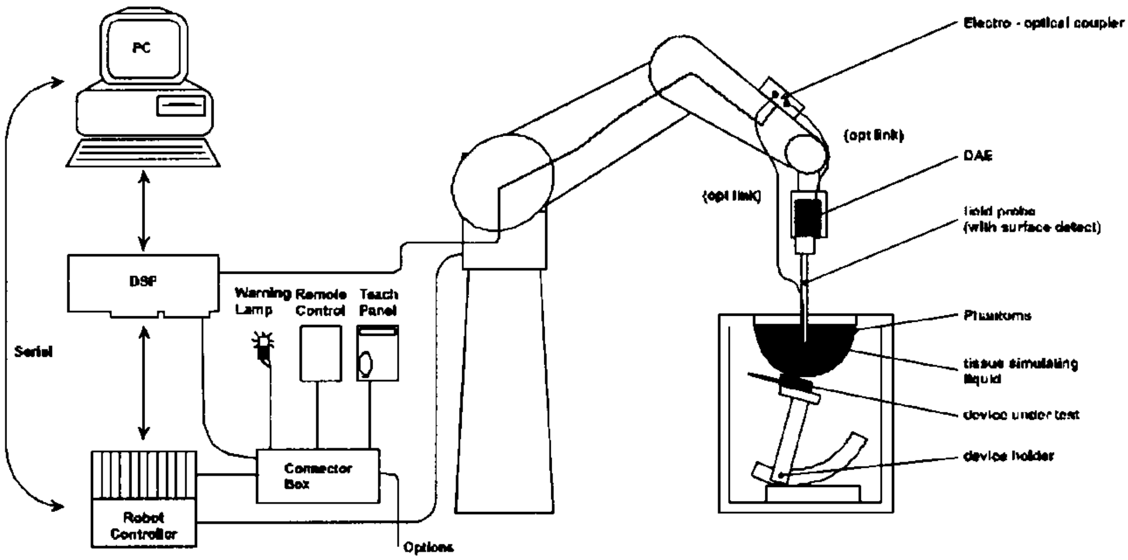
Start Date of test	2017-05-25	2017-07-05
End Date of test	2017-06-08	2017-07-05

1.8 Ambient Condition

Ambient temperature	20°C – 24°C
Relative Humidity	30% – 70%

2 SAR Measurement System

2.1 SAR Measurement Set-up



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

- A standard high precision 6-axis robot (Stäubli RX family) with controller and software. An arm extension for accommodating the data acquisition electronics (DAE).

- A dosimetric probe, i.e. an isotropic E-field probe optimized and calibrated for usage in tissue simulating liquid. The probe is equipped with an optical surface detector system.

- A data acquisition electronic (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.
- A unit to operate the optical surface detector which is connected to the EOC.
- The Electro-Optical Coupler (EOC) performs the conversion from the optical into a digital electric signal of the DAE. The EOC is connected to the DASY measurement server.
- The DASY measurement server, which performs all real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operation. A computer operating Windows 7.
- DASY software and SEMCAD data evaluation software.
- Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.
- The generic twin phantom enabling the testing of left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- System check dipoles allowing to validate the proper functioning of the system.

2.2 Test environment

The DASY measurement system is placed at the head end of a room with dimensions:
5 x 2.5 x 3 m^3, the SAM phantom is placed in a distance of 75 cm from the side walls and 1.1m from the rear wall. Above the test system a 1.5 x 1.5 m^2 array of pyramid absorbers is installed to reduce reflections from the ceiling.
Picture 1 of the photo documentation shows a complete view of the test environment.
The system allows the measurement of SAR values larger than 0.005 mW/g.

2.3 Data Acquisition Electronics description

The data acquisition electronics (DAE) consist of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converte and a command decoder with a control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information, as well as an optical uplink for commands and the clock.

The mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection.

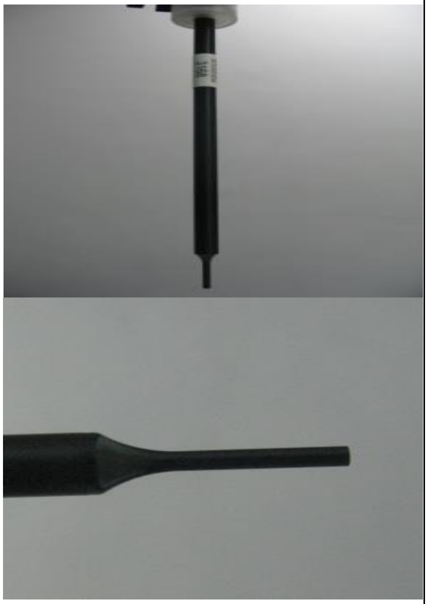
DAE4

<table>
<tr><td>Input Impedance</td><td>200MOhm</td><td rowspan="3">
</td></tr>
<tr><td>The Inputs</td><td>symmetrical and floating</td></tr>
<tr><td>Common mode rejection</td><td>above 80 dB</td></tr>
</table>

2.4 Probe description

These probes are specially designed and calibrated for use in liquids with high permittivities. They should not be used in air, since the spherical isotropy in air is poor (±2 dB). The dosimetric probes have special calibrations in various liquids at different frequencies.

Isotropic E-Field Probe ES3DV3 for Dosimetric Measurements

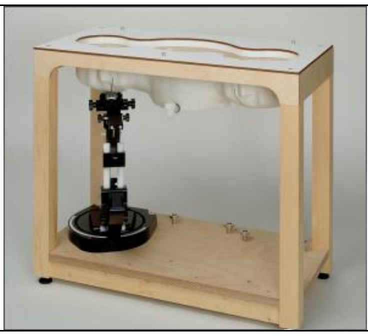
Construction	Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Calibration	ISO/IEC 17025 calibration service available.	
Frequency	10 MHz to 4 GHz; Linearity: ± 0.2 dB (30 MHz to 4 GHz)	
Directivity	± 0.2 dB in HSL (rotation around probe axis) ± 0.3 dB in tissue material (rotation normal to probe axis)	
Dynamic range	5 µW/g to > 100 mW/g; Linearity: ± 0.2 dB	
Dimensions	Overall length: 337 mm (Tip: 20 mm) Tip diameter: 3.9 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.0 mm	
Application	General dosimetry up to 4 GHz Dosimetry in strong gradient fields Compliance tests of mobile phones	

Isotropic E-Field Probe EX3DV4 for Dosimetric Measurements

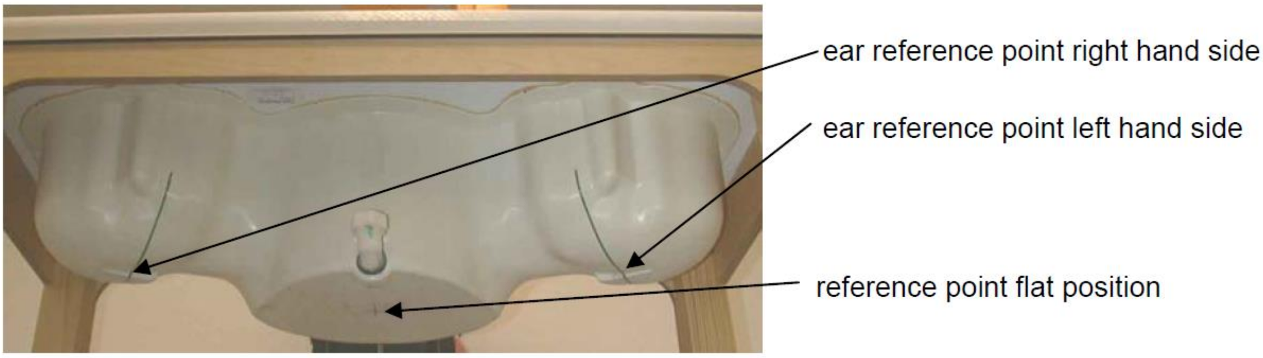
Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Calibration	ISO/IEC 17025 calibration service available.	
Frequency	10 MHz to >6 GHz; Linearity: ± 0.2 dB (30 MHz to 6 GHz)	
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)	
Dynamic range	10 µW/g to > 100 mW/g; Linearity: ± 0.2 dB(noise:typically<1µW/g)	
Dimensions	Overall length: 337 mm (Tip:20 mm) Tip diameter:2.5 mm (Body:12 mm) Typical distance from probe tip to dipole centers: 1mm	
Application	High precision dosimetric measurements in any exposure scenario(e.g.,very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%	

2.5 Phantom description

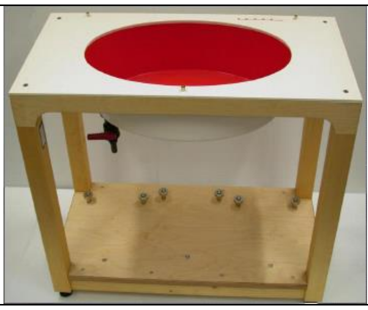
SAM Twin Phantom

Shell Thickness	2mm±0.2mm;The ear region:6.0±0.2mm	
Filling Volume	Approximately 25 liters	
Dimensions	Length:1000mm; Width:500mm; Height: adjustable feet	
Measurement Areas	Left hand Right hand Flat phantom	
The bottom plate contains three pairs of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. A white cover is provided to cover the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. Free space scans of devices on top of this phantom cover are possible. Three reference marks are provided on the phantom counter. These reference marks are used to teach the absolute phantom position relative to the robot.		

The following figure shows the definition of reference point:



ELI4 Phantom

Shell Thickness	2mm±0.2mm	
Filling Volume	Approximately 30 liters	
Dimensions	Major axis:600mm; Minor axis:400mm;	
Measurement Areas	Flat phantom	
The ELI4 phantom is intended for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30MHz to 6GHz. ELI4 is fully compatible with the latest draft of the standard IEC 62209-2 and all known tissue simulating liquids.		

The phantom shell material is resistant to all ingredients used in the tissue-equivalent liquid recipes. The shell of the phantom including ear spacers is constructed from low permittivity and low loss material, with a relative permittivity $2 \le \varepsilon_r \le 5$ at ≤3 GHz,$3 \le \varepsilon_r \le 4$ at >3 GHz and and a loss tangent ⩽0.05.

2.6 Device holder description

The DASY device holder has two scales for device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear openings). The plane between the ear openings and the mouth tip has a rotation angle of 65°. The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. This device holder is used for standard mobile phones or PDA's only. If necessary an additional support of polystyrene material is used.

The DASY device holder is constructed of low-loss POM material having the following dielectric parameters: relative permittivity ε =3 and loss tangent σ =0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.
The device holder permits the device to be positioned with a tolerance of ±1° in the tilt angle.

Larger DUT's (e.g. notebooks) cannot be tested using this device holder. Instead a support of bigger polystyrene cubes and thin polystyrene plates is used to position the DUT in all relevant positions to find and measure spots with maximum SAR values.
Therefore those devices are normally only tested at the flat part of the SAM.

2.7 Test Equipment List

This table gives a complete overview of the SAR measurement equipment.
Devices used during testing are ☒

	Manufacturer	Device	Type	Serial number	Date of last calibration	Valid Period
☒	SPEAG	Dosimetric E-Field Probe	EX3DV4	7381	2016-09-29	One year
☒	SPEAG	835 MHz Dipole	D835V2	4d126	2015-07-23	Three years
☐	SPEAG	1750 MHz Dipole	D1750V2	1145	2016-02-02	Three years
☒	SPEAG	1900 MHz Dipole	D1900V2	5d143	2014-09-23	Three years
☒	SPEAG	2450 MHz Dipole	D2450V2	978	2016-02-08	Three years
☒	SPEAG	2600 MHz Dipole	D2600V2	1119	2016-02-03	Three years
☒	SPEAG	5GHz Dipole	D5GHzV2	1155	2017-04-26	Three years
☒	SPEAG	Data acquisition electronics	DAE4	1492	2016-09-28	One year
☒	SPEAG	Software	DASY	N/A	NCR	NCR
☐	SPEAG	Twin Phantom	SAM1	TP-1475	NCR	NCR
☐	SPEAG	Twin Phantom	SAM2	TP-1474	NCR	NCR
☐	SPEAG	Twin Phantom	SAM3	TP-1597	NCR	NCR
☐	SPEAG	Twin Phantom	SAM4	TP-1620	NCR	NCR
☒	SPEAG	Twin Phantom	SAM6	TP-1892	NCR	NCR
☒	R & S	Universal Radio Communication Tester	CMU 200	111379	2016-12-29	One year
☒	R & S	WideBand Radio Communication Tester	CMW 500	126855	2017-05-15	One year
☒	Agilent	Network Analyser	E5071C	MY46213349	2016-12-30	One year
☒	SPEAG	Dielectric Assessment Kit DAK3.5	DAK3.5	1143	NCR	NCR
☒	Agilent	Signal Generator	N5181A	MY50145341	2016-11-14	One year
☒	MINI-CIRCUITS	Amplifier	ZHL-42W	QA1402001	NCR	NCR
☒	AR	Directional Coupler	DC7144AM1	0423264	2017-04-12	One year
☒	MINI-CIRCUITS	Amplifier	ZVE-8G+	N523101139	NCR	NCR
☒	Agilent	Dual Directional Coupler	772D	MY52180173	2017-01-03	One year
☒	Agilent	Power Meter	E4417A	MY54100027	2017-04-10	One year
☒	Agilent	Power Meter Sensor	E9321A	MY54130007	2017-04-10	One year
☒	Agilent	Power Meter Sensor	E9321A	MY54130001	2017-04-10	One year

Note:
1) Per KDB865664D01 requirements for dipole calibration, the test laboratory has adopted three-year extended calibration interval. Each measured dipole is expected to evaluate with the following criteria at least on annual interval in Appendix C.
a) There is no physical damage on the dipole;
b) System check with specific dipole is within 10% of calibrated value;
c) The most recent return-loss result, measured at least annually, deviates by no more than 20% from the previous measurement.
d) The most recent measurement of the real or imaginary parts of the impedance, measured at least annually is within 5Ω from the previous measurement.
2) Network analyzer probe calibration against air, distilled water and a shorting block performed before measuring liquid parameters.

3 SAR Measurement Procedure

3.1 Scanning procedure

The DASY installation includes predefined files with recommended procedures for measurements and system check. They are read-only document files and destined as fully defined but unmeasured masks. All test positions (head or body-worn) are tested with the same configuration of test steps differing only in the grid definition for the different test positions.

- The “reference” and “drift” measurements are located at the beginning and end of the batch process. They measure the field drift at one single point in the liquid over the complete procedure. The indicated drift is mainly the variation of the DUT’s output power and should vary max. +/- 5 %.

- The “surface check” measurement tests the optical surface detection system of the DASY system by repeatedly detecting the surface with the optical and mechanical surface detector and comparing the results. The output gives the detecting heights of both systems, the difference between the two systems and the standard deviation of the detection repeatability. Air bubbles or refraction in the liquid due to separation of the sugar-water mixture gives poor repeatability (above ± 0.1mm). To prevent wrong results tests are only executed when the liquid is free of air bubbles. The difference between the optical surface detection and the actual surface depends on the probe and is specified with each probe. (It does not depend on the surface reflectivity or the probe angle to the surface within ± 30°.)

- The “area scan” measures the SAR above the DUT or verification dipole on a parallel plane to the surface. It is used to locate the approximate location of the peak SAR with 2D spline interpolation. The robot performs a stepped movement along one grid axis while the local electrical field strength is measured by the probe. The probe is touching the surface of the SAM during acquisition of measurement values. The standard scan uses large grid spacing for faster measurement. Standard grid spacing for head measurements is 15 mm in x- and y- dimension(≤2GHz)，12 mm in x- and y-dimension(2-4 GHz) and 10mm in x- and y- dimension(4-6GHz). If a finer resolution is needed, the grid spacing can be reduced. Grid spacing and orientation have no influence on the SAR result. For special applications where the standard scan method does not find the peak SAR within the grid, e.g. mobile phones with flip cover, the grid can be adapted in orientation.
  Results of this coarse scan are shown in Appendix B.

- A “zoom scan” measures the field in a volume around the 2D peak SAR value acquired in the previous “coarse” scan. This is a fine grid with maximum scan spatial resolution: Δx_{zoom}, Δy_{zoom}≤ 2GHz - ≤8mm, 2-4GHz - ≤5 mm and 4-6 GHz-≤4mm; Δz_{zoom} ≤3GHz - ≤5 mm, 3-4 GHz- ≤4mm and 4-6GHz-≤2mm where the robot additionally moves the probe along the z-axis away from the bottom of the Phantom. DASY is also able to perform repeated zoom scans if more than 1 peak is found during area scan. In this document, the evaluated peak 1g and 10g averaged SAR values are shown in the 2D-graphics in Appendix B. Test results relevant for the specified standard (see chapter 1.4.)are shown in table form form in chapter 7.2.

- A Z-axis scan measures the total SAR value at the x-and y-position of the maximum SAR value found during the cube scan. The probe is moved away in z-direction from the bottom of the SAM phantom in 2 mm steps. This measurement shows the continuity of the liquid and can - depending in the field strength – also show the liquid depth. A z-axis scan of the measurement with maximum SAR value is shown in Appendix B.

The following table summarizes the area scan and zoom scan resolutions per FCC KDB 865664D01:

Frequency	Maximun Area Scan resolution (Δx_{area}, Δy_{area})	Maximun Zoom Scan spatial resolution (Δx_{Zoom}, Δy_{Zoom})	Maximun Zoom Scan spatial resolution			Minimum zoom scan volume (x,y,z)
			Uniform Grid	Graded Grad		
			$\Delta z_{Zoom}(n)$	$\Delta z_{Zoom}(1)$*	$\Delta z_{Zoom}(n>1)$*	
≤2GHz	≤15mm	≤8mm	≤5mm	≤4mm	≤1.5*Δz_{Zoom}(n-1)	≥30mm
2-3GHz	≤12mm	≤5mm	≤5mm	≤4mm	≤1.5*Δz_{Zoom}(n-1)	≥30mm
3-4GHz	≤12mm	≤5mm	≤4mm	≤3mm	≤1.5*Δz_{Zoom}(n-1)	≥28mm
4-5GHz	≤10mm	≤4mm	≤3mm	≤2.5mm	≤1.5*Δz_{Zoom}(n-1)	≥25mm
5-6GHz	≤10mm	≤4mm	≤2mm	≤2mm	≤1.5*Δz_{Zoom}(n-1)	≥22mm

3.2 Spatial Peak SAR Evaluation

The spatial peak SAR - value for 1 and 10 g is evaluated after the Cube measurements have been done. The basis of the evaluation are the SAR values measured at the points of the fine cube grid consisting of 5 x 5 x 7 points(with 8mm horizontal resolution) or 7 x 7 x 7 points(with 5mm horizontal resolution) or 8 x 8 x 7 points(with 4mm horizontal resolution). The algorithm that finds the maximal averaged volume is separated into three different stages.

- The data between the dipole center of the probe and the surface of the phantom are extrapolated. This data cannot be measured since the center of the dipole is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is about 1 mm (see probe calibration sheet). The extrapolated data from a cube measurement can be visualized by selecting 'Graph Evaluated'.

- The maximum interpolated value is searched with a straight-forward algorithm. Around this maximum the SAR - values averaged over the spatial volumes (1g or 10 g) are computed using the 3d-spline interpolation algorithm. If the volume cannot be evaluated (i.e., if a part of the grid was cut off by the boundary of the measurement area) the evaluation will be started on the corners of the bottom plane of the cube.

- All neighboring volumes are evaluated until no neighboring volume with a higher average value is found.

Extrapolation

The extrapolation is based on a least square algorithm [W. Gander, Computermathematik, p.168-180]. Through the points in the first 3 cm along the z-axis, polynomials of order four are calculated. These polynomials are then used to evaluate the points between the surface and the probe tip. The points, calculated from the surface, have a distance of 1 mm from each other.

Interpolation

The interpolation of the points is done with a 3d-Spline. The 3d-Spline is composed of three one-dimensional splines with the "Not a knot"-condition [W. Gander, Computermathematik, p.141-150] (x, y and z -direction) [Numerical Recipes in C, Second Edition, p.123ff].

Volume Averaging

At First the size of the cube is calculated. Then the volume is integrated with the trapezoidal algorithm. 8000 points (20x20x20) are interpolated to calculate the average.

Advanced Extrapolation

DASY uses the advanced extrapolation option which is able to compansate boundary effects on E-field probes.

3.3 Data Storage and Evaluation

Data Storage

The DASY software stores the acquired data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension "DAE4". The software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of incorrect parameter settings. For example, if a measurement has been performed with a wrong crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be re-evaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type ([V/m], [A/m], [°C], [mW/g], [mW/cm²], [dBrel], etc.). Some of these units are not available in certain situations or show meaningless results, e.g., a SAR output in a lossless media will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

Data Evaluation by SEMCAD

The SEMCAD software automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe parameters:	- Sensitivity	$Norm_i$, a_{i0}, a_{i1}, a_{i2}
	- Conversion factor	$ConvF_i$
	- Diode compression point	Dcpi
Device parameters:	- Frequency	f
	- Crest factor	cf
Media parameters:	- Conductivity	σ
	- Density	ρ

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY components. In the direct measuring mode of the multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

The first step of the evaluation is a linearization of the filtered input signal to account for the compression characteristics of the detector diode. The compensation depends on the input signal, the diode type and the DC-transmission factor from the diode to the evaluation electronics.

If the exciting field is pulsed, the crest factor of the signal must be known to correctly compensate for peak power. The formula for each channel can be given as:

$$V_i = U_i + U_i^2 \cdot cf/dcp_i$$

with V_i = compensated signal of channel i (i = x, y, z)
U_i = input signal of channel i (i = x, y, z)
cf = crest factor of exciting field (DASY parameter)
dcp_i = diode compression point (DASY parameter)

From the compensated input signals the primary field data for each channel can be evaluated:

E-field probes: $E_i = (V_i / Norm_i \cdot ConvF)^{1/2}$
H-field probes: $H_i = (V_i)^{1/2} \cdot (a_{i0} + a_{i1}f + a_{i2}f^2)/f$

with
V_i = compensated signal of channel i (i = x, y, z)
$Norm_i$ = sensor sensitivity of channel i (i = x, y, z) $[mV/(V/m)^2]$ for E-field Probes
ConvF = sensitivity enhancement in solution
a_{ij} = sensor sensitivity factors for H-field probes
f = carrier frequency [GHz]
E_i = electric field strength of channel i in V/m
H_i = magnetic field strength of channel i in A/m

The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = (E_X^2 + E_Y^2 + E_Z^2)^{1/2}$$

The primary field data are used to calculate the derived field units.

$$SAR = (E_{tot}^2 \cdot \sigma) / (\rho \cdot 1000)$$

with
SAR = local specific absorption rate in mW/g
E_{tot} = total field strength in V/m
σ = conductivity in [mho/m] or [Siemens/m]
ρ = equivalent tissue density in g/cm^3

Note that the density is normally set to 1 (or 1.06), to account for actual brain density rather than the density of the simulation liquid.The power flow density is calculated assuming the excitation field to be a free space field.

$P_{pwe} = E_{tot}^2 / 3770$ or $P_{pwe} = H_{tot}^2 \cdot 37.7$

with
P_{pwe} = equivalent power density of a plane wave in mW/cm^2
E_{tot} = total electric field strength in V/m
H_{tot} = total magnetic field strength in A/m

4 System Verification Procedure

4.1 Tissue Verification

The simulating liquids should be checked at the beginning of a series of SAR measurements to determine of the dielectic parameter are within the tolerances of the specified target values. The measured conductivity and relative permittivity should be within ± 5% of the target values.

The following materials are used for producing the tissue-equivalent materials.

Ingredients (% of weight)	**Head Tissue**					
Frequency Band (MHz)	750	835	1750	1900	2450	2600
Water	39.2	41.45	52.64	55.242	62.7	55.242
Salt (NaCl)	2.7	1.45	0.36	0.306	0.5	0.306
Sugar	57.0	56.0	0.0	0.0	0.0	0.0
HEC	0.0	1.0	0.0	0.0	0.0	0.0
Bactericide	0.0	0.1	0.0	0.0	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0
DGBE	0.0	0.0	47.0	44.542	36.8	44.452
Ingredients (% of weight)	**Body Tissue**					
Frequency Band (MHz)	750	835	1750	1900	2450	2600
Water	50.3	52.4	69.91	69.91	73.2	64.493
Salt (NaCl)	1.60	1.40	0.13	0.13	0.04	0.024
Sugar	47.0	45.0	0.0	0.0	0.0	0.0
HEC	0.0	1.0	0.0	0.0	0.0	0.0
Bactericide	0.0	0.1	0.0	0.0	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0
DGBE	0.0	0.0	29.96	29.96	26.7	32.252

Table 4: Tissue Dielectric Properties

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

☐**Simulating Head Liquid (HBBL600-6000MHz), Manufactured by SPEAG:**

Ingredients	(% by weight)
Water	50-65%
Mineral oil	10-30%
Emulsifiers	8-25%
Sodium salt	0-1.5%

☒**Simulating Body Liquid (MBBL600-6000MHz),Manufactured by SPEAG:**

Ingredients	(% by weight)
Water	60-80%
Esters,Emulsifiers,Inhibitors	20-40%
Sodium salt	0-1.5%

Tissue Type	Measured Frequency (MHz)	Target Tissue		Measured Tissue		Deviation (Within +/-5%)		Liquid Temp.	Test Date
		εr	σ (S/m)	εr	σ (S/m)	$\Delta\varepsilon_r$	Δσ		
835MHz Body	825	55.20	0.97	54.85	0.999	-0.63%	2.98%	22.4°C	2017/6/8
	835	55.20	0.97	54.80	1.002	-0.72%	3.30%		
	850	55.20	0.99	54.77	1.009	-0.78%	1.92%		
1900MHz Body	1850	53.30	1.52	53.79	1.525	0.92%	0.33%	22.5°C	2017/6/8
	1880	53.30	1.52	53.73	1.551	0.81%	2.04%		
	1900	53.30	1.52	53.70	1.565	0.75%	2.96%		
	1910	53.30	1.52	53.69	1.573	0.73%	3.49%		
2450MHz Body	2410	52.80	1.91	50.30	1.944	-4.73%	1.78%	22.6°C	2017/6/8
	2435	52.70	1.94	50.11	1.972	-4.91%	1.65%		
	2450	52.70	1.95	50.11	1.996	-4.91%	2.36%		
	2460	52.70	1.96	50.15	2.007	-4.84%	2.40%		
2600MHz Body	2510	52.62	2.03	52.87	2.102	0.48%	3.55%	22.4°C	2017/5/25
	2535	52.59	2.07	52.82	2.126	0.44%	2.71%		
	2560	52.57	2.09	52.76	2.152	0.36%	2.97%		
	2600	52.50	2.16	52.72	2.193	0.42%	1.53%		
2600MHz Body	2510	52.62	2.03	52.40	2.081	-0.42%	2.51%	22.5°C	2017/7/5
	2535	52.59	2.07	52.36	2.106	-0.44%	1.74%		
	2560	52.57	2.09	52.32	2.132	-0.48%	2.01%		
	2600	52.50	2.16	52.25	2.171	-0.48%	0.51%		
5G Hz Body	5250	48.90	5.36	47.93	5.245	-1.98%	-2.15%	23.4°C	2017/6/8
	5750	48.30	5.94	47.02	5.938	-2.65%	-0.03%	23.4°C	2017/6/8

Table 5:Measured Tissue Parameter

Note: 1）The dielectric parameters of the tissue-equivalent liquid should be measured under similar ambient conditions and within 2 °C of the conditions expected during the SAR evaluation to satisfy protocol requirements.

2）KDB 865664 was ensured to be applied for probe calibration frequencies greater than or equal to 50MHz of the EUT frequencies.

3）The above measured tissue parameters were used in the DASY software to perform interpolation via the DASY software to determine actual dielectric parameters at the test frequencies. The SAR test plots may slightly differ from the table above since the DASY rounds to three significant digits.

4.2 System Check

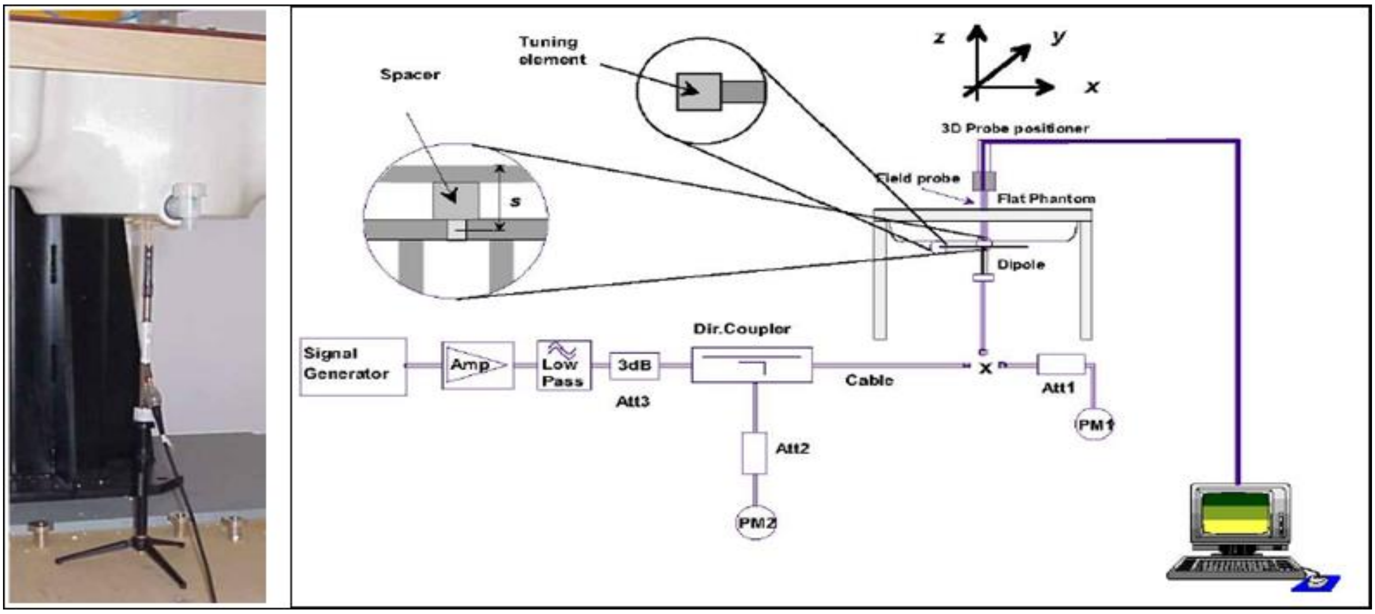
The system check is performed for verifying the accuracy of the complete measurement system and performance of the software. The system check is performed with tissue equivalent material according to IEEE P1528 (described above). The following table shows system check results for all frequency bands and tissue liquids used during the tests(Graphic Plot(s) see Appendix A).

System Check	Target SAR (1W)		Measured SAR (Normalized to 1W)		Deviation (Within +/-10%)		Liquid Temp.	Test Date
	1-g (W/kg)	10-g (W/kg)	1-g (W/kg)	10-g (W/kg)	Δ1-g	Δ10-g		
835MHz Body	9.41	6.16	9.28	6.40	-1.38%	3.90%	22.4°C	2017/6/8
1900MHz Body	40.20	21.30	38.80	20.96	-3.48%	-1.60%	22.5°C	2017/6/8
2450MHz Body	52.10	24.70	48.00	23.40	-7.87%	-5.26%	22.6°C	2017/6/8
2600MHz Body	51.60	23.00	54.40	25.20	5.43%	9.57%	22.4°C	2017/5/25
2600MHz Body	51.60	23.00	53.20	25.16	3.10%	9.39%	22.5°C	2017/7/5
5250MHz Body	74.80	20.90	69.70	21.90	-6.82%	4.78%	23.4°C	2017/6/8
5750MHz Body	75.90	21.20	68.50	21.80	-9.75%	2.83%	23.4°C	2017/6/8

Table 6:System Check Results

4.3 System check Procedure

The system check is performed by using a system check dipole which is positioned parallel to the planar part of the SAM phantom at the reference point. The distance of the dipole to the SAM phantom is determined by a plexiglass spacer. The dipole is connected to the signal source consisting of signal generator and amplifier via a directional coupler, N-connector cable and adaption to SMA. It is fed with a power of 250 mW(below 3GHz) or 100mW(3-6GHz). To adjust this power a power meter is used. The power sensor is connected to the cable before the system check to measure the power at this point and do adjustments at the signal generator. At the outputs of the directional coupler both return loss as well as forward power are controlled during the system check to make sure that emitted power at the dipole is kept constant. This can also be checked by the power drift measurement after the test (result on plot).
System check results have to be equal or near the values determined during dipole calibration (target SAR in table above) with the relevant liquids and test system.



5 SAR measurement variability and uncertainty

5.1 SAR measurement variability

Per KDB865664 D01 SAR measurement 100 MHz to 6 GHz v01r04, SAR measurement variability must be assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. The 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.

The same procedures should be adapted for measurements according to extremity and occupational exposure limits by applying a factor of 2.5 for extremity exposure and a factor of 5 for occupational exposure to the corresponding SAR thresholds.

The detailed repeated measurement results are shown in Section 7.2.

5.2 SAR measurement uncertainty

Per KDB865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04,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. The equivalent ratio (1.5/1.6) is applied to extremity and occupational exposure conditions.

6 SAR Test Configuration

6.1 Test Positions Configuration

The Wi-Fi and WWAN transmitters used for hotspot mode are usually built-in within the device, such as battery-operated personal wireless routers and wireless handsets.

Per FCC KDB 941225D06, The Body SAR test separation distance for hotspot mode is determined according to device form factor. When the overall length and width of a device is > 9 cm x 5 cm, a test separation distance of 10 mm is required for hotspot mode SAR measurements. A test separation distance of 5 mm or less is required for smaller devices. Hotspot mode SAR is measured for all edges and surfaces of the device with a transmitting antenna located within 25 mm from that surface or edge; for the data modes, wireless technologies and frequency bands supporting hotspot mode. The SAR results are used to determine simultaneous transmission SAR test exclusion for hotspot mode; otherwise, simultaneous transmission SAR measurement is required.

6.2 3G SAR Test Reduction Procedure

Per KDB941225 D01, in the following procedures, the mode tested for SAR is referred to as the primary mode. The equivalent modes considered for SAR test reduction are denoted as secondary modes. Both primary and secondary modes must be in the same frequency band. 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. This is referred to as the 3G SAR test reduction procedure in the following SAR test guidance, where the primary mode is identified in the applicable wireless mode test procedures and the secondary mode is wireless mode being considered for SAR test reduction by that procedure. When the 3G SAR test reduction procedure is not satisfied, it is identified as “otherwise” in the applicable procedures; SAR measurement is required for the secondary mode.

6.3 GSM Test Configuration

SAR tests for GSM850 and GSM1900, a communication link is set up with a base station by air link. Using CMU200 the power lever is set to “5”and “0” in SAR of GSM850 and GSM1900. The tests in the band of GSM850 and GSM1900 are performed in the mode of GPRS/EGPRS function. Since the GPRS class is 12 for this EUT, it has at most 4 timeslots in uplink and at most 4 timeslots in downlink, the maximum total timeslot is 5. The EGPRS class is 12 for this EUT, it has at most 4 timeslots in uplink, and at most 4 timeslots in downlink, the maximum total timeslot is 5.

When SAR tests for EGPRS mode is necessary, GMSK modulation should be used to minimize SAR measurement error due to higher peak-to-average power (PAR) ratios inherent in 8-PSK.

6.4 UMTS Test Configuration

1) Output Power Verification

Maximum output power is verified on the high, middle and low channels according to procedures described in section 5.2 of 3GPP TS 34.121, using the appropriate RMC or AMR with TPC (transmit power control) set to all “1’s” for WCDMA/HSDPA or by applying the required inner loop power control procedures to maintain maximum output power while HSUPA is active. Results for all applicable physical channel configurations (DPCCH, DPDCHn and spreading codes, HSDPA, HSPA) are requied in the SAR report. All configurations that are not supported by the handset or cannot be measured due to technical or equipment limitations must be clearly identified.

2) WCDMA

a. Body SAR Measurements

SAR for body-worn accessory configurations is measured using a 12.2 kbps RMC with TPC bits configured to all “1’s”. The 3G SAR test reduction procedure is applied to other spreading codes and multiple DPDCHn configurations supported by the handset with 12.2 kbps RMC as the primary mode

3) HSDPA

SAR for body exposure configurations is measured according to the “Body SAR Measurements’’ procedures of 3G device. 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. This is referred to as the 3G SAR test reduction procedure in the following SAR test guidance, where the primary mode is identified in the applicable wireless mode test procedures and the secondary mode is wireless mode being considered for SAR test reduction by that procedure. When the 3G SAR test reduction procedure is not satisfied, it is identified as “otherwise” in the applicable procedures; SAR measurement is required for the secondary mode.

Per KDB941225 D01v03, the 3G SAR test reduction procedure is applied to HSDPA body configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for HSDPA using the HSDPA body SAR procedures for the highest reported SAR body exposure configuration in 12.2 kbps RMC.

HSDPA should be configured according to UE category of a test device. The number of HS-DSCH/HS-PDSCHs, HAPRQ processes, minimum inter-TTI interval, transport block sizes and RV coding sequence are defined by the H-set. To maintain a consistent test configuration and stable transmission condition, QPSK is used in the H-set for SAR testing. HS-DPCCH should be configured with a CQI feedback cycle of 4ms with a CQI repetition factor of 2 to maintain a constant rate of active CQI slots. The β_c and β_d gain factors for DPCCH and DPDCH were set according to the values in the below table, β_{hs} for HS-DPCCH is set automatically to the correct value when ΔACK, ΔNACK, ΔCQI = 8. The variation of the β_c /β_d ratio causes a power reduction at sub-tests 2 - 4.

Sub-test	β_c	β_d	β_d (SF)	β_c/β_d	β_{hs} (1)	CM(dB)(2)	MPR (dB)
1	2/15	15/15	64	2/15	4/15	0.0	0
2	12/15(3)	15/15(3)	64	12/15(3)	24/15	1.0	0
3	15/15	8/15	64	15/8	30/15	1.5	0.5
4	15/15	4/15	64	15/4	30/15	1.5	0.5

Note 1: $\triangle$ACK, $\triangle$NACK and $\triangle$CQI = 8 $A_{hs} = \beta_{hs}/\beta_c = 30/15$ $\beta_{hs} = 30/15 * \beta_c$

Note 2 : CM=1 for β_c/β_{d}= 12/15, $\beta_{hs}/\beta_c = 24/15$. For all other combinations of DPDCH,DPCCH and HS-DPCCH the MPR is based on the relative CM difference. This is applicable for only UEs that support HSDPA in release 6 and later releases.

Note 3 : For subtest 2 the β_c/β_d ratio of 12/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1,TF1) to $\beta_c = 11/15$ and $\beta_d = 15/15$

Table 7: Sub-tests for UMTS Release 5 HSDPA

The measurements were performed with a Fixed Reference Channel (FRC) and H-Set 1 QPSK.

Parameter	Value
Nominal average inf. bit rate	534 kbit/s
Inter-TTI Distance	3 TTI's
Number of HARQ Processes	2 Processes
Information Bit Payload	3202 Bits
MAC-d PDU size	336 Bits
Number Code Blocks	1 Block
Binary Channel Bits Per TTI	4800 Bits
Total Available SMLs in UE	19200 SMLs
Number of SMLs per HARQ Process	9600 SMLs
Coding Rate	0.67
Number of Physical Channel Codes	5

Table 8:settings of required H-Set 1 QPSK acc. to 3GPP 34.121

HS-DSCH Category	Maximum HS-DSCH Codes Received	Minimum Inter-TTI Interval	Maximum HS-DSCH Transport Block Bits/HS-DSCH TTI	Total Soft Channel Bits
1	5	3	7298	19200
2	5	3	7298	28800
3	5	2	7298	28800
4	5	2	7298	38400
5	5	1	7298	57600
6	5	1	7298	67200
7	10	1	14411	115200
8	10	1	14411	134400
9	15	1	25251	172800
10	15	1	27952	172800
11	5	2	3630	14400
12	5	1	3630	28800
13	15	1	34800	259200
14	15	1	42196	259200
15	15	1	23370	345600
16	15	1	27952	345600

Table 9:HSDPA UE category

4) HSUPA

SAR for body exposure configurations is measured according to the “Body SAR Measurements’’ procedures of 3G device. 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.

Per KDB941225 D01v03, the 3G SAR test reduction procedure is applied to HSPA (HSUPA/HSDPA with RMC) body configurations with 12.2 kbps RMC as the primary mode. Otherwise, SAR is measured for HSPA using the HSPA body SAR procedures for the highest reported body exposure SAR configuration in 12.2 kbps RMC.

Due to inner loop power control requirements in HSDPA, a commercial communication test set should be used for the output power and SAR tests. The 12.2 kbps RMC, FRC H-set 1 and E-DCH configurations for HSDPA should be configured according to the values indicated below as well as other applicable procedures described in the ‘WCDMA Handset’ and ‘Release 5 HSDPA Data Device’ sections of 3G device.

Sub-test	β_c	β_d	β_d (SF)	β_c/β_d	β_{hs} (1)	β_{ec}	β_{ed}	β_{ec} (SF)	β_{ed} (codes)	CM (2) (dB)	MPR (dB)	AG (4) Index	E-TFCI
1	11/15 (3)	15/15 (3)	64	11/15 (3)	22/15	209/225	1039/225	4	1	1.0	0.0	20	75
2	6/15	15/15	64	6/15	12/15	12/15	94/75	4	1	3.0	2.0	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	2/15	56/75	4	1	3.0	2.0	17	71
5	15/15 (4)	15/15 (4)	64	15/15 (4)	30/15	24/15	134/15	4	1	1.0	0.0	21	81

Note 1: Δ ACK, Δ NACK and Δ CQI = 8 $A_{hs} = \beta_{hs}/\beta_c = 30/15$ $\beta_{hs} = 30/15 * \beta_c$

Note 2: CM = 1 for $\beta_c/\beta_d = 12/15$, $\beta_{hs}/\beta_c = 24/15$. For all other combinations of DPDCH, DPCCH, HS-DPCCH, E-DPDCH and E-DPCCH the MPR is based on the relative CM difference

Note 3 : For subtest 1 the β_c/β_d ratio of 11/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1,TF1) to $\beta_c = 10/15$ and $\beta_d = 15/15$

Note 4 : For subtest 5 the β_c/β_d ratio of 15/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1,TF1) to $\beta_c = 14/15$ and $\beta_d = 15/15$

Note 5 : Testing UE using E-DPDCH Physical Layer category 1 Sub-test 3 is not required according to TS 25.306 Table 5.1g

Note 6: β_{ed} can not be set directly; it is set by Absolute Grant Value.

Table 10:Subtests for UMTS Release 6 HSUPA

UE E-DCH Category	Maximum E-DCH Codes Transmitted	Number of HARQ Processes	E-DCH TTI(ms)	Minimum Speading Factor	Maximum E-DCH Transport Block Bits	Max Rate (Mbps)
1	1	4	10	4	7110	0.7296
2	2	8	2	4	2798	1.4592
	2	4	10	4	14484	
3	2	4	10	4	14484	1.4592
4	2	8	2	2	5772	2.9185
	2	4	10	2	20000	2.00
5	2	4	10	2	20000	2.00
6 (No DPDCH)	4	8	10	2SF2&2SF4	11484	5.76
	4	4	2		20000	2.00
7 (No DPDCH)	4	8	2	2SF2&2SF4	22996	?
	4	4	10		20000	?
NOTE: When 4 codes are transmitted in parallel, two codes shall be transmitted with SF2 and two with SF4.UE categories 1 to 6 support QPSK only. UE category 7 supports QPSK and 16QAM.(TS25.306-7.3.0).						

Table 11:HSUPA UE category

5) DC-HSDPA

SAR is required for Rel. 8 DC-HSDPA when SAR is required for Rel. 5 HSDPA; otherwise, the 3G SAR test reduction procedure is applied to DC-HSDPA with 12.2 kbps RMC as the primary mode. Power is measured for DC-HSDPA according to the H-Set 12, FRC configuration in Table C.8.1.12 of 3GPP TS 34.121-1 to determine SAR test reduction. A primary and a Second serving HS-DSCH Cell are required to perform the power measurement and for the results to be acceptable.

The following tests were completed according to procedures in section 7.3.13 of 3GPP TS 34.108 v9.5.0. A summary of these settings are illustrated below:

Downlink Physical Channels are set as per 3GPP TS34.121-1 v9.0.0 E.5.0

Table E.5.0: Levels for HSDPA connection setup

Parameter During Connection setup	Unit	Value
P-CPICH_Ec/Ior	dB	-10
P-CCPCH and SCH_Ec/Ior	dB	-12
PICH _Ec/Ior	dB	-15
HS-PDSCH	dB	off
HS-SCCH_1	dB	off
DPCH_Ec/Ior	dB	-5
OCNS_Ec/Ior	dB	-3.1

Call is set up as per 3GPP TS34.108 v9.5.0 sub clause 7.3.13

The configurations of the fixed reference channels for HSDPA RF tests are described in 3GPP TS 34.121, annex C for FDD and 3GPP TS 34.122.

The measurements were performed with a Fixed Reference Channel (FRC) H-Set 12 with QPSK

Parameter	Value
Nominal average inf. bit rate	60 kbit/s
Inter-TTI Distance	1 TTI's
Number of HARQ Processes	6 Processes
Information Bit Payload	120 Bits
Number Code Blocks	1 Block
Binary Channel Bits Per TTI	960 Bits
Total Available SMLs in UE	19200 SMLs
Number of SMLs per HARQ Process	3200 SMLs
Coding Rate	0.15
Number of Physical Channel Codes	1

Table 12:settings of required H-Set 12 QPSK acc. to 3GPP 34.121

Note:

1.The RMC is intended to be used for DC-HSDPA mode and both cells shall transmit with identical parameters as listed in the table above.

2.Maximum number of transmission is limited to 1,i.e.,retransmission is not allowed. The redundancy and constellation version 0 shall be used.

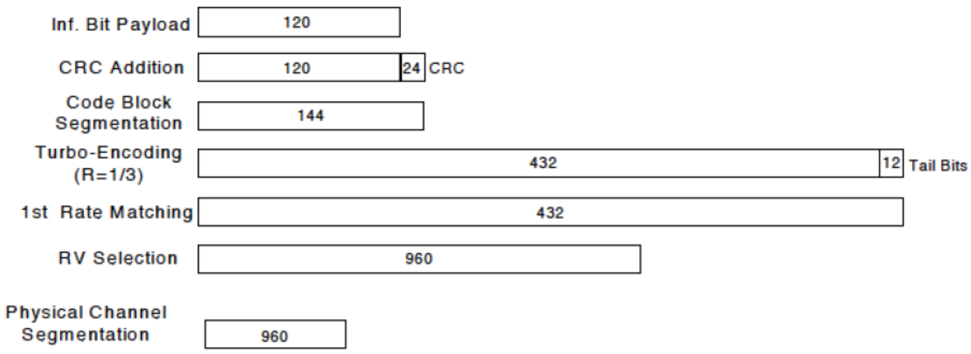


Figure C.8.19: Coding rate for Fixed reference Channel H-Set 12 (QPSK)

The following 4 Sub-tests for HSDPA were completed according to Release 5 procedures. A summary of subtest settings are illustrated below:

Sub-test	β_c	β_d	β_d (SF)	β_c/β_d	β_{hs} (1)	CM(dB)(2)	MPR (dB)
1	2/15	15/15	64	2/15	4/15	0.0	0
2	12/15(3)	15/15(3)	64	12/15(3)	24/15	1.0	0
3	15/15	8/15	64	15/8	30/15	1.5	0.5
4	15/15	4/15	64	15/4	30/15	1.5	0.5
Note 1: ΔACK, ΔNACK and ΔCQI=8 $A_{hs}=\beta_{hs}/\beta_c=30/15$ $\beta_{hs}=30/15*\beta_c$ Note 2: CM=1 for β_c/β_d=12/15, β_{hs}/β_c=24/15. For all other combinations of DPDCH,DPCCH and HS-DPCCH the MPR is based on the relative CM difference. This is applicable for only UEs that support HSDPA in release 6 and later releases. Note 3: For subtest 2 the β_c/β_d ratio of 12/15 for the TFC during the measurement period (TF1, TF0) is achieved by setting the signalled gain factors for the reference TFC (TF1,TF1) to β_c=11/15 and β_d=15/15							

Up commands are set continuously to set the UE to Max power.

Note:

1.The Dual Carriers transmission only applies to HSDPA physical channels

2.The Dual Carriers belong to the same Node and are on adjacent carriers.

3.The Dual Carriers do not support MIMO to serve UEs configured for dual cell operation

4.The Dual Carriers operate in the same frequency band .

5.The device doesn't support the modulation of 16QAM in uplink but 64QAM in downlink for DC-HSDPA mode.

6.The device doesn't support carrier aggregation for it just can operate in Release 8.

6.5 LTE Test Configuration

SAR for LTE band exposure configurations is measured according to the procedures of KDB 941225 D05 SAR for LTE Devices. The CMW500 WideBand Radio Communication Tester was used for LTE output power measurements and SAR testing. Closed loop power control was used so the UE transmits with maximum output power during SAR testing.SAR test were performed with the same number of RB and RB offsets transmitting on all TTI frames(Maximum TTI)

1) Spectrum Plots for RB configurations

A properly configured base station simulator was used for LTE output power measurements and SAR testing.Therefore, spectrum plots for RB configurations were not required to be included in this report.

2) MPR

When MPR is implemented permanently within the UE, regardless of network requirements, only those RB configurations allowed by 3GPP for the channel bandwidth and modulation combinations may be tested with MPR active. Configurations with RB allocations less than the RB thresholds required by 3GPP must be tested without MPR.

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

3) A-MPR

A-MPR(Additional MPR) has been disabled for all SAR tests by using Network Signalling Value of "NS_01"on the base station simulator.

4) LTE procedures for SAR testing

A) Largest channel bandwidth standalone SAR test requirements

i) 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 for 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.

ii) QPSK with 50% RB allocation

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

iii) 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 i) and ii) are ≤ 0.8 W/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.

iv) Higher order modulations

For each modulation besides QPSK; e.g., 16-QAM, 64-QAM, apply the QPSK procedures in above sections to determine the QAM configurations that may need SAR measurement. For each configuration identified as required for testing, SAR is required only when the highest maximum output power for the configuration in the higher order modulation is > ½ dB higher than the same configuration in QPSK or when the reported SAR for the QPSK configuration is > 1.45 W/kg.

B) Other channel bandwidth standalone SAR test requirements

For the other channel bandwidths used by the device in a frequency band, apply all the procedures required for the largest channel bandwidth in section A) to determine the channels and RB configurations that need SAR testing and only measure SAR when the highest maximum output power of a configuration requiring testing in the smaller channel bandwidth is > ½ dB higher than the equivalent channel configurations in the largest channel bandwidth configuration or the reported SAR of a configuration for the largest channel bandwidth is > 1.45 W/kg.

TDD Test Configurations

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

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

Figure 4.2-1: Frame structure type 2

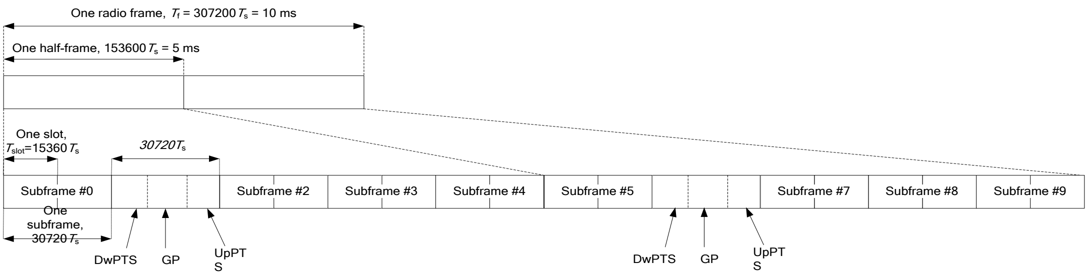


Table 4.2-1: Configuration of special subframe (lengths of DwPTS/GP/UpPTS)

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

Table 4.2-2: Uplink-downlink configurations

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

According to Figure 4.2-1, one radio frame is configured by 10 subframes, which consist of Uplink-subframe, Downlink-subframe and Special subframe. For TDD-LTE, the Duty Cycle should be calculated on Uplink-subframes and Special subframes, due to Special subframe containing both Uplink transmissions. So for one radio frame, Duty Cycle can be calculated with formula as below. The count of Uplink subframes are according to Table 4.2-2:

Duty cycle =(30720Ts*Ups+Uplink Component*Specials)/(307200Ts)

About the uplink component of Special subframes, we can figure out by Table 4.2-1:

Uplink Component=UpPTS

In conclusion, for the TDD LTE Band, Duty Cycle can be calculated with formula as below .all these sets are ok when we test, or we can set as below.

Duty cycle =[(30720Ts*Ups)+ UpPTS *Specials]/(307200Ts)

And we can get different Duty cycles under different configurations:

Uplink-downlink configuration	Subframe number			Configuration of special subframe							
				Normal cyclic prefix in downlink				Extended cyclic prefix in downlink			
				Normal cyclic prefix in uplink		Extended cyclic prefix in uplink		Normal cyclic prefix in uplink		Extended cyclic prefix in uplink	
	D	S	U	configuration 0~4	configuration 5~9	configuration 0~4	configuration 5~9	configuration 0~3	configuration 4~7	configuration 0~3	configuration 4~7
0	2	2	6	61.43%	62.85%	61.67%	63.33%	61.43%	62.85%	61.67%	63.33%
1	4	2	4	41.43%	42.85%	41.67%	43.33%	41.43%	42.85%	41.67%	43.33%
2	6	2	2	21.43%	22.85%	21.67%	23.33%	21.43%	22.85%	21.67%	23.33%
3	6	1	3	30.71%	31.43%	30.83%	31.67%	30.71%	31.43%	30.83%	31.67%
4	7	1	2	20.71%	21.43%	20.83%	21.67%	20.71%	21.43%	20.83%	21.67%
5	8	1	1	10.71%	11.43%	10.83%	11.67%	10.71%	11.43%	10.83%	11.67%
6	3	2	5	51.43%	52.85%	51.67%	53.33%	51.43%	52.85%	51.67%	53.33%

SAR test Plan: For TDD LTE, SAR should be tested with the highest transmission duty factor (63.33%) using Uplink-downlink configuration 0 and Special subframe configuration 7 for Frame structure type 2.

6.6 WiFi Test Configuration

For WiFi SAR testing, a communication link is set up with the testing software for WiFi mode test. During the test,at the each test frequency channel, the EUT is operated at the RF continuous emission mode. The reported SAR must be scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit per KDB248227.

6.6.1 Initial Test Position Procedure

For exposure condition with multiple test position, such as handsets operating next to the ear, devices with hotspot mode or UMPC mini-tablet , procedures for initial test position can be applied. Using the transmission mode determined by the DSSS procedure or initial test configuration, area scans are measured for all position in an exposure condition. The test position with the highest extrapolated(peak) SAR is used as the initial test position. When reported SAR for the initial test position is ≤ 0.4W/kg, no additional testing for the remaining test position is required. Otherwise, SAR is evaluated at the subsequent highest peak SAR position until the reported SAR result is ≤ 0.8W/kg or all test position are measured. For all positions/configurations tested using the initial test position and subsequent test positions, when the *reported* SAR is > 0.8 W/kg, SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel(s) until the *reported* SAR is ≤ 1.2 W/kg or all required channels are tested.

6.6.2 Initial Test Configuration Procedure

An initial test configuration is determined for OFDM transmission modes according to the channel bandwidth, modulation and data rate combination(s) with the highest maximum output power specified for production units in each standalone and aggregated frequency band. SAR is measured using the highest measured maximum output power channel. For configurations with the same specified or measured maximum output power, additional transmission mode and test channel selection procedures are required (see section 5.3.2 of KDB 248227D01v02). SAR test reduction of subsequent highest output test channels is based on the *reported* SAR of the initial test configuration.

For next to the ear, hotspot mode and UMC mini-tablet exposure configurations where multiple test positions are required, the initial test position procedure is applied to minimize the number of test positions required for SAR measurement using the initial test configuration transmission mode. For fixed exposure conditions that do not have multiple SAR test positions, SAR is measured in the transmission mode determined by the initial test configuration.

When the *reported* SAR of the initial test configuration is > 0.8 W/kg, SAR measurement is required for the subsequent next highest measured output power channel(s) in the initial test configuration until the *reported* SAR is ≤ 1.2 W/kg or all required channels are tested.

6.6.3 Sub Test Configuration Procedure

SAR measurement requirements for the remaining 802.11 transmission mode configurations that have not been tested in the initial test configuration are determined separately for each standalone and aggregated frequency band, in each exposure condition, according to the maximum output power specified for production units.

When the highest reported SAR for the initial test configuration, according to the initial test position or fixed exposure position requirements, is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for that subsequent test configuration.

6.6.4 WiFi 2.4G SAR Test Procedures

Separate SAR procedures are applied to DSSS and OFDM configurations in the 2.4 GHz band to simplify DSSS test requirements. For 802.11b DSSS SAR measurements, DSSS SAR procedure applies to fixed exposure test position and initial test position procedure applies to multiple exposure test positions.

A) 802.11b DSSS SAR Test Requirements

SAR is measured for 2.4 GHz 802.11b DSSS using either a fixed test position or, when applicable, the initial test position procedure. SAR test reduction is determined according to the following:

1) When the *reported* SAR of the highest measured maximum output power channel (section 3.1 of of KDB 248227D01v02) for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.

2) When the *reported* SAR is > 0.8 W/kg, SAR is required for that exposure configuration using the next highest measured output power channel. When any *reported* SAR is > 1.2 W/kg, SAR is required for the third channel; i.e., all channels require testing.

B) 2.4GHz 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 (section 5.3 of of KDB 248227D01v02). SAR is not required for the following 2.4 GHz OFDM conditions.

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

2) 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.

C) SAR Test Requirements for OFDM configurations

When SAR measurement is required for 802.11 g/n OFDM configurations, each standalone and frequency aggregated band is considered separately for SAR test reduction. In applying the initial test configuration and subsequent test configuration procedures, the 802.11 transmission configuration with the highest specified maximum output power and the channel within a test configuration with the highest measured maximum output power should be clearly distinguished to apply the procedures.

6.6.5 WiFi 5G SAR Test Procedures

For 5 GHz bands, When the same maximum output power was specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration with the largest channel bandwidth,lowest order modulation and lowest data rate. When the maximum output power of a channel is the same for equivalent OFDM configurations(for example 802.11a, 802.11n and 802.11ac,with the same channel bandwidth, modulation, and data rate, etc), the lower order 802.11 mode (i.e., 802.11a is chosen over 802.11n then 802.11ac) is used for SAR measurement. When the maximum output power are the same for multiple test channel, either according to the default or additional power measurement requirement, SAR is measured using the channel closest to the middle of the frequency band or aggregted band. When there are multiple channels with the same maximum output power, SAR is measured using the higher number channel.

6.6.6 MIMO SAR Considerations

Per KDB 248227D01v02, simultaneous transmission provisions in KDB Publication 447498 should be used to determine simultaneous transmission SAR test exclusion for WiFi MIMO. If the sum of 1-g SAR single transmission SAR measurement is <1.6W/kg, no additional SAR measurements for MIMO are required. Alternatively,SAR for MIMO can be measured with all antennas transmitting simultaneously at the specified maximum output power of MIMO operation.

7 SAR Measurement Results

7.1 Conducted power measurements

For the measurements a Rohde & Schwarz Radio Communication Tester CMU 200&CMW500 was used. SAR drift measured at the same position in liquid before and after each SAR test as below 7.2 chapter.

Note: CMU200 measures GSM peak and average output power for active timeslots.For SAR the timebased average power is relevant. The difference in between depends on the duty cycle of the TDMA signal :

No. of timeslots	1	2	3	4
Duty Cycle	1:8.3	1:4.1	1:2.77	1:2.08
timebased avg. power compared to slotted avg. power	-9.19dB	-6.13dB	-4.42dB	-3.18dB

The signalling modes differ as follows:

mode	coding scheme	modulation
GPRS	CS1 to CS4	GMSK
EDGE	MCS1 to MCS4	GMSK
EDGE	MCS5 to MCS9	8PSK

Apart from modulation change (GMSK/8PSK) coding schemes differ in code rate without influence on the RF signal. Therefore one coding scheme per mode was selected for conducted power measurements.

7.1.1 Conducted power measurements of GSM850

GSM850		Burst-Averaged output Power (dBm)				Division Factors	Frame-Averaged output Power (dBm)			
		Tune-up	128CH	190CH	251CH		Tune-up	128CH	190CH	251CH
GPRS /EDGE (GMSK)	1 Tx Slot	33.00	31.80	31.76	31.62	-9.19	21.81	23.81	22.61	22.57
	2 Tx Slots	**31.00**	**29.71**	**29.65**	**29.55**	**-6.13**	**22.87**	**24.87**	**23.58**	**23.52**
	3 Tx Slots	29.00	27.82	27.73	27.59	-4.42	22.58	24.58	23.40	23.31
	4 Tx Slots	27.00	25.92	25.81	25.66	-3.18	21.82	23.82	22.74	22.63
EDGE (8PSK)	1 Tx Slot	26.50	25.43	25.40	25.44	-9.19	15.31	17.31	16.24	16.21
	2 Tx Slots	25.00	23.12	23.21	23.35	-6.13	16.87	18.87	16.99	17.08
	3 Tx Slots	23.00	21.26	21.20	21.45	-4.42	16.58	18.58	16.84	16.78
	4 Tx Slots	21.00	19.37	19.55	19.48	-3.18	15.82	17.82	16.19	16.37

Table 13:Conducted power measurement results of GSM850

Note:

1) The conducted power of GSM850 is measured with RMS detector.

2) Frame-averaged output power was calculated from the measured burst-averaged output power by converting the slot powers into linear units and calculating the energy over 8 timesolts.

3) Per KDB941225 D01v03, SAR test reduction for GPRS and EDGE modes is determined by the source-based time-averaged output power specified for production units, including tune-up tolerance. The data mode with highest specified time-averaged output power should be tested for SAR compliance in the applicable exposure conditions. For modes with the same specified maximum output power and tolerance, the higher number time-slot configuration should be tested.

7.1.2 Conducted power measurements of GSM1900

GSM1900		Burst-Averaged output Power (dBm)				Division Factors	Frame-Averaged output Power (dBm)			
		Tune-up	512CH	661CH	810CH		Tune-up	512CH	661CH	810CH
GPRS /EDGE (GMSK)	1 Tx Slot	30.00	29.54	29.36	29.38	-9.19	19.81	20.81	20.35	20.17
	2 Tx Slots	**28.00**	**27.75**	**27.63**	**27.66**	**-6.13**	**19.87**	**21.87**	**21.62**	**21.50**
	3 Tx Slots	26.00	25.71	25.54	25.54	-4.42	19.58	21.58	21.29	21.12
	4 Tx Slots	24.00	23.65	23.55	23.61	-3.18	18.82	20.82	20.47	20.37
EDGE (8PSK)	1 Tx Slot	26.00	25.68	25.66	25.66	-9.19	14.81	16.81	16.49	16.47
	2 Tx Slots	24.00	23.20	23.21	23.27	-6.13	15.87	17.87	17.07	17.08
	3 Tx Slots	22.00	21.08	21.12	21.05	-4.42	15.58	17.58	16.66	16.70
	4 Tx Slots	20.00	19.04	19.28	19.25	-3.18	14.82	16.82	15.86	16.10

Table 14: Conducted power measurement results of GSM1900

Note:

1) The conducted power of GSM1900 is measured with RMS detector.

2) Frame-averaged output power was calculated from the measured burst-averaged output power by converting the slot powers into linear units and calculating the energy over 8 timesolts.

3) Per KDB941225 D01v03, SAR test reduction for GPRS and EDGE modes is determined by the source-based time-averaged output power specified for production units, including tune-up tolerance. The data mode with highest specified time-averaged output power should be tested for SAR compliance in the applicable exposure conditions. For modes with the same specified maximum output power and tolerance, the higher number time-slot configuration should be tested.

7.1.1 Conducted power measurements of UMTS Band II

UMTS1900 (Band II)		Tune-up	Average Power (dBm)		
			9262CH	9400CH	9538CH
WCDMA	12.2kbps RMC	**23.00**	**22.78**	**22.78**	**22.60**
HSDPA	Subtest 1	23.00	22.25	22.24	22.06
	Subtest 2	23.00	21.84	21.78	21.61
	Subtest 3	22.00	21.13	21.12	20.94
	Subtest 4	21.00	20.92	20.91	20.91
HSUPA	Subtest 1	21.00	20.28	20.43	20.19
	Subtest 2	20.00	18.12	18.17	18.18
	Subtest 3	21.00	20.49	20.47	20.30
	Subtest 4	20.00	18.79	18.86	18.72
	Subtest 5	22.00	20.60	20.62	20.52
DC-HSDPA	Subtest 1	23.00	22.18	22.20	21.88
	Subtest 2	23.00	21.74	21.69	21.51
	Subtest 3	22.00	21.07	20.93	20.93
	Subtest 4	21.00	20.73	20.91	20.72

Table 15: Conducted power measurement results of UMTS Band II

Note: 1) The conducted power of UMTS Band II is measured with RMS detector.

2) The bolded 12.2kbps RMC mode was selected for SAR testing(the primary mode).

3) Per KDB941225 D01v03, When the maximum output power and tune-up tolerance specified for production units in a Second 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 Second to primary mode and the adjusted SAR is ≤ 1.2 W/kg, SAR measurement is not required for the Second mode.

7.1.2 Conducted power measurements of UMTS Band V

UMTS850 (Band V)		Tune-up	Average Power (dBm)		
			4132CH	4182CH	4233CH
WCDMA	12.2kbps RMC	**23.00**	**22.09**	**22.18**	**22.08**
HSDPA	Subtest 1	23.00	21.58	21.65	21.54
	Subtest 2	23.00	21.14	21.18	21.11
	Subtest 3	22.00	20.39	20.44	20.37
	Subtest 4	21.00	20.40	20.46	20.36
HSUPA	Subtest 1	21.00	19.60	19.48	19.59
	Subtest 2	20.00	18.54	18.25	18.30
	Subtest 3	21.00	19.74	19.60	19.20
	Subtest 4	20.00	18.28	18.26	18.36
	Subtest 5	22.00	20.12	20.08	20.10
DC-HSDPA	Subtest 1	23.00	21.56	21.60	21.47
	Subtest 2	23.00	21.04	21.12	21.01
	Subtest 3	22.00	20.21	20.33	20.25
	Subtest 4	21.00	20.35	20.40	20.31

Table 16: Conducted power measurement results of UMTS Band V

Note: 1) The conducted power of UMTS Band V is measured with RMS detector.

2) The bolded 12.2kbps RMC mode was selected for SAR testing(the primary mode).

3) Per KDB941225 D01v03, When the maximum output power and tune-up tolerance specified for production units in a Second 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 Second to primary mode and the adjusted SAR is ≤ 1.2 W/kg, SAR measurement is not required for the Second mode.

7.1.3 Conducted power measurements of LTE Band V

Bandwidth	Modulation	RB size	RB offset	Tune-up	Channel 20425CH	Channel 20525CH	Channel 20625CH
5MHz	QPSK	1	0	24.2	22.32	22.46	22.45
		1	13	24.2	22.30	22.32	22.43
		1	24	24.2	22.25	22.22	22.51
		12	0	23.2	21.42	21.44	21.49
		12	6	23.2	21.25	21.37	21.54
		12	13	23.2	21.22	21.20	21.29
		25	0	23.2	21.25	21.41	21.36
	16QAM	1	0	23.2	21.52	21.90	22.04
		1	13	23.2	21.60	21.79	21.91
		1	24	23.2	21.65	21.67	22.00
		12	0	22.2	20.95	21.70	21.63
		12	6	22.2	21.09	21.59	21.60
		12	13	22.2	21.13	21.33	21.46
		25	0	22.2	20.75	21.61	21.51
Bandwidth	Modulation	RB size	RB offset	Tune-up	Channel 20450CH	Channel 20525CH	Channel 20600CH
10MHz	QPSK	1	0	24.2	22.21	**22.77**	22.39
		1	25	24.2	22.41	22.62	22.45
		1	49	24.2	22.38	22.31	22.37
		25	0	23.2	21.50	21.74	21.36
		25	13	23.2	**21.37**	**21.78**	**21.70**
		25	25	23.2	21.49	21.21	21.47
		50	0	23.2	21.32	21.32	21.70
	16QAM	1	0	23.2	21.22	21.91	21.70
		1	25	23.2	21.76	21.80	21.87
		1	49	23.2	21.97	21.60	21.55
		25	0	22.2	21.29	21.69	21.46
		25	13	22.2	21.52	21.81	21.75
		25	25	22.2	21.55	21.22	21.54
		50	0	22.2	21.25	21.40	21.78

Table 17: Conducted power measurement results of LTE Band V

7.1.1 Conducted power measurements of LTE Band VII

Bandwidth	Modulation	RB size	RB offset	Tune-up	Channel 20775CH	Channel 21100CH	Channel 21425CH
5MHz	QPSK	1	0	23.2	21.48	21.40	21.25
		1	13	23.2	21.20	21.20	21.20
		1	24	23.2	21.74	21.21	21.52
		12	0	22.2	20.29	20.30	20.25
		12	6	22.2	20.29	20.25	20.30
		12	13	22.2	20.25	20.25	20.21
		25	0	22.2	20.23	20.21	20.20
	16QAM	1	0	22.2	21.71	21.44	21.67
		1	13	22.2	21.52	21.16	21.54
		1	24	22.2	22.11	21.76	22.14
		12	0	21.2	20.18	19.61	19.52
		12	6	21.2	20.16	19.54	19.61
		12	13	21.2	19.99	19.47	19.57
		25	0	21.2	19.96	19.49	19.57
Bandwidth	Modulation	RB size	RB offset	Tune-up	Channel 20800CH	Channel 21100CH	Channel 21400CH
10MHz	QPSK	1	0	23.2	21.25	21.20	21.20
		1	25	23.2	21.36	21.23	21.20
		1	49	23.2	21.85	21.26	21.45
		25	0	22.2	20.33	20.44	20.33
		25	13	22.2	20.46	20.45	20.29
		25	25	22.2	20.38	20.35	20.41
		50	0	22.2	20.58	20.45	20.44
	16QAM	1	0	22.2	21.54	21.13	21.13
		1	25	22.2	21.81	20.99	20.99
		1	49	22.2	22.17	21.58	21.72
		25	0	21.2	20.07	19.56	19.44
		25	13	21.2	20.23	19.62	19.43
		25	25	21.2	20.22	19.55	19.58
		50	0	21.2	20.25	19.58	19.60

Bandwidth	Modulation	RB size	RB offset	Tune-up	Channel 20825CH	Channel 21100CH	Channel 21375CH
15MHz	QPSK	1	0	23.2	21.25	21.42	21.52
		1	38	23.2	21.53	21.32	21.32
		1	74	23.2	21.43	21.30	21.25
		36	0	22.2	20.47	20.25	20.24
		36	18	22.2	20.57	20.48	20.32
		36	39	22.2	20.49	20.42	20.43
		75	0	22.2	20.66	20.50	20.52
	16QAM	1	0	22.2	21.30	20.87	21.14
		1	38	22.2	22.06	21.19	20.92
		1	74	22.2	21.84	21.51	21.33
		36	0	21.2	20.26	19.50	19.59
		36	18	21.2	20.33	19.58	19.43
		36	39	21.2	20.24	19.60	19.37
		75	0	21.2	20.32	19.61	19.72
Bandwidth	Modulation	RB size	RB offset	Tune-up	Channel 20850CH	Channel 21100CH	Channel 21350CH
20MHz	QPSK	1	0	23.2	21.66	21.23	21.98
		1	50	23.2	21.65	21.32	21.22
		1	99	23.2	**22.06**	**22.36**	**22.08**
		50	0	22.2	20.63	20.30	**20.63**
		50	25	22.2	20.66	20.23	20.30
		50	50	22.2	**20.66**	**20.32**	20.25
		100	0	22.2	**20.78**	20.27	20.50
	16QAM	1	0	22.2	22.20	21.51	22.20
		1	50	22.2	22.12	21.17	21.18
		1	99	22.2	22.12	22.10	22.12
		50	0	21.2	20.22	19.73	20.05
		50	25	21.2	20.28	19.70	19.72
		50	50	21.2	20.25	19.76	19.46
		100	0	21.2	20.37	19.79	19.90

Table 18: Conducted power measurement results of LTE Band VII

7.1.1 Conducted power measurements of LTE Band XXXVIII

Bandwidth	Modulation	RB size	RB offset	Tune-up Max.	Channel 37775CH	Channel 38000CH	Channel 38225CH
5MHz	QPSK	1	0	23.7	22.85	23.12	22.78
		1	13	23.7	22.76	23.30	22.93
		1	24	23.7	22.35	22.91	22.57
		12	0	22.7	22.20	22.29	22.00
		12	6	22.7	22.12	22.40	22.01
		12	13	22.7	21.83	22.19	21.79
		25	0	22.7	22.00	22.33	21.88
	16QAM	1	0	22.7	21.98	22.07	21.65
		1	13	22.7	21.74	22.28	21.75
		1	24	22.7	21.27	21.89	21.39
		12	0	21.7	20.91	20.91	20.88
		12	6	21.7	20.85	21.09	20.89
		12	13	21.7	20.55	20.88	20.68
		25	0	21.7	20.71	21.05	20.71
Bandwidth	Modulation	RB size	RB offset	Tune-up Max.	Channel 37800CH	Channel 38000CH	Channel 38200CH
10MHz	QPSK	1	0	23.7	22.85	23.09	22.93
		1	25	23.7	22.91	23.28	23.00
		1	49	23.7	22.50	22.91	22.64
		25	0	22.7	21.99	22.27	22.07
		25	13	22.7	22.04	22.38	22.00
		25	25	22.7	21.80	22.26	21.84
		50	0	22.7	21.79	22.17	21.95
	16QAM	1	0	22.7	21.82	21.90	21.86
		1	25	22.7	21.73	22.13	21.96
		1	49	22.7	21.30	21.81	21.54
		25	0	21.7	20.74	20.91	20.93
		25	13	21.7	20.72	21.10	20.88
		25	25	21.7	20.48	20.95	20.69
		50	0	21.7	20.44	20.77	20.83

Bandwidth	Modulation	RB size	RB offset	Tune-up Max.	Channel 37825CH	Channel 38000CH	Channel 38175CH
15MHz	QPSK	1	0	23.7	22.68	22.71	22.95
		1	38	23.7	22.90	23.27	23.07
		1	74	23.7	22.71	22.85	22.48
		36	0	22.7	21.89	22.17	22.11
		36	18	22.7	21.92	22.38	22.13
		36	39	22.7	21.81	22.19	21.84
		75	0	22.7	21.87	22.17	21.97
	16QAM	1	0	22.7	21.64	21.48	21.86
		1	38	22.7	21.78	21.97	21.96
		1	74	22.7	21.31	21.61	21.25
		36	0	21.7	20.51	20.80	20.94
		36	18	21.7	20.52	21.10	21.01
		36	39	21.7	20.38	20.89	20.68
		75	0	21.7	20.49	20.92	20.85
Bandwidth	Modulation	RB size	RB offset	Tune-up Max.	Channel 37850CH	Channel 38000CH	Channel 38150CH
20MHz	QPSK	1	0	23.7	22.98	23.06	**23.48**
		1	50	23.7	23.01	**23.35**	23.22
		1	99	23.7	**23.02**	23.18	22.72
		50	0	22.7	21.96	22.36	**22.49**
		50	25	22.7	**22.12**	22.31	22.25
		50	50	22.7	22.02	**22.48**	22.06
		100	0	22.7	22.01	22.41	22.25
	16QAM	1	0	22.7	22.14	21.82	22.18
		1	50	22.7	22.08	22.26	22.21
		1	99	22.7	21.98	22.17	21.60
		50	0	21.7	20.66	20.94	21.35
		50	25	21.7	20.74	20.95	21.10
		50	50	21.7	20.66	21.22	20.93
		100	0	21.7	20.58	21.13	21.08

Table 19: Conducted power measurement results of LTE Band XXXVIII

7.1.1 Conducted power measurements of Downlink LTE CA

In this section, the following conducted power measurement results of downlink LTE carrier aggregation are provided to quantify downlink only carrier aggregation SAR test exclusion per KDB 941225 D05A. Uplink maximum output power is measured with downlink carrier aggregation active, using the channel with highest measured maximum output power when downlink carrier aggregation is inactive, to confirm that when downlink carrier aggregation is active uplink maximum output power remains within the specified tune-up tolerance limits and not more than ¼ dB higher than the maximum output power measured when downlink carrier aggregation inactive.

Power test equipment: R&S Radio Communication Tester CMW500

DL LTE CA Class	PCC								SCC			Power		
	PCC Band	PCC Bandwidth (MHz)	PCC UL RB size	PCC UL RB offset	PCC DL RB size	PCC DL RB offset	PCC UL Channel	PCC DL Channel	SCC Band	SCC Bandwidth (MHz)	SCC DL Channel	Rel 8 LTE Tx Power (dBm)	DL LTE CA Tx Power (dBm)	Tune-up
CA_7C	7	20	1	99	100	0	21152	3152	7	20	3350	23.05	23.03	23.20
CA_38C	38	20	1	0	100	0	38150	38150	38	20	37952	23.48	23.50	23.70
CA_3A-5A	5	10	1	0	50	0	20525	2525	3	20	1575	23.16	23.26	24.20
CA_3A-7A	7	20	1	99	100	0	21100	3100	3	20	1575	23.10	23.20	23.20
CA_7A-20A	7	20	1	99	100	0	21100	3100	20	20	6300	23.10	23.15	23.20

Note: Testing is not required in bands or modes not intended/allowed for US operation.

According to KDB 941225 D05A, the downlink LTE CA SAR test is not required and PAG requirements can be excluded.

7.1.2 Conducted power measurements of WiFi 2.4G

The output power of WiFi antenna is as following:

Mode	Ant	Channel	Frequency (MHz)	Data Rate (Mbps)	Tune-up	Average Power (dBm)	SAR Test (Yes/No)
802.11b	Ant1	1	2412	1Mbps	18	**16.84**	**Yes**
		5	2432		18	16.01	No
		10	2457		18	16.45	No
	Ant2	1	2412	1Mbps	18	17.14	No
		5	2432		18	16.13	No
		10	2457		18	**17.40**	**Yes**
802.11g	Ant1	1	2412	6Mbps	15	Not Required	No
		5	2432		15	Not Required	No
		10	2457		15	Not Required	No
	Ant2	1	2412	6Mbps	15	Not Required	No
		5	2432		15	Not Required	No
		10	2457		15	Not Required	No
802.11n 20M	Ant1	1	2412	6.5Mbps	14	Not Required	No
		5	2432		14	Not Required	No
		10	2457		14	Not Required	No
	Ant2	1	2412	6.5Mbps	14	Not Required	No
		5	2432		14	Not Required	No
		10	2457		14	Not Required	No
802.11n 40M	Ant1	3	2422	13.5Mbps	13	Not Required	No
		5	2432		13	Not Required	No
		8	2437		13	Not Required	No
	Ant2	3	2422	13.5Mbps	13	Not Required	No
		5	2432		13	Not Required	No
		8	2437		13	Not Required	No
802.11n-20M MIMO	Sum	1	2412	13Mbps	14	13.60	No
		5	2432		14	12.88	No
		10	2457		14	**13.67**	Yes
802.11n-40M MIMO	Sum	3	2422	27Mbps	13	Not Required	No
		5	2432		13	Not Required	No
		8	2447		13	Not Required	No

Table 20: Conducted power measurement results of WiFi 2.4G.

Note: 1) The Average conducted power of WiFi is measured with RMS detector.

7.1.3 Conducted power measurements of WiFi 5G

Mode	Antenna	Channel	Frequency (MHz)	Data Rate (Mbps)	Tune-up	Average Power (dBm)	SAR Test (Yes/No)
802.11a	Ant1	CH 36	5180	6Mbps	13	11.71	NO
		CH 40	5200		13	11.96	NO
		CH 44	5220		13	12.08	NO
		CH 48	5240		13	**12.09**	Yes
		CH 149	5745		13	**11.59**	Yes
		CH 153	5765		13	11.37	NO
		CH 157	5785		13	11.31	NO
		CH 161	5805		13	11.45	NO
		CH 165	5825		13	11.50	NO
	Ant2	CH 36	5180	6Mbps	13	11.89	NO
		CH 40	5200		13	12.21	NO
		CH 44	5220		13	12.42	NO
		CH 48	5240		13	**12.71**	Yes
		CH 149	5745		13	**12.53**	Yes
		CH 153	5765		13	12.44	NO
		CH 157	5785		13	12.36	NO
		CH 161	5805		13	12.27	NO
		CH 165	5825		13	12.28	NO
Mode	**Antenna**	**Channel**	**Frequency (MHz)**	**Data Rate (Mbps)**	**Tune-up**	**Average Power (dBm)**	**SAR Test (Yes/No)**
802.11n 20M (5GHz)	Ant1	CH 36	5180	6.5Mbps	13	11.91	NO
		CH 40	5200		13	11.92	NO
		CH 44	5220		13	11.92	NO
		CH 48	5240		13	12.06	NO
		CH 149	5745		13	11.16	NO
		CH 153	5765		13	11.02	NO
		CH 157	5785		13	11.05	NO
		CH 161	5805		13	11.02	NO
		CH 165	5825		13	11.12	NO
	Ant2	CH 36	5180	6.5Mbps	13	11.55	NO
		CH 40	5200		13	12.02	NO
		CH 44	5220		13	12.32	NO
		CH 48	5240		13	12.58	NO
		CH 149	5745		13	12.37	NO
		CH 153	5765		13	12.16	NO
		CH 157	5785		13	12.10	NO
		CH 161	5805		13	11.99	NO
		CH 165	5825		13	12.05	NO

Mode	Antenna	Channel	Frequency (MHz)	Data Rate (Mbps)	Tune-up	Average Power (dBm)	SAR Test (Yes/No)
802.11n 40M (5GHz)	Ant1	CH 38	5190	13.5Mbps	12	Not Required	NO
		CH 46	5230		12	Not Required	NO
		CH 151	5755		12	Not Required	NO
		CH 159	5795		12	Not Required	NO
	Ant2	CH 38	5190	13.5Mbps	12	Not Required	NO
		CH 46	5230		12	Not Required	NO
		CH 151	5755		12	Not Required	NO
		CH 159	5795		12	Not Required	NO
Mode	**Antenna**	**Channel**	**Frequency (MHz)**	**Data Rate (Mbps)**	**Tune-up**	**Average Power (dBm)**	**SAR Test (Yes/No)**
802.11ac-20M (5GHz)	Ant1	CH 36	5180	6.5Mbps	13	11.74	NO
		CH 40	5200		13	11.91	NO
		CH 44	5220		13	12.01	NO
		CH 48	5240		13	12.17	NO
		CH 149	5745		13	11.32	NO
		CH 153	5765		13	11.19	NO
		CH 157	5785		13	11.17	NO
		CH 161	5805		13	11.07	NO
		CH 165	5825		13	11.12	NO
	Ant2	CH 36	5180	6.5Mbps	13	11.72	NO
		CH 40	5200		13	11.98	NO
		CH 44	5220		13	12.27	NO
		CH 48	5240		13	12.65	NO
		CH 149	5745		13	12.42	NO
		CH 153	5765		13	12.37	NO
		CH 157	5785		13	12.21	NO
		CH 161	5805		13	12.08	NO
		CH 165	5825		13	12.12	NO
Mode	**Antenna**	**Channel**	**Frequency (MHz)**	**Data Rate (Mbps)**	**Tune-up**	**Average Power (dBm)**	**SAR Test (Yes/No)**
802.11ac-40M (5GHz)	Ant1	CH 38	5190	13.5Mbps	12	Not Required	NO
		CH 46	5230		12	Not Required	NO
		CH 151	5755		12	Not Required	NO
		CH 159	5795		12	Not Required	NO
	Ant2	CH 38	5190	13.5Mbps	12	Not Required	NO
		CH 46	5230		12	Not Required	NO
		CH 151	5755		12	Not Required	NO
		CH 159	5795		12	Not Required	NO

Mode	Antenna	Channel	Frequency (MHz)	Data Rate (Mbps)	Tune-up	Average Power (dBm)	SAR Test (Yes/No)
802.11ac 80M (5GHz)	Ant1	CH 42	5210	6.5Mbps	11	Not Required	NO
		CH 155	5775		11	Not Required	NO
	Ant2	CH 42	5210	6.5Mbps	11	Not Required	NO
		CH 155	5775		11	Not Required	NO
Mode	**Antenna**	**Channel**	**Frequency (MHz)**	**Data Rate (Mbps)**	**Tune-up**	**Average Power (dBm)**	**SAR Test (Yes/No)**
802.11n-20M MIMO (5GHz)	Sum	CH 36	5180	13Mbps	13	11.43	NO
		CH 40	5200		13	11.74	NO
		CH 44	5220		13	12.00	NO
		CH 48	5240		13	**12.23**	Yes
		CH 149	5745		13	**11.64**	Yes
		CH 153	5765		13	11.49	NO
		CH 157	5785		13	11.45	NO
		CH 161	5805		13	11.35	NO
		CH 165	5825		13	11.40	NO
Mode	**Antenna**	**Channel**	**Frequency (MHz)**	**Data Rate (Mbps)**	**Tune-up**	**Average Power (dBm)**	**SAR Test (Yes/No)**
802.11n-40M MIMO (5GHz)	Sum	CH 38	5190	27Mbps	12	Not Required	NO
		CH 46	5230		12	Not Required	NO
		CH 151	5755		12	Not Required	NO
		CH 159	5795		12	Not Required	NO
Mode	**Antenna**	**Channel**	**Frequency (MHz)**	**Data Rate (Mbps)**	**Tune-up**	**Average Power (dBm)**	**SAR Test (Yes/No)**
802.11ac-20M MIMO (5GHz)	Sum	CH 36	5180	13Mbps	13	11.52	NO
		CH 40	5200		13	11.72	NO
		CH 44	5220		13	11.95	NO
		CH 48	5240		13	12.26	NO
		CH 149	5745		13	11.67	NO
		CH 153	5765		13	11.59	NO
		CH 157	5785		13	11.54	NO
		CH 161	5805		13	11.37	NO
		CH 165	5825		13	11.40	NO
Mode	**Antenna**	**Channel**	**Frequency (MHz)**	**Data Rate (Mbps)**	**Tune-up**	**Average Power (dBm)**	**SAR Test (Yes/No)**
802.11ac-40M MIMO (5GHz)	Sum	CH 38	5190	27Mbps	12	Not Required	NO
		CH 46	5230		12	Not Required	NO
		CH 151	5755		12	Not Required	NO
		CH 159	5795		12	Not Required	NO

Mode	Antenna	Channel	Frequency (MHz)	Data Rate (Mbps)	Tune-up	Average Power (dBm)	SAR Test (Yes/No)
802.11ac-80MHz MIMO (5GHz)	Sum	CH 42	5210	58.5Mbps	11	Not Required	NO
		CH 155	5775		11	Not Required	NO

Table 21: Conducted power measurement results of WiFi 5G.

Note: 1) The Average conducted power of WiFi is measured with RMS detector.

7.2 SAR measurement Results

General Notes:

1) Per KDB447498 D01, all SAR measurement results are scaled to the maximum tune-up tolerance limit to demonstrate SAR compliance.

2) Per KDB447498 D01, 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:

● ≤ 0.8W/kg for 1-g or 2.0W/kg for 10-g respectively, when the transmission band is ≤ 100MHz.

● ≤ 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.

When the maximum output power variation across the required test channels is > ½ dB, instead of the middle channel, the highest output power channel must be used.

3) Per KDB865664 D01,for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥0.8W/kg; if the deviation among the repeated measurement is ≤20%, and the measured SAR <1.45W/kg, only one repeated measurement is required.

4) Per KDB941225 D06, the DUT Dimension is bigger than 9 cm x 5 cm, so 10mm is chosen as the test separation distance for Hotspot mode. When the antenna-to-edge distance is greater than 2.5cm, such position does not need to be tested.

5) Per KDB865664 D02, SAR plot is only required for the highest measured SAR in each exposure configuration, wireless mode and frequency band combination; Plots are also required when the measured SAR is > 1.5 W/kg, or > 7.0 W/kg for occupational exposure. The published RF exposure KDB procedures may require additional plots; for example, to support SAR to peak location separation ratio test exclusion and/or volume scan post-processing(Refer to appendix B for details).

GSM Notes:

1) Per KDB941225 D01, SAR test reduction for GPRS and EDGE modes is determined by the source-based time-averaged output power specified for production units, including tune-up tolerance. The data mode with highest specified time-averaged output power should be tested for SAR compliance in the applicable exposure conditions. For modes with the same specified maximum output power and tolerance, the higher number time-slot configuration should be tested.

UMTS Notes:

1) Per KDB941225 D01, When the maximum output power and tune-up tolerance specified for production units in a Second 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 Second to primary mode and the adjusted SAR is ≤ 1.2 W/kg, SAR measurement is not required for the Second mode.

LTE Notes:

1) The LTE test configurations are determined according to KDB941225 D05 SAR for LTE Devices.The general test procedures used for SAR testing can be found in Section 6.5.
2) A-MPR was disabled for all SAR test by setting NS_01 on the base station simulator.SAR tests were performed with the same number of RB and RB offsets transmitting on all TTI frames(maximum TTI)
3) For Time-Division Duplex (TDD) systems, SAR is tested using a fixed periodic duty factor according to the highest transmission duty factor (63.33%) implemented for the device and supported by the defined 3GPP LTE TDD configurations.

WiFi Notes:

Per KDB248227D01:
1) When reported SAR for the initial test position is ≤ 0.4W/kg, no additional testing for the remaining test position is required. Otherwise, SAR is evaluated at the subsequent highest peak SAR position until the reported SAR result is ≤ 0.8W/kg or all test position are measured. For all positions/configurations tested using the initial test position and subsequent test positions, when the *reported* SAR is > 0.8 W/kg, SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel(s) until the *reported* SAR is ≤ 1.2 W/kg or all required channels are tested..
2) When the DSSS *reported* SAR of the highest measured maximum output power channel for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.
3) 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, SAR measurement is not required for 2.4 GHz 802.11g/n OFDM configurations
4) The highest SAR measured for the initial test position or initial test configuration should be used to determine SAR test exclusion according to the sum of 1-g SAR and SAR peak to location ratio provisions in KDB 447498. In addition, a test lab may also choose to perform standalone SAR measurements for test positions and 802.11 configurations that are not required by the initial test position or initial test configuration procedures and apply the results to determine simultaneous transmission SAR test exclusion, according to sum of 1-g and SAR peak to location ratio requirements to reduce the number of simultaneous transmission SAR measurements.

7.2.1 SAR measurement Result of GSM850

Test Position of Hotspot with 10mm	Test channel /Freq.(MHz)	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Power (dBm)	Tune-up Limit (dBm)	Reported SAR1-g (W/kg)	Plot.
			1-g	10-g					
Front Side	190/836.6	GPRS 2TS	0.498	0.380	0.12	29.65	31.00	0.680	/
Back Side	190/836.6	GPRS 2TS	0.532	0.404	0.09	29.65	31.00	0.726	/
Right Side	190/836.6	GPRS 2TS	0.054	0.041	-0.19	29.65	31.00	0.074	/
Top Side	190/836.6	GPRS 2TS	0.385	0.277	0.10	29.65	31.00	0.525	/
Bottom Side	190/836.6	GPRS 2TS	0.360	0.262	-0.02	29.65	31.00	0.491	/
Back Side	128/824.2	GPRS 2TS	**0.551**	0.415	-0.14	29.71	31.00	**0.742**	Yes
Back Side	251/848.8	GPRS 2TS	0.530	0.403	-0.15	29.55	31.00	0.740	/

Table 22: Hotspot SAR test results of GSM850

7.2.2 SAR measurement Result of GSM1900

Test Position of Hotspot with 10mm	Test channel /Freq.(MHz)	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Power (dBm)	Reported SAR1-g (W/kg)	Plot.
			1-g	10-g					
Front Side	661/1880	GPRS 2TS	0.368	0.226	-0.08	27.63	28.00	0.401	/
Back Side	661/1880	GPRS 2TS	0.377	0.227	-0.17	27.63	28.00	0.411	/
Right Side	661/1880	GPRS 2TS	0.236	0.133	-0.05	27.63	28.00	0.257	/
Top Side	661/1880	GPRS 2TS	0.322	0.209	-0.16	27.63	28.00	0.351	/
Bottom Side	661/1880	GPRS 2TS	0.227	0.148	0.03	27.63	28.00	0.247	/
Back Side	512/1850.2	GPRS 2TS	0.325	0.203	-0.10	27.75	28.00	0.344	/
Back Side	810/1909.8	GPRS 2TS	**0.395**	0.242	-0.10	27.66	28.00	**0.427**	Yes

Table 23: Hotspot SAR test results of GSM1900

7.2.1 SAR measurement Result of UMTS Band II

Test Position of Hotspot with 10mm	Test channel / Freq.(MHz)	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Power (dBm)	Reported SAR1-g (W/kg)	Plot.
			1-g	10-g					
Front Side	9400/1880	RMC	0.660	0.391	-0.17	22.78	23.00	0.694	/
Back Side	9400/1880	RMC	0.495	0.312	-0.12	22.78	23.00	0.521	/
Right Side	9400/1880	RMC	0.253	0.143	-0.09	22.78	23.00	0.266	/
Top Side	9400/1880	RMC	0.454	0.293	-0.11	22.78	23.00	0.478	/
Bottom Side	9400/1880	RMC	0.303	0.197	-0.07	22.78	23.00	0.319	/
Front Side	9262/1852.4	RMC	**0.699**	0.430	-0.09	22.78	23.00	**0.735**	Yes
Front Side	9538/1907.6	RMC	0.658	0.385	-0.18	22.60	23.00	0.721	/

Table 24: Hotspot SAR test results of UMTS Band II

7.2.2 SAR measurement Result of UMTS Band V

Test Position of Hotspot with 10mm	Test channel / Freq.(MHz)	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Power (dBm)	Reported SAR1-g (W/kg)	Plot.
			1-g	10-g					
Front Side	4182/836.4	RMC	**0.449**	0.343	-0.14	22.18	23.00	0.542	Yes
Back Side	4182/836.4	RMC	0.409	0.309	-0.15	22.18	23.00	0.494	/
Right Side	4182/836.4	RMC	0.040	0.029	-0.18	22.18	23.00	0.048	/
Top Side	4182/836.4	RMC	0.298	0.215	-0.07	22.18	23.00	0.360	/
Bottom Side	4182/836.4	RMC	0.284	0.206	-0.06	22.18	23.00	0.343	/
Front Side	4132/826.4	RMC	0.447	0.341	-0.15	22.09	23.00	**0.551**	/
Front Side	4233/846.6	RMC	0.344	0.264	-0.18	22.08	23.00	0.425	/

Table 25: Hotspot SAR test results of UMTS Band V

7.2.3 SAR measurement Result of LTE Band V

Test Position of Hotspot with 10mm	Test channel / Freq. (MHz)	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Power (dBm)	Reported SAR_{1-g} (W/kg)	Plot.
			1-g	10-g					
1RB									
Front Side	20525/836.5	10M QPSK 1RB#0	0.498	0.381	-0.14	22.77	24.20	0.692	/
Back Side	20525/836.5	10M QPSK 1RB#0	0.454	0.343	-0.09	22.77	24.20	0.631	/
Right Side	20525/836.5	10M QPSK 1RB#0	0.046	0.031	-0.04	22.77	24.20	0.064	/
Top Side	20525/836.5	10M QPSK 1RB#0	0.319	0.230	-0.12	22.77	24.20	0.443	/
Bottom Side	20525/836.5	10M QPSK 1RB#0	0.302	0.218	-0.11	22.77	24.20	0.420	/
50%RB									
Front Side	20525/836.5	10M QPSK 50%RB#13	**0.559**	0.428	-0.09	21.78	23.20	**0.775**	Yes
Back Side	20525/836.5	10M QPSK 50%RB#13	0.494	0.340	-0.01	21.78	23.20	0.685	/
Right Side	20525/836.5	10M QPSK 50%RB#13	0.052	0.036	-0.13	21.78	23.20	0.073	/
Top Side	20525/836.5	10M QPSK 50%RB#13	0.333	0.225	-0.01	21.78	23.20	0.462	/
Bottom Side	20525/836.5	10M QPSK 50%RB#13	0.321	0.217	-0.02	21.78	23.20	0.445	/
Front Side	20450/829	10M QPSK 50%RB#13	0.352	0.269	-0.12	21.37	23.20	0.536	/
Front Side	20600/844	10M QPSK 50%RB#13	0.359	0.275	-0.05	21.70	23.20	0.507	/

Table 26: Hotspot SAR test results of LTE Band V

7.2.4 SAR measurement Result of LTE Band VII

Test Position of Hotspot with 10mm	Test channel / Freq.(MHz)	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Power (dBm)	Reported SAR_{1-g} (W/kg)	Plot.
			1-g	10-g					
1RB									
Front Side	21100/2535	20M QPSK 1RB#99	**1.030**	0.542	-0.16	22.36	23.20	1.250	Yes
Front Side	20850/2510	20M QPSK 1RB#99	0.868	0.464	-0.19	22.06	23.20	1.129	/
Front Side	21350/2560	20M QPSK 1RB#99	0.972	0.495	-0.19	22.08	23.20	**1.258**	/
Front Side-Repeated	21100/2535	20M QPSK 1RB#99	0.919	0.479	-0.14	22.36	23.20	1.115	/
Back Side	21100/2535	20M QPSK 1RB#99	0.318	0.185	-0.18	22.36	23.20	0.386	/
Right Side	21100/2535	20M QPSK 1RB#99	0.297	0.158	-0.06	22.36	23.20	0.360	/
Top Side	21100/2535	20M QPSK 1RB#99	0.183	0.200	-0.18	22.36	23.20	0.222	/
Bottom Side	21100/2535	20M QPSK 1RB#99	0.335	0.179	0.11	22.36	23.20	0.406	/
50%RB									
Front Side	20850/2510	20M QPSK 50%RB#50	0.796	0.421	-0.11	20.66	22.20	1.135	/
Front Side	21100/2535	20M QPSK 50%RB#50	0.778	0.404	-0.17	20.32	22.20	1.199	/
Front Side	21350/2560	20M QPSK 50%RB#0	0.758	0.387	-0.19	20.63	22.20	1.088	/
Back Side	20850/2510	20M QPSK 50%RB#50	0.206	0.115	0.15	20.66	22.20	0.294	/
Right Side	20850/2510	20M QPSK 50%RB#50	0.144	0.082	0.02	20.66	22.20	0.205	/
Top Side	20850/2510	20M QPSK 50%RB#50	0.124	0.068	0.11	20.66	22.20	0.177	/
Bottom Side	20850/2510	20M QPSK 50%RB#50	0.204	0.110	0.08	20.66	22.20	0.291	/
100%RB									
Front Side	20850/2510	20M QPSK 100%RB#0	0.902	0.470	-0.14	20.78	22.20	1.251	/

Table 27: Hotspot SAR test results of LTE Band VII

7.2.5 SAR measurement Result of LTE Band XXXVIII

Test Position of Hotspot with 10mm	Test channel / Freq.(MHz)	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Power (dBm)	Reported SAR_{1-g} (W/kg)	Plot.
			1-g	10-g					
1RB									
Front Side	38150/2610	20M QPSK 1RB#0	**0.419**	0.245	-0.17	23.48	23.7	0.441	Yes
Back Side	38150/2610	20M QPSK 1RB#0	0.246	0.146	-0.16	23.48	23.7	0.259	/
Right Side	38150/2610	20M QPSK 1RB#0	0.108	0.061	-0.11	23.48	23.7	0.114	/
Top Side	38150/2610	20M QPSK 1RB#0	0.204	0.107	-0.07	23.48	23.7	0.215	/
Bottom Side	38150/2610	20M QPSK 1RB#0	0.211	0.11	0.12	23.48	23.7	0.222	/
Front Side	37850/2580	20M QPSK 1RB#99	0.415	0.242	-0.17	23.02	23.7	**0.485**	/
Front Side	38000/2595	20M QPSK 1RB#50	0.409	0.238	0.02	23.35	23.7	0.443	/
50%RB									
Front Side	38150/2610	20M QPSK 50%RB#0	0.337	0.198	0.01	22.49	22.7	0.354	/
Back Side	38150/2610	20M QPSK 50%RB#0	0.199	0.111	-0.13	22.49	22.7	0.209	/
Right Side	38150/2610	20M QPSK 50%RB#0	0.061	0.035	0.15	22.49	22.7	0.064	/
Top Side	38150/2610	20M QPSK 50%RB#0	0.129	0.0657	-0.08	22.49	22.7	0.135	/
Bottom Side	38150/2610	20M QPSK 50%RB#0	0.118	0.0611	-0.09	22.49	22.7	0.124	/

Table 28: Hotspot SAR test results of LTE Band XXXVIII

7.2.6 SAR measurement Result of WiFi 2.4G

Test Position of Hotspot with 10mm	Test channel /Freq.(MHz)	Test Mode	SAR Value (W/kg)			Power Drift (dB)	Conducted Power (dBm)	Tune-up Power (dBm)	Scaled SAR1-g (W/kg)
			1-g Area Scan	1-g Zoom Scan	10-g Zoom Scan				
ANT 1									
Front Side	1/2412	802.11b	0.170	0.172	0.093	0.09	16.84	18.00	0.225
Back Side	1/2412	802.11b	0.103	/	/	-0.03	16.84	18.00	/
Left Side	1/2412	802.11b	0.022	/	/	0.04	16.84	18.00	/
Bottom Side	1/2412	802.11b	0.129	/	/	0.08	16.84	18.00	/
ANT 2									
Front Side	10/2457	802.11b	0.165	/	/	-0.02	17.40	18.00	/
Back Side	10/2457	802.11b	0.111	/	/	-0.14	17.40	18.00	/
Left Side	10/2457	802.11b	0.046	/	/	0.14	17.40	18.00	/
Top Side	10/2457	802.11b	0.231	**0.226**	0.128	0.09	17.40	18.00	0.259
MIMO 20M									
Front Side	10/2457	20M 802.11n	0.099	0.103	0.065	-0.13	13.67	14.00	0.111
Back Side	10/2457	20M 802.11n	0.065	/	/	0.19	13.67	14.00	/
Left Side	10/2457	20M 802.11n	0.017	/	/	0.02	13.67	14.00	/
Top Side	10/2457	20M 802.11n	0.063	/	/	0.18	13.67	14.00	/
Bottom Side	10/2457	20M 802.11n	0.046	/	/	0.03	13.67	14.00	/

Table 29: Hotspot SAR test results of WiFi 2.4G

According to KDB248227 D01,The reported SAR must be scaled to 100% transmission duty factor to determine compliance at maximum tune-up tolerance limit.The scaled reported SAR is presented as below.

Test Position of Hotspot with 10mm	Test channel / Freq.(MHz)	Test Mode	Scaled $SAR_{1\text{-}g}$ (W/kg)	Actual duty factor	Maximum duty factor	Reported $SAR_{1\text{-}g}$ (W/kg)
ANT1						
Front Side	1/2412	802.11b	0.225	97.49%	100%	0.230
ANT2						
Top Side	10/2457	802.11b	0.259	97.49%	100%	0.266
MIMO						
Front Side	10/2457	20M 802.11n	0.111	91.18%	100%	0.122

WiFi 2.4G	Tune-up Limit （dBm）	Tune-up Limit （mW）	Hightest Reported SAR(W/kg)	Adjusted SAR (W/kg)	SAR test
802.11b	18.00	63.10	0.266	/	Yes
802.11g	15.00	31.62	/	0.133	No
802.11n 20M SISO	14.00	25.12	/	0.106	No
802.11n 40M SISO	13.00	19.95	/	0.084	No
WiFi 2.4G	**Tune-up Limit （dBm）**	**Tune-up Limit （mW）**	**Hightest Reported SAR(W/kg)**	**Adjusted SAR (W/kg)**	**SAR test**
802.11n 20M MIMO	14.00	25.12	0.122	/	Yes
802.11n 40M MIMO	13.00	19.95	/	0.097	No

Table 30: Adjusted SAR for WiFi 2.4G

Note:

1) SAR is measured for WiFi 2.4 GHz 802.11b DSSS using the initial test position procedure.

2) For WiFi 2.4G SISO, SAR is measured for 802.11b DSSS using the initial test position procedure. As the highest reported SAR for DSSS is adjusted by the ratio of OFDM 802.11g/n to DSSS specified maximum output power and the adjusted SAR is < 1.2 W/kg, so SAR for 802.11g/n is not required.

3) For WiFi 2.4G MIMO, SAR is measured for 802.11n 20M MIMO using the initial test position procedure according to the specified maximum output power and maximum bandwidth. As the the adjusted SAR is < 1.2 W/kg, so SAR test for OFDM 802.11 n 40M MIMO is not required.

7.2.1 SAR measurement Result of WiFi 5G

Test Position of Hotspot with 10mm	Test channel /Freq.(MHz)	Test Mode	SAR Value (W/kg)			Power Drift (dB)	Conducted Power (dBm)	Tune-up Power (dBm)	Scaled SAR1-g (W/kg)
			1-g Area Scan	1-g Zoom Scan	10-g Zoom Scan				
ANT 1									
Test data of UNII-1									
Front Side	48/5240	802.11a	0.164	/	/	-0.13	12.09	13.00	/
Back Side	48/5240	802.11a	0.057	/	/	0.06	12.09	13.00	/
Left Side	48/5240	802.11a	0.037	/	/	-0.01	12.09	13.00	/
Bottom Side	48/5240	802.11a	0.202	**0.261**	0.158	0.18	12.09	13.00	0.322
Test data of UNII-3									
Front Side	149/5745	802.11a	0.078	/	/	0.19	11.59	13.00	/
Back Side	149/5745	802.11a	0.048	/	/	0.15	11.59	13.00	/
Left Side	149/5745	802.11a	0.037	/	/	0.00	11.59	13.00	/
Bottom Side	149/5745	802.11a	0.141	/	/	0.17	11.59	13.00	/
ANT 2									
Test data of UNII-1									
Front Side	48/5240	802.11a	0.167	/	/	0.17	12.71	13.00	/
Back Side	48/5240	802.11a	0.036	/	/	-0.03	12.71	13.00	/
Left Side	48/5240	802.11a	0.035	/	/	-0.15	12.71	13.00	/
Top Side	48/5240	802.11a	0.178	/	/	0.10	12.71	13.00	/
Test data of UNII-3									
Front Side	149/5745	802.11a	0.179	0.260	0.160	-0.19	12.53	13.00	0.290
Back Side	149/5745	802.11a	0.067	/	/	0.19	12.53	13.00	/
Left Side	149/5745	802.11a	0.028	/	/	0.18	12.53	13.00	/
Top Side	149/5745	802.11a	0.090	/	/	0.19	12.53	13.00	/
MIMO 20M									
Test data of UNII-1									
Front Side	48/5240	802.11n	0.102	/	/	0.09	12.23	13.00	/
Back Side	48/5240	802.11n	0.038	/	/	0.13	12.23	13.00	/
Left Side	48/5240	802.11n	0.038	/	/	-0.11	12.23	13.00	/
Top Side	48/5240	802.11n	0.133	0.185	0.117	-0.10	12.23	13.00	0.221
Bottom Side	48/5240	802.11n	0.113	/	/	-0.06	12.23	13.00	/
Test data of UNII-3									
Front Side	149/5745	802.11n	0.091	/	/	0.05	11.64	13.00	/
Back Side	149/5745	802.11n	0.037	/	/	0.17	11.64	13.00	/
Left Side	149/5745	802.11n	0.046	/	/	0.11	11.64	13.00	/
Top Side	149/5745	802.11n	0.092	/	/	-0.13	11.64	13.00	/
Bottom Side	149/5745	802.11n	0.098	/	/	0.18	11.64	13.00	/

Table 31: Hotspot SAR test results of WiFi 5G

According to KDB248227 D01,The reported SAR must be scaled to 100% transmission duty factor to determine compliance at maximum tune-up tolerance limit.The scaled reported SAR is presented as below.

Test Position of Hotspot with 10mm	Test channel / Freq.(MHz)	Test Mode	Scaled SAR_{1-g} (W/kg)	Actual duty factor	Maximum duty factor	Reported SAR_{1-g} (W/kg)
ANT1						
Bottom Side	48/5240	802.11a	0.322	96%	100%	**0.335**
ANT2						
Bottom Side	48/5240	802.11a	0.290	96%	100%	0.302
MIMO						
Top Side	48/5240	802.11n	0.221	92%	100%	0.240

WiFi 5G	Tune-up Limit（dBm）	Tune-up Limit（mW）	Hightest Reported SAR(W/kg)	Adjusted SAR (W/kg)	SAR test
802.11a	13.0	19.95	0.335	/	Yes
802.11n 20M SISI	13.0	19.95	/	0.335	No
802.11n 40M SISO	12.0	15.85	/	0.266	No
802.11ac 20M SISO	13.0	19.95	/	0.335	No
802.11ac 40M SISO	12.0	15.85	/	0.266	No
802.11ac 80M SISO	11.0	12.59	/	0.211	No
WiFi 5G	**Tune-up Limit（dBm）**	**Tune-up Limit（mW）**	**Hightest Reported SAR(W/kg)**	**Adjusted SAR (W/kg)**	**SAR test**
802.11n 20M MIMO	13.0	19.95	0.240	/	Yes
802.11n 40M MIMO	12.0	15.85	/	0.191	No
802.11ac 20M MIMO	13.0	19.95	/	0.240	No
802.11ac 40M MIMO	12.0	15.85	/	0.191	No
802.11ac 80M MIMO	11.0	12.59	/	0.151	No

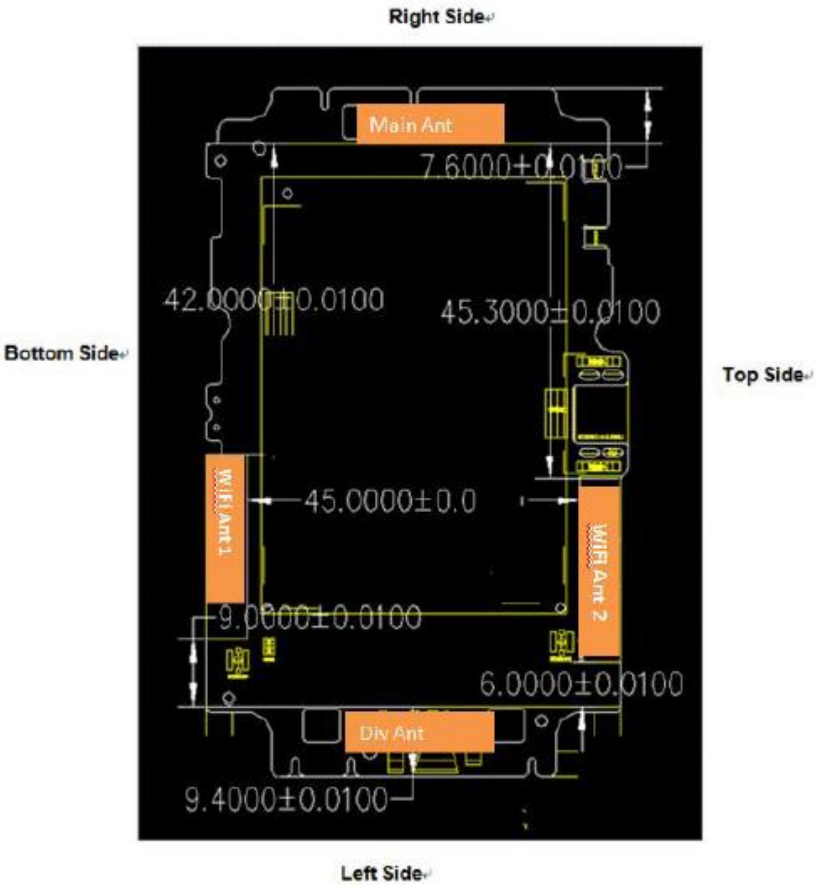
Table 32 Adjusted SAR for WiFi 5G

Note: SAR is not required for other WiFi 5GHz modes 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.

7.3 Multiple Transmitter Evaluation

The following tables list information which is relevant for the decision if a simultaneous transmit evaluation is necessary according to FCC KDB 447498D01 General RF Exposure Guidance.

The location of the antennas inside the device is shown as below picture:



Note:

1) Diversity antenna is used to improve the acceptance of performance of the main antenna. it does not have a transmitter function.

Mode	Exposure Condition	Front Side	Back Side	Left Side	Right Side	Top Side	Bottom Side
Main antenna	Hotspot	Yes	Yes	No	Yes	Yes	Yes
WiFi ANT1	Hotspot	Yes	Yes	Yes	No	No	Yes
WiFi ANT2	Hotspot	Yes	Yes	Yes	No	Yes	No
WiFi MIMO	Hotspot	Yes	Yes	Yes	No	Yes	Yes

Table 33: Sides for Hotspot SAR testing

Note:

Note: Per KDB 941225 D06, particular DUT edges were not required to be evaluated for SAR if the antenna-to-edge distance is greater than 2.5cm.

7.3.1 Simultaneous Transmission Possibilities

The Simultaneous Transmission Possibilities of this device are as below:

No.	Configuration	Body
1	GSM/UMTS/LTE + WiFi 2.4G SISO ANT1	Yes
2	GSM/UMTS/LTE + WiFi 2.4G SISO ANT2	Yes
3	GSM/UMTS/LTE + WiFi 2.4G MIMO	Yes
4	GSM/UMTS/LTE + WiFi 5G SISO ANT1	Yes
5	GSM/UMTS/LTE + WiFi 5G SISO ANT2	Yes
6	GSM/UMTS/LTE + WiFi 5G MIMO	Yes

Table 34: Simultaneous Transmission Possibilities

Note: 1) WiFi 2.4G and WiFi 5G can't transmit simutanously.

7.3.2 SAR Summation Scenario

Test Position of Hotspot with 10mm	Main antenna SAR_{Max}							WiFi antenna SARMax		Σ1-g SAR (1.6W/kg Limit)
	GSM 850	GSM 1900	UMTS Band II	UMTS Band V	LTE Band V	LTE Band VII	LTE Band XXXVIII	WiFi 2.4G	WiFi 5G	
Front side	0.680	0.401	0.735	0.551	0.775	1.258	0.485	0.267	0.335	**1.593**
Back side	0.742	0.427	0.521	0.494	0.685	0.386	0.259	0.267	0.335	1.077
Left side	/	/	/	/	/	/	/	0.267	0.335	0.335
Right side	0.074	0.257	0.266	0.048	0.073	0.360	0.114	/	/	0.360
Top side	0.525	0.351	0.478	0.360	0.462	0.222	0.215	0.267	0.335	0.860
Bottom side	0.491	0.247	0.319	0.343	0.445	0.406	0.222	0.267	0.335	0.826

7.3.3 Simultaneous Transmission Conlcusion

The above numeral summed SAR results and SPLSR analysis is sufficient to determine that simultaneous transmission cases will not exceed the SAR limit and therefore simultaneous transmission SAR with Volume Scans is not required per KDB 447498 D01v06

Appendix A. System Check Plots
(Pls See Appendix No.: SYBH(Z-SAR)009052017-2A, total: 10 pages)

Appendix B. SAR Measurement Plots
(Pls See Appendix No.: SYBH(Z-SAR)009052017-2B, total: 10 pages)

Appendix C. Calibration Certificate
(Pls See Appendix No.: SYBH(Z-SAR)009052017-2C, total: 94 pages)

Appendix D. Photo documentation
(Pls See Appendix No.: SYBH(Z-SAR)009052017-2D, total: 4 pages)

End