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TESTING CERT #2174.01

FCC SAR Compliance Test Report

Product Name: Smart Phone

Model: HUAWEI CUN-L01,CUN-L01

Report No.: SYBH(Z-SAR)005012016-2

FCC ID: QISCUN-L01

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DATE	2016-03-31	2016-03-31

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※ ※ 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.

3. The laboratory (Reliability Lab of Huawei Technologies Co., Ltd) is also named as “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.

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

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※ ※ Modified History ※ ※

REV.	DESCRIPTION	ISSUED DATE	REMARK
Rev.1.0	Initial Test Report Release	2016-03-31	Li Wei

1 General Information

1.1 Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for HUAWEI CUN-L01, CUN-L01 is as below Table 1.

Band	Max Reported SAR(W/kg)		
	1-g Head	1-g Body-worn (15mm) *	1-g Hotspot (10mm)
GSM850	0.80	**0.80**	**1.46**
GSM1900	0.52	0.23	0.93
LTE Band VII	0.13	0.38	1.03
WiFi 2.4G	**1.37**	0.09	0.22
The highest simultaneous SAR value is 1.56 W/kg per KDB690783 D01			

Table 1:Summary of test result

Note:

1)* For body worn operation, this device has been tested and meets FCC RF exposure guidelines when used with any accessory that contains no metal and that positions the handset a minimum of 15mm from the body. Use of other accessories may not ensure compliance with FCC RF exposure guidelines.

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

Device Information:			
Product Name:	Smart Phone		
Model:	HUAWEI CUN-L01,CUN-L01		
FCC ID :	QISCUN-L01		
SN.:	ECPBBBB5C0100543; ECPBBBB5C0100247		
Device Type :	Portable device		
Device Phase:	Identical Prototype		
Exposure Category:	Uncontrolled environment / general population		
Hardware Version :	Ver.A		
Software Version :	CUN-L01C577B008		
Antenna Type :	Internal antenna		
Others Accessories	Headset		
Device Operating Configurations:			
Supporting Mode(s)	GSM850/1900, LTE Band VII, WiFi 2.4G, BT		
Test Modulation	GSM(GMSK/8PSK),LTE(QPSK/16QAM), WiFi(DSSS/OFDM),BT(GFSK)		
Device Class	B		
Operating Frequency Range(s)	Band	Tx (MHz)	Rx (MHz)
	GSM850	824-849	869-894
	GSM1900	1850-1910	1930-1990
	LTE Band VII	2500-2570	2620-2690
	BT	2400-2483.5	
	WiFi 2.4G	2412-2462	
GPRS Multislot Class(12)	Max Number of Timeslots in Uplink:	4	
	Max Number of Timeslots in Downlink:	4	
	Max Total Timeslot:	5	
EGPRS Multislot Class(12)	Max Number of Timeslots in Uplink:	4	
	Max Number of Timeslots in Downlink:	4	
	Max Total Timeslot:	5	
LTE Release	Release 8		
Power Class:	4,tested with power level 5(GSM850)		
	1,tested with power level 0(GSM1900)		
	3, tested with power control all Max.(LTE Band VII)		
Test Channels (low-mid-high):	128-190-251(GSM850)		
	512-661-810(GSM1900)		
	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)		
	802.11b/g/n 20M:1-6-11(WiFi 2.4G) 802.11n 40M:3-6-9(WiFi 2.4G)		

Table 3:Device information and operating configuration

1.3.1 General Description

HUAWEI CUN-L01,CUN-L01 is subscriber equipment in the GSM/UMTS/LTE system.
The GSM frequency band includes GSM850 and GSM900 and DCS1800 and PCS1900. but only GSM850/1900 test data included in this report.
The UMTS frequency band is band I and band VIII,no band test data included in this report.
The LTE frequency band is Band I and Band III and band VII and band VIII and band XX , but only Band VII test data included in this report.
The Mobile Phone implements such functions as RF signal receiving/transmitting, LTE/UMTS and GSM/GPRS/EDGE protocol processing, voice, video MMS service, GPS and Wi-Fi etc. Externally it provides micro SD card interface, earphone port (to provide voice service) and USIM card interface. It also provides Bluetooth module to synchronize data between a PC and the phone, or to use the built-in modem of the phone to access the Internet with a PC, or to exchange data with other Bluetooth devices.

Battery information:

Name	Manufacture	Serials number	Description
Li-Polymer Battery	SCUD(FUJIAN) Electronics Co.,Ltd	1834ACFA24(G153BC)	Battery Model: HB4342A1RBC Rated capacity: 2200mAh Nominal Voltage: ⎓ +3.8V
	Sunwoda Electronics Co.,Ltd	1834UIFA08(X96096)	

1.4 Test specification(s)

ANSI C95.1:1992	Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz – 300 GHz.(IEEE Std C95.1-1991)
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
RSS-102	Radio Frequency Exposure Compliance of Radiocommunication Apparatus (All Frequency Bands (Issue 5 of March 2015)
KDB941225 D01	3G SAR Procedures v03r01
KDB941225 D05	SAR for LTE Devices v02r05
KDB941225 D06	Hotspot SAR v02r01
KDB447498 D01	General RF Exposure Guidance v06
KDB648474 D04	Handsets SAR v01r03
KDB248227 D01	SAR Guidance for IEEE 802 11 Wi-Fi SAR v02r02
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

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

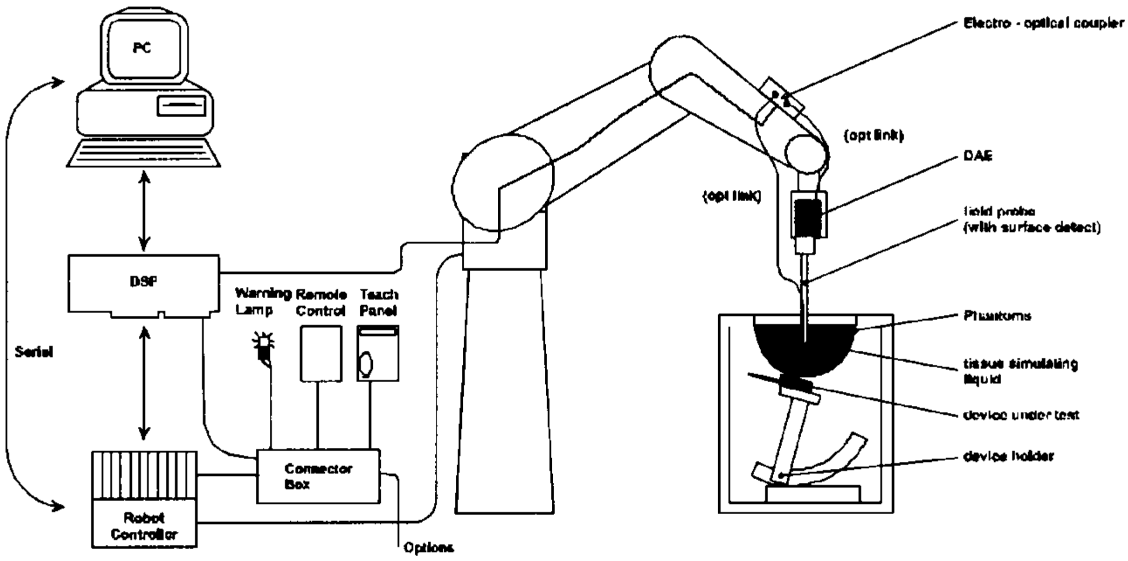
Start Date of test	2016-03-06
End Date of test	2016-03-26

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 DASY5 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 DASY5 measurement server.
- The DASY5 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.
- DASY5 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 DASY5 measurement system is placed at the head end of a room with dimensions:
5 x 2.5 x 3 m³, 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 m² 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

Input Impedance	200MOhm	
The Inputs	symmetrical and floating	
Common mode rejection	above 80 dB	

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

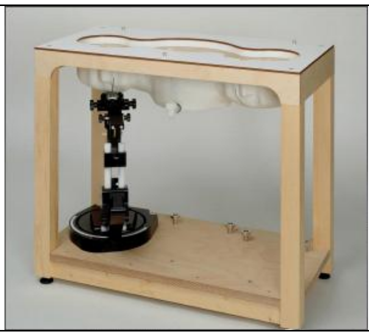
Construction	Symmetrical design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	 
Calibration	ISO/IEC 17025 calibration service available.	
Frequency	10 MHz to 4 GHz; Linearity: ± 0.2 dB (30 MHz to 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

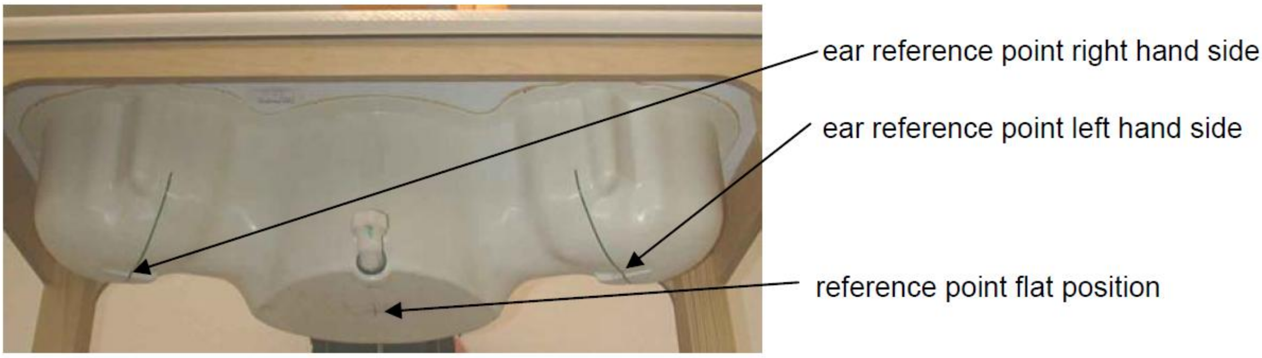
Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	 
Calibration	ISO/IEC 17025 calibration service available.	
Frequency	10 MHz to >6 GHz; Linearity: ± 0.2 dB (30 MHz to 6 GHz)	
Directivity	± 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

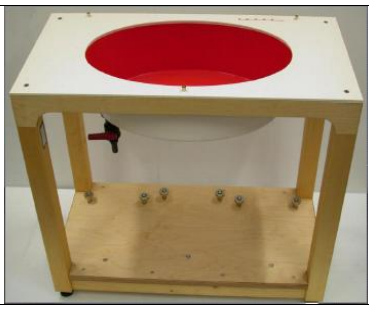
SAM Twin Phantom

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≤εr≤5 at ≤3 GHz,3≤ εr≤4 at >3 GHz and and a loss tangent ≤0.05.

2.6 Device holder description

The DASY5 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 the test described are marked ☒

	Manufacturer	Device	Type	Serial number	Date of last calibration *	Valid period
☒	SPEAG	Dosimetric E-Field Probe	EX3DV4	3744	2015-07-24	One year
☐	SPEAG	Dosimetric E-Field Probe	ES3DV3	3168	2015-09-28	One year
☐	SPEAG	750MHz Dipole	D750V3	1044	2015-09-14	Three years
☒	SPEAG	835MHz Dipole	D835V2	4d059	2013-05-02	Three years
☐	SPEAG	1750MHz Dipole	D1750V2	1123	2014-07-08	Three years
☒	SPEAG	1900MHz Dipole	D1900V2	5d091	2015-09-21	Three years
☐	SPEAG	2300MHz Dipole	D2300V2	1016	2014-11-19	Three years
☒	SPEAG	2450MHz Dipole	D2450V2	860	2015-11-25	Three years
☒	SPEAG	2600MHz Dipole	D2600V2	1021	2015-07-24	Three years
☐	SPEAG	5GHz Dipole	D5GHzV2	1155	2015-04-27	Three years
☒	SPEAG	Data acquisition electronics	DAE4	852	2015-04-27	One year
☒	SPEAG	Software	DASY 5	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	Flat Phantom	ELI 4.0	TP-1038	NCR	NCR
☐	SPEAG	Flat Phantom	ELI 4.0	TP-1111	NCR	NCR
☒	R & S	Universal Radio Communication Tester	CMU 200	113989	2015-05-18	One year
☒	R & S	Universal Radio Communication Tester	CMW 500	126855	2015-07-02	One year
☒	Agilent	Network Analyser	E5071C	MY46213349	2016-01-08	One year
☒	Agilent	Dielectric Probe Kit	85070E	2484	NCR	NCR
☒	Agilent	Signal Generator	N5181A	MY47420989	2015-10-30	One year
☒	MINI-CIRCUITS	Amplifier	ZHL-42W	QA1402001	NCR	NCR
☐	MINI-CIRCUITS	Amplifier	ZVE-8G+	N523101139	NCR	NCR
☒	AR	Directional Coupler	DC7144M1	0423264	2015-03-31	One year
☐	Agilent	Dual Directional Coupler	772D	MY52180173	2016-01-06	One year
☒	R & S	Power Meter	NRP	100740	2015-07-02	One year
☒	R & S	Power Meter Sensor	NRP-Z11	106288	2015-07-02	One year
☒	Agilent	Power Meter	E4417A	MY54100027	2015-03-31	One year
☒	Agilent	Power Meter Sensor	E9321A	MY54130001	2015-05-05	One year
☒	Agilent	Power Meter Sensor	E9321A	MY54130007	2015-05-05	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) * These equipments are within the calibration period when test is perfromed.

3 SAR Measurement Procedure

3.1 Scanning procedure

The DASY5 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 DASY5 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*$\Delta z_{Zoom}(n-1)$	≥30mm
2-3GHz	≤12mm	≤5mm	≤5mm	≤4mm	≤1.5*$\Delta z_{Zoom}(n-1)$	≥30mm
3-4GHz	≤12mm	≤5mm	≤4mm	≤3mm	≤1.5*$\Delta z_{Zoom}(n-1)$	≥28mm
4-5GHz	≤10mm	≤4mm	≤3mm	≤2.5mm	≤1.5*$\Delta z_{Zoom}(n-1)$	≥25mm
5-6GHz	≤10mm	≤4mm	≤2mm	≤2mm	≤1.5*$\Delta z_{Zoom}(n-1)$	≥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

DASY5 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 DASY5 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 DASY5 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**	2300	**2450**	**2600**
Water	39.2	41.45	52.64	55.242	62.82	62.7	55.242
Salt (NaCl)	2.7	1.45	0.36	0.306	0.51	0.5	0.306
Sugar	57.0	56.0	0.0	0.0	0.0	0.0	0.0
HEC	0.0	1.0	0.0	0.0	0.0	0.0	0.0
Bactericide	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DGBE	0.0	0.0	47.0	44.542	36.67	36.8	44.452
Ingredients (% of weight)	**Body Tissue**						
Frequency Band (MHz)	750	**835**	1750	**1900**	2300	**2450**	**2600**
Water	50.3	52.4	69.91	69.91	73.32	73.2	64.493
Salt (NaCl)	1.60	1.40	0.13	0.13	0.06	0.04	0.024
Sugar	47.0	45.0	0.0	0.0	0.0	0.0	0.0
HEC	0.0	1.0	0.0	0.0	0.0	0.0	0.0
Bactericide	0.0	0.1	0.0	0.0	0.0	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0	0.0
DGBE	0.0	0.0	29.96	29.96	26.62	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 for 5G(HBBL3500-5800MHz), Manufactured by SPEAG:**

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

☐**Simulating Body Liquid for 5G(MBBL3500-5800MHz),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		
835H	825	41.60	0.90	42.28	0.914	1.63%	1.50%	21.4°C	2016/03/13
	835	41.50	0.90	42.14	0.923	1.54%	2.57%		
	850	41.50	0.92	41.94	0.938	1.06%	1.95%		
835H	825	41.60	0.90	40.51	0.890	-2.62%	-1.09%	21.6°C	2016/03/26
	835	41.50	0.90	40.32	0.900	-2.84%	0.02%		
	850	41.50	0.92	40.28	0.913	-2.94%	-0.78%		
835B	825	55.20	0.97	53.13	0.964	-3.75%	-0.60%	21.4°C	2016/03/13
	835	55.20	0.97	52.98	0.976	-4.02%	0.65%		
	850	55.20	0.99	52.83	0.997	-4.29%	0.70%		
1900H	1850	40.00	1.40	38.79	1.372	-3.03%	-2.00%	21.5°C	2016/03/06
	1880	40.00	1.40	38.67	1.402	-3.33%	0.14%		
	1900	40.00	1.40	38.58	1.421	-3.55%	1.50%		
	1910	40.00	1.40	38.54	1.432	-3.65%	2.29%		
1900B	1850	53.30	1.52	51.36	1.465	-3.64%	-3.62%	21.4°C	2016/03/11
	1880	53.30	1.52	51.14	1.484	-4.05%	-2.37%		
	1900	53.30	1.52	51.11	1.512	-4.11%	-0.53%		
	1910	53.30	1.52	51.13	1.526	-4.07%	0.39%		
2450H	2410	39.30	1.76	37.85	1.766	-3.69%	0.34%	21.4°C	2016/03/19
	2435	39.20	1.79	37.78	1.788	-3.62%	-0.11%		
	2450	39.20	1.80	37.72	1.803	-3.78%	0.17%		
	2460	39.20	1.81	37.67	1.814	-3.90%	0.22%		
2450H	2410	39.30	1.76	38.98	1.814	-0.81%	3.07%	21.3°C	2016/03/25
	2435	39.20	1.79	38.90	1.841	-0.77%	2.85%		
	2450	39.20	1.80	38.86	1.858	-0.87%	3.22%		
	2460	39.20	1.81	38.83	1.871	-0.94%	3.37%		
2450B	2410	52.80	1.91	51.32	1.932	-2.80%	1.15%	21.4°C	2016/03/18
	2435	52.70	1.94	51.19	1.966	-2.87%	1.34%		
	2450	52.70	1.95	51.15	1.984	-2.94%	1.74%		
	2460	52.70	1.96	51.16	1.994	-2.92%	1.73%		
2600H	2510	39.12	1.86	38.89	1.883	-0.59%	1.24%	21.6°C	2016/03/13
	2535	39.10	1.89	38.80	1.912	-0.77%	1.16%		
	2560	39.00	1.92	38.71	1.941	-0.74%	1.25%		
	2600	39.00	1.96	38.57	1.986	-1.10%	1.33%		
2600B	2510	52.62	2.03	51.05	2.072	-2.98%	2.07%	21.3°C	2016/03/06
	2535	52.59	2.07	50.96	2.105	-3.10%	1.69%		
	2560	52.57	2.09	50.88	2.141	-3.21%	2.44%		
	2600	52.50	2.16	50.75	2.196	-3.33%	1.67%		

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).

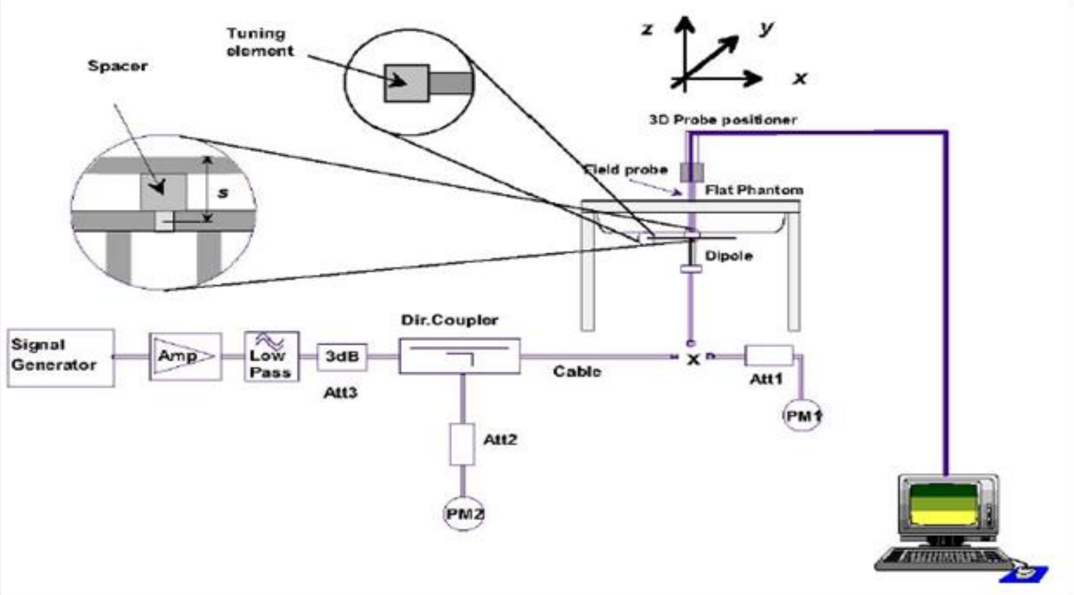
System Check	Target SAR (1W)		Measured SAR (Normalized to 1W)		Deviation (Within +/-10%)		Liquid Temp.	Test Date
	1-g (W/kg)	10-g (W/kg)	1-g (W/kg)	10-g (W/kg)	$\Delta\varepsilon_r$	$\Delta\sigma$		
835MHz Head	9.49	6.18	9.80	6.44	3.27%	4.21%	21.4°C	2016/03/13
835MHz Head	9.49	6.18	9.56	6.28	0.74%	1.62%	21.6°C	2016/03/26
1900MHz Head	40.20	21.10	39.12	19.84	-2.69%	-5.97%	21.5°C	2016/03/06
2450MHz Head	50.80	23.70	55.20	25.64	8.66%	8.19%	21.4°C	2016/03/19
2450MHz Head	50.80	23.70	55.20	25.20	8.66%	6.33%	21.3°C	2016/03/25
2600MHz Head	57.80	26.30	60.00	26.72	3.81%	1.60%	21.6°C	2016/03/13
835MHz Body	9.42	6.19	9.80	6.40	4.03%	3.39%	21.4°C	2016/03/13
1900MHz Body	39.90	21.00	42.80	22.40	7.27%	6.67%	21.4°C	2016/03/11
2450MHz Body	51.90	24.30	56.00	25.56	7.90%	5.19%	21.4°C	2016/03/18
2600MHz Body	57.50	25.90	56.00	24.80	-2.61%	-4.25%	21.3°C	2016/03/06

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 5GHz) or 100mW(above 5GHz). 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

6.1.1 General considerations

Per IEEE 1528-2013，two imaginary lines on the handset were established: the vertical centerline and the horizontal line (See Figure 1).

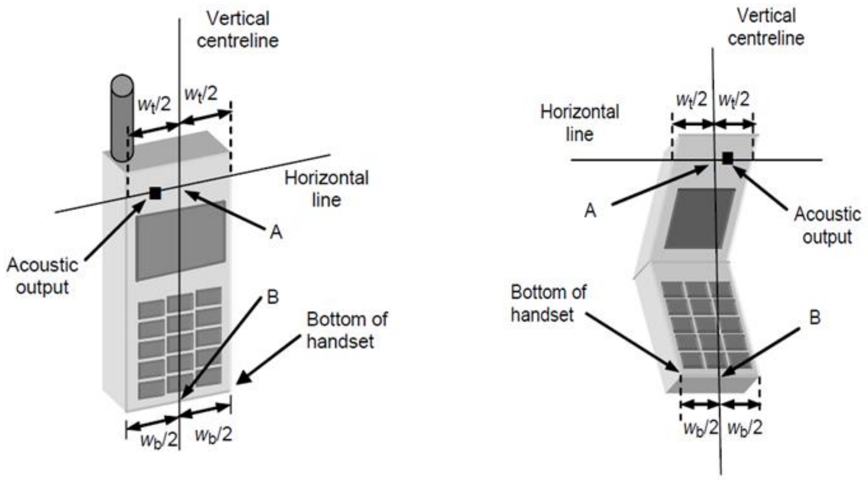


Figure 1 Hand Vertical Center & Horizontal Line Reference Points

6.1.2 Head Exposure Condition

Per IEEE 1528-2013, Head SAR measurements were made in the “cheek” position (See Figure 2) and the “tilt” position (See Figure 3). The device should be tested in both positions on left and right sides of the SAM phantom.

Figure 2 Front, Side and Top View of Cheek Position

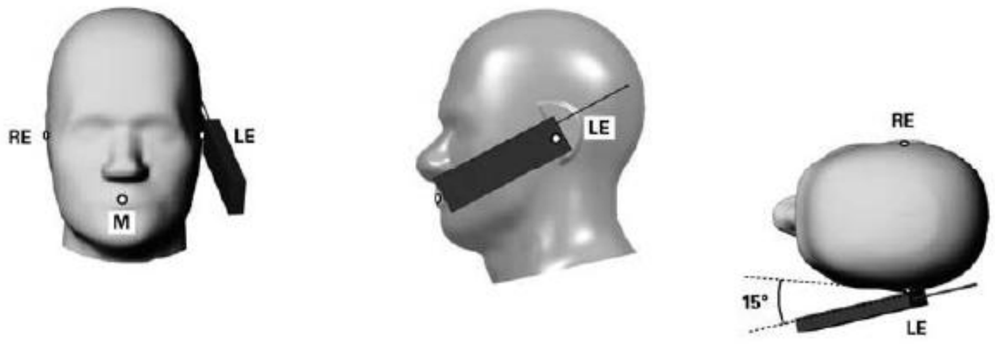


Figure 3 Front, Side and Top View of Tilt 15° Position

Note:

M Mouth reference point

LE Left ear reference point (ERP)

RE Right ear reference point(ERP)

6.1.3 Body-worn Exposure Condition

Body-worn operating configurations are tested with the holder attached to the device and positioned against a flat phantom with test separation distance of 15mm in a normal use configuration (See Figure 4). Per FCC KDB648474 D04v01, Body-worn accessory exposure is typically related to voice mode operations when handsets are carried in body-worn accessories. The body-worn accessory procedures in FCC KDB 447498 should be used to test for body-worn accessory SAR compliance, without a headset connected to it. When the reported SAR for a body-worn accessory, measured without a headset connected to the handset, is > 1.2 W/kg, the highest reported SAR configuration for that wireless mode and frequency band should be repeated for that body-worn accessory with a headset attached to the handset.

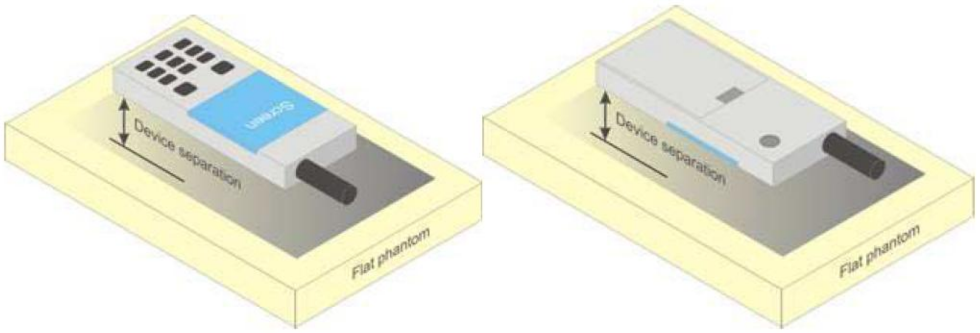


Figure 4 Test position for Body-Worn device

6.1.4 Hotspot Exposure Condition

Per FCC KDB 941225D06, The 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 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.

6.3 LTE Test Configuration

SAR for LTE band exposure configurations is measured according to the procedures of KDB 941225 D05 SAR for LTE Devices v02r04. 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.

6.4 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 RF signal utilized in SAR measurement has 100% duty cycle and its crest factor is 1. The test procedures in KDB 248227D01v02r02 are applied.

6.4.1 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.

6.4.2 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.

6.4.3 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.

6.4.4 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 248227D01v02r02). 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.

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
GSM (CS)		33.5	32.09	32.17	32.10	-9.19	24.31	22.90	22.98	22.91
GPRS/ EDGE (GMSK)	1 Tx Slot	33.5	32.08	32.19	32.11	-9.19	24.31	22.89	23.00	22.92
	2 Tx Slots	**32.5**	**31.35**	**31.36**	**31.39**	**-6.13**	**26.37**	**25.22**	**25.23**	**25.26**
	3 Tx Slots	30.5	29.69	29.70	29.67	-4.42	26.11	25.27	25.28	25.25
	4 Tx Slots	29.5	28.61	28.59	28.56	-3.18	26.32	25.43	25.41	25.38
EDGE (8PSK)	1 Tx Slot	27.1	25.23	25.31	25.42	-9.19	17.91	16.04	16.12	16.23
	2 Tx Slots	26.1	24.11	24.13	24.19	-6.13	19.97	17.98	18.00	18.06
	3 Tx Slots	24.1	22.13	22.11	22.24	-4.42	19.68	17.71	17.69	17.82
	4 Tx Slots	23.1	21.15	21.11	21.18	-3.18	19.92	17.97	17.93	18.00

Table 7: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 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.

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
GSM (CS)		30.5	28.89	28.66	28.99	-9.19	21.31	19.70	19.47	19.80
GPRS/ EDGE (GMSK)	1 Tx Slot	30.5	28.85	28.75	29.05	-9.19	21.31	19.66	19.56	19.86
	2 Tx Slots	**29.5**	**28.11**	**27.93**	**28.29**	**-6.13**	**23.37**	**21.98**	**21.80**	**22.16**
	3 Tx Slots	27.5	26.38	26.19	26.58	-4.42	23.08	21.96	21.77	22.16
	4 Tx Slots	26.5	25.39	25.17	25.61	-3.18	23.32	22.21	21.99	22.43
EDGE (8PSK)	1 Tx Slot	26.1	24.49	24.22	24.71	-9.19	16.91	15.30	15.03	15.52
	2 Tx Slots	25.1	23.25	23.11	23.45	-6.13	18.97	17.12	16.98	17.32
	3 Tx Slots	23.1	21.91	21.56	22.01	-4.42	18.68	17.49	17.14	17.59
	4 Tx Slots	22.1	20.98	20.51	21.01	-3.18	18.92	17.80	17.33	17.83

Table 8: 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 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.

7.1.3 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	23.0	22.35	22.42	22.63
		1	13	23.0	22.35	22.46	22.64
		1	24	23.0	22.31	22.38	22.60
		12	0	22.0	21.22	21.35	21.52
		12	6	22.0	21.22	21.37	21.53
		12	13	22.0	21.22	21.34	21.54
		25	0	22.0	21.18	21.30	21.48
	16QAM	1	0	22.0	21.31	21.44	21.60
		1	13	22.0	21.32	21.44	21.61
		1	24	22.0	21.27	21.38	21.57
		12	0	21.0	20.23	20.39	20.55
		12	6	21.0	20.24	20.39	20.55
		12	13	21.0	20.23	20.39	20.58
		25	0	21.0	20.15	20.28	20.47
Bandwidth	Modulation	RB size	RB offset	Tune-up	Channel 20800CH	Channel 21100CH	Channel 21400CH
10MHz	QPSK	1	0	23.0	22.27	22.31	22.46
		1	25	23.0	22.27	22.36	22.52
		1	49	23.0	22.26	22.31	22.49
		25	0	22.0	21.19	21.29	21.42
		25	13	22.0	21.20	21.31	21.43
		25	25	22.0	21.20	21.28	21.46
		50	0	22.0	21.20	21.30	21.42
	16QAM	1	0	22.0	21.04	21.15	21.26
		1	25	22.0	21.06	21.19	21.33
		1	49	22.0	21.03	21.12	21.34
		25	0	21.0	20.15	20.28	20.41
		25	13	21.0	20.16	20.29	20.42
		25	25	21.0	20.18	20.26	20.45
		50	0	21.0	20.16	20.26	20.39

Bandwidth	Modulation	RB size	RB offset	Tune-up	Channel 20825CH	Channel 21100CH	Channel 21375CH
15MHz	QPSK	1	0	23.0	22.25	22.32	22.38
		1	38	23.0	22.29	22.36	22.49
		1	74	23.0	22.23	22.30	22.51
		36	0	22.0	21.34	21.33	21.47
		36	18	22.0	21.31	21.39	21.49
		36	39	22.0	21.28	21.37	21.51
		75	0	22.0	21.31	21.38	21.50
	16QAM	1	0	22.0	21.05	21.11	21.22
		1	38	22.0	21.07	21.18	21.29
		1	74	22.0	21.06	21.11	21.34
		36	0	21.0	20.25	20.28	20.39
		36	18	21.0	20.27	20.34	20.43
		36	39	21.0	20.20	20.32	20.48
		75	0	21.0	20.26	20.32	20.45
Bandwidth	Modulation	RB size	RB offset	Tune-up	Channel 20850CH	Channel 21100CH	Channel 21350CH
20MHz	QPSK	1	0	23.0	22.31	22.36	22.46
		1	50	23.0	**22.33**	**22.40**	22.51
		1	99	23.0	22.30	22.34	**22.55**
		50	0	22.0	21.21	21.26	21.36
		50	25	22.0	21.20	21.31	21.40
		50	50	22.0	21.24	21.29	**21.45**
		100	0	22.0	21.20	21.30	**21.39**
	16QAM	1	0	22.0	21.65	21.77	21.78
		1	50	22.0	21.68	21.79	21.86
		1	99	22.0	21.69	21.71	21.97
		50	0	21.0	20.19	20.26	20.33
		50	25	21.0	20.20	20.30	20.39
		50	50	21.0	20.20	20.28	20.44
		100	0	21.0	20.20	20.29	20.40

Table 9: Conducted power measurement results of LTE Band VII

7.1.4 Conducted power measurements of WiFi 2.4G

Mode	Channel	Frequency (MHz)	Data Rate (Mbps)	Tune-up	Average Power (dBm)	SAR Test (Yes/No)
802.11b	1	2412	1	18.00	**16.55**	Yes
	6	2437		18.00	**16.60**	Yes
	11	2462		18.00	**16.73**	Yes
802.11g	1	2412	6	16.00	Not Required	No
	6	2437		16.00	Not Required	No
	11	2462		16.00	Not Required	No
802.11n-20M	1	2412	6.5	15.00	Not Required	No
	6	2437		15.00	Not Required	No
	11	2462		15.00	Not Required	No
802.11n-40M	3	2422	13.5	15.00	Not Required	No
	6	2437		15.00	Not Required	No
	9	2452		15.00	Not Required	No

Table 10: Conducted power measurement results of WiFi 2.4G.

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

7.1.5 Conducted power measurements of BT

The output power of BT antenna is as following:

BT 2450	Tune-up	Average Conducted Power (dBm)		
		0CH	39CH	78CH
DH5	8.0	5.12	**6.11**	5.72
2DH5	8.0	4.65	5.50	5.31
3DH5	8.0	4.80	5.62	5.81

BT 2450	Tune-up	Average Conducted Power (dBm)		
		0CH	19CH	39CH
BT 4.0	3.0	-1.32	-1.18	-1.30

Table 11: Conducted power measurement results of BT.

Note: The conducted power of BT 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 KDB648474 D04, SAR is evaluated without a headset connected to the device. When the standalone reported body-worn SAR is ≤1.2 W/kg, no additional SAR evaluations using a headset are required.

6) 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 detailed SAR plots).

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.

2) Per KDB648474 D04, the device does not support DTM function. Body-worn accessory testing is typically associated with voice operations. Therefore, GSM voice was evaluated for body-worn SAR.

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.

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)

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 Head	**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)**	**SAR Plot**
			1-g	**10-g**					
Test data with battery 1#									
Left touch	190/836.6	GSM	0.539	0.413	0.15	32.17	33.50	0.732	/
Left tilt	190/836.6	GSM	0.315	0.219	0.05	32.17	33.50	0.428	/
Right touch	190/836.6	GSM	0.501	0.389	-0.02	32.17	33.50	0.681	Yes
Right tilt	190/836.6	GSM	0.309	0.242	0.03	32.17	33.50	0.420	/
Left touch	128/824.2	GSM	0.455	0.351	0.12	32.09	33.50	0.630	/
Left touch	251/848.8	GSM	**0.580**	0.444	0.08	32.10	33.50	**0.801**	Yes
Tested at the worst position with battery 2#									
Left touch	251/848.8	GSM	0.578	0.442	0.06	32.10	33.50	0.798	/

Table 12: Head SAR test results of GSM850

Test Position of Body-Worn with 15mm	**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)**	**SAR Plot**
			1-g	**10-g**					
Test data with battery 1#									
Front Side	190/836.6	GSM	0.531	0.408	-0.02	32.17	33.50	0.721	/
Back Side	190/836.6	GSM	0.557	0.426	0.01	32.17	33.50	0.757	/
Tested at the worst position with battery 2#									
Back Side	190/836.6	GSM	**0.587**	0.449	-0.02	32.17	33.50	**0.797**	Yes

Table 13: Body-Worn SAR test results of GSM850

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)**	**SAR Plot**
			1-g	**10-g**					
Test data with battery 1#									
Front Side	190/836.6	GPRS 2TS	0.812	0.629	-0.03	31.36	32.50	1.056	/
Front Side	128/824.2	GPRS 2TS	0.704	0.498	0.01	31.35	32.50	0.917	/
Front Side	251/848.8	GPRS 2TS	0.863	0.666	0.04	31.39	32.50	1.114	/
Back Side	190/836.6	GPRS 2TS	1.020	0.721	-0.01	31.36	32.50	1.326	/
Back Side	128/824.2	GPRS 2TS	0.920	0.655	-0.02	31.35	32.50	1.199	/
Back Side	251/848.8	GPRS 2TS	1.120	0.861	-0.03	31.39	32.50	1.446	/
Left Side	190/836.6	GPRS 2TS	0.962	0.667	-0.04	31.36	32.50	1.251	/
Left Side	128/824.2	GPRS 2TS	0.896	0.662	-0.09	31.35	32.50	1.168	/
Left Side	251/848.8	GPRS 2TS	1.040	0.722	-0.06	31.39	32.50	1.343	/
Right Side	190/836.6	GPRS 2TS	0.806	0.545	-0.07	31.36	32.50	1.048	/
Right Side	128/824.2	GPRS 2TS	0.784	0.530	-0.06	31.35	32.50	1.022	/
Right Side	251/848.8	GPRS 2TS	0.836	0.576	-0.05	31.39	32.50	1.079	/
Bottom Side	190/836.6	GPRS 2TS	0.137	0.079	-0.13	31.36	32.50	0.178	/
Tested at the worst position with battery 2#									
Back Side	251/848.8	GPRS 2TS	**1.130**	0.866	-0.05	31.39	32.50	**1.459**	Yes
Back Side-Repeated	251/848.8	GPRS 2TS	1.110	0.850	-0.14	31.39	32.50	1.433	/

Table 14: Hotspot SAR test results of GSM850

7.2.2 SAR measurement Result of GSM1900

Test Position of Head	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)	SAR Plot
			1-g	10-g					
Test data with battery 1#									
Left touch	661/1880	GSM	0.161	0.100	0.02	28.66	30.50	0.246	/
Left tilt	661/1880	GSM	0.139	0.080	0.00	28.66	30.50	0.212	/
Right touch	661/1880	GSM	0.280	0.175	0.05	28.66	30.50	0.428	/
Right tilt	661/1880	GSM	0.154	0.091	-0.03	28.66	30.50	0.235	/
Right touch	512/1850.2	GSM	0.298	0.174	0.15	28.89	30.50	0.432	/
Right touch	810/1909.8	GSM	0.365	0.223	-0.19	28.99	30.50	**0.517**	Yes
Tested at the worst position with battery 2#									
Right touch	810/1909.8	GSM	0.302	0.175	0.04	28.99	30.50	0.428	/

Table 15: Head SAR test results of GSM1900

Test Position of Body-Worn with 15mm	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)	SAR Plot
			1-g	10-g					
Test data with battery 1#									
Front Side	661/1880	GSM	0.146	0.094	-0.13	28.66	30.50	0.223	/
Back Side	661/1880	GSM	0.127	0.081	0.16	28.66	30.50	0.194	/
Tested at the worst position with battery 2#									
Front Side	661/1880	GSM	0.150	0.096	0.18	28.66	30.50	**0.229**	Yes

Table 16: Body-Worn SAR test results 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)	Scaled SAR1-g (W/kg)	SAR Plot
			1-g	10-g					
Test data with battery 1#									
Front Side	661/1880	GPRS 2TS	0.379	0.210	-0.07	27.93	29.50	0.544	/
Back Side	661/1880	GPRS 2TS	0.573	0.285	0.12	27.93	29.50	0.823	/
Back Side	512/1850.2	GPRS 2TS	0.498	0.260	0.19	28.11	29.50	0.686	/
Back Side	810/1909.8	GPRS 2TS	0.706	0.346	0.11	28.29	29.50	**0.933**	Yes
Left Side	661/1880	GPRS 2TS	0.129	0.073	-0.04	27.93	29.50	0.185	/
Right Side	661/1880	GPRS 2TS	0.308	0.179	-0.07	27.93	29.50	0.442	/
Bottom Side	661/1880	GPRS 2TS	0.380	0.212	-0.19	27.93	29.50	0.545	/
Tested at the worst position with battery 2#									
Back Side	810/1909.8	GPRS 2TS	0.567	0.281	0.10	28.29	29.50	0.749	/

Table 17: Hotspot SAR test results of GSM1900

7.2.3 SAR measurement Result of LTE Band VII

Test Position of Head	Test channel / Freq.(MHz)	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Power (dBm)	Scaled $SAR_{1\text{-}g}$ (W/kg)	SAR Plot
			1-g	10-g					
Test data with battery 1#									
1RB									
Left touch	21350/2560	20M QPSK 1RB#99	0.105	0.053	-0.18	22.55	23.00	0.116	/
Left tilt	21350/2560	20M QPSK 1RB#99	0.030	0.017	0.12	22.55	23.00	0.034	/
Right touch	21350/2560	20M QPSK 1RB#99	0.073	0.036	0.14	22.55	23.00	0.081	/
Right tilt	21350/2560	20M QPSK 1RB#99	0.029	0.015	0.14	22.55	23.00	0.032	/
Left touch	20850/2510	20M QPSK 1RB#50	**0.113**	0.061	0.13	22.33	23.00	**0.132**	Yes
Left touch	21100/2535	20M QPSK 1RB#50	0.101	0.053	0.15	22.40	23.00	0.116	/
50%RB									
Left touch	21350/2560	20M QPSK 50%RB#50	0.071	0.036	0.16	21.45	22.00	0.081	/
Left tilt	21350/2560	20M QPSK 50%RB#50	0.026	0.016	0.11	21.45	22.00	0.030	/
Right touch	21350/2560	20M QPSK 50%RB#50	0.094	0.195	0.06	21.45	22.00	0.106	/
Right tilt	21350/2560	20M QPSK 50%RB#50	0.029	0.015	0.15	21.45	22.00	0.033	/
Tested at the worst position with battery 2#									
Left touch	20850/2510	20M QPSK 1RB#50	0.094	0.047	0.19	22.33	23.00	0.109	/

Table 18: Head SAR test results of LTE Band VII

Test Position of Body-Worn with 15mm	Test channel / Freq.(MHz)	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Power (dBm)	Scaled $SAR_{1\text{-}g}$ (W/kg)	SAR Plot
			1-g	10-g					
Test data with battery 1#									
1RB									
Front Side	21350/2560	20M QPSK 1RB#99	0.243	0.130	0.09	22.55	23.00	0.270	/
Back Side	21350/2560	20M QPSK 1RB#99	**0.343**	0.185	0.16	22.55	23.00	**0.380**	Yes
50%RB									
Front Side	21350/2560	20M QPSK 50%RB#50	0.193	0.103	0.14	21.45	22.00	0.219	/
Back Side	21350/2560	20M QPSK 50%RB#50	0.267	0.141	0.17	21.45	22.00	0.303	/
Tested at the worst position with battery 2#									
Back Side	21350/2560	20M QPSK 1RB#99	0.341	0.182	-0.10	22.55	23.00	0.378	/

Table 19: Body-Worn SAR test results 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)	Scaled SAR_{1-g} (W/kg)	SAR Plot
			1-g	10-g					
Test data with battery 1#									
1RB									
Front Side	21350/2560	20M QPSK 1RB#99	0.418	0.209	0.16	22.55	23.00	0.464	/
Back Side	21350/2560	20M QPSK 1RB#99	0.757	0.380	-0.02	22.55	23.00	0.840	/
Back Side	20850/2510	20M QPSK 1RB#50	0.694	0.367	0.18	22.33	23.00	0.810	/
Back Side	21100/2535	20M QPSK 1RB#50	0.753	0.387	-0.01	22.40	23.00	0.865	/
Left Side	21350/2560	20M QPSK 1RB#99	0.140	0.078	0.03	22.55	22.00	0.123	/
Right edge	21350/2560	20M QPSK 1RB#99	0.052	0.029	-0.17	22.55	22.00	0.046	/
Bottom Side	21350/2560	20M QPSK 1RB#99	0.882	0.424	-0.02	22.55	23.00	0.978	/
Bottom Side-Repeated	21350/2560	20M QPSK 1RB#99	**0.889**	0.426	-0.17	22.55	23.00	0.986	Yes
Bottom Side	20850/2510	20M QPSK 1RB#50	0.881	0.437	-0.09	22.33	23.00	**1.028**	/
Bottom Side	21100/2535	20M QPSK 1RB#50	0.873	0.427	-0.19	22.40	23.00	1.002	/
50%RB									
Front Side	21350/2560	20M QPSK 50%RB#50	0.331	0.166	0.17	21.45	22.00	0.376	/
Back Side	21350/2560	20M QPSK 50%RB#50	0.523	0.266	0.18	21.45	22.00	0.594	/
Left Side	21350/2560	20M QPSK 50%RB#50	0.109	0.061	-0.19	21.45	22.00	0.124	/
Right edge	21350/2560	20M QPSK 50%RB#50	0.041	0.023	0.10	21.45	22.00	0.046	/
Bottom Side	21350/2560	20M QPSK 50%RB#50	0.695	0.334	-0.12	21.45	22.00	0.789	/
100%RB									
Back Side	21350/2560	20M QPSK 100%RB#0	0.642	0.325	0.16	21.39	22.00	0.739	/
Bottom Side	21350/2560	20M QPSK 100%RB#0	0.706	0.340	-0.11	21.39	22.00	0.812	/
Tested at the worst position with battery 2#									
Bottom Side	20850/2510	20M QPSK 1RB#50	0.815	0.394	-0.13	22.33	23.00	0.951	/

Table 20: Hotspot SAR test results of LTE Band VII

7.2.4 SAR measurement Result of WiFi 2.4G

Test Position of Head	Test channel / Freq.(MHz)	Test Mode	SAR Value (W/kg) 1-g Area Scan	SAR Value (W/kg) 1-g Zoom Scan	Power Drift (dB)	Conducted Power (dBm)	Tune-up Power (dBm)	Scaled SAR_{1-g} (W/kg)	SAR Plot
Test data with battery 1#									
Left touch	11/2462	802.11 b	0.333	0.346	-0.020	16.73	18.00	0.464	/
Left tilt	11/2462	802.11 b	0.290	0.276	-0.170	16.73	18.00	0.370	/
Right touch	11/2462	802.11 b	0.888	**1.020**	0.170	16.73	18.00	**1.366**	Yes
Right touch Repeated	11/2462	802.11 b	0.881	0.954	-0.090	16.73	18.00	1.278	/
Right tilt	11/2462	802.11 b	0.464	0.569	0.180	16.73	18.00	0.762	/
Right touch	1/2412	802.11 b	0.705	0.815	0.100	16.55	18.00	1.138	/
Tested at the worst position with battery 2#									
Right touch	11/2462	802.11 b	0.830	0.962	-0.120	16.73	18.00	1.289	/

Table 21: Head SAR test results of WiFi 2450MHz

Mode	Tune-up (dBm)	Tune-up (dBm)	Hightest Reported SAR(W/kg)	Adjusted SAR (W/kg)	SAR test
802.11b	18.00	63.10	1.366	/	Yes
802.11g	16.00	39.81	/	0.862	No
802.11n 20M	15.00	31.62	/	0.685	No
802.11n 40M	15.00	31.62	/	0.685	No

Note: Per KDB248227D01, for Head SAR test of WiFi 2.4G,

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

2) As the highest *reported* SAR for DSSS 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.

Test Position of Body-Worn with 15mm	Test channel / Freq.(MHz)	Test Mode	SAR Value (W/kg)		Power Drift (dB)	Conducted Power (dBm)	Tune-up Power (dBm)	Scaled SAR_{1-g} (W/kg)	SAR Plot
			1-g Area Scan	1-g Zoom Scan					
Test data with battery 1#									
Front Side	11/2462	802.11 b	0.064	/	0.120	16.73	18.00	/	/
Back Side	11/2462	802.11 b	0.075	**0.068**	-0.070	16.73	18.00	**0.092**	Yes
Tested at the worst position with battery 2#									
Back Side	11/2462	802.11 b	0.120	0.067	0.160	16.73	18.00	0.089	/

Table 22: Body-Worn SAR test results of WiFi 2450MHz

Mode	Tune-up (dBm)	Tune-up (dBm)	Hightest Reported SAR(W/kg)	Adjusted SAR (W/kg)	SAR test
802.11b	18.00	63.10	0.092	/	Yes
802.11g	16.00	39.81	/	0.058	No
802.11n 20M	15.00	31.62	/	0.046	No
802.11n 40M	15.00	31.62	/	0.046	No

Note: Per KDB248227D01, for Body-worn SAR test of WiFi 2.4G:

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

2) 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.

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 SAR_{1-g} (W/kg)	SAR Plot
			1-g Area Scan	1-g Zoom Scan					
Test data with battery 1#									
Front Side	11/2462	802.11 b	0.186	/	0.060	16.73	18.00	/	/
Back Side	11/2462	802.11 b	0.218	**0.163**	0.150	16.73	18.00	**0.218**	Yes
Left Side	11/2462	802.11 b	0.212	/	-0.080	16.73	18.00	/	/
Top Side	11/2462	802.11 b	0.004	/	-0.010	16.73	18.00	/	/
Tested at the worst position with battery 2#									
Back Side	11/2462	802.11 b	0.179	0.158	-0.190	16.73	18.00	0.212	/

Table 23: Hotspot SAR test results of WiFi 2450MHz

Mode	Tune-up (dBm)	Tune-up (dBm)	Hightest Reported SAR(W/kg)	Adjusted SAR (W/kg)	SAR test
802.11b	18.00	63.10	0.218	/	Yes
802.11g	16.00	39.81	/	0.138	No
802.11n 20M	15.00	31.62	/	0.109	No
802.11n 40M	15.00	31.62	/	0.109	No

Note: Per KDB248227D01, for Hotspot SAR test of WiFi 2.4G:

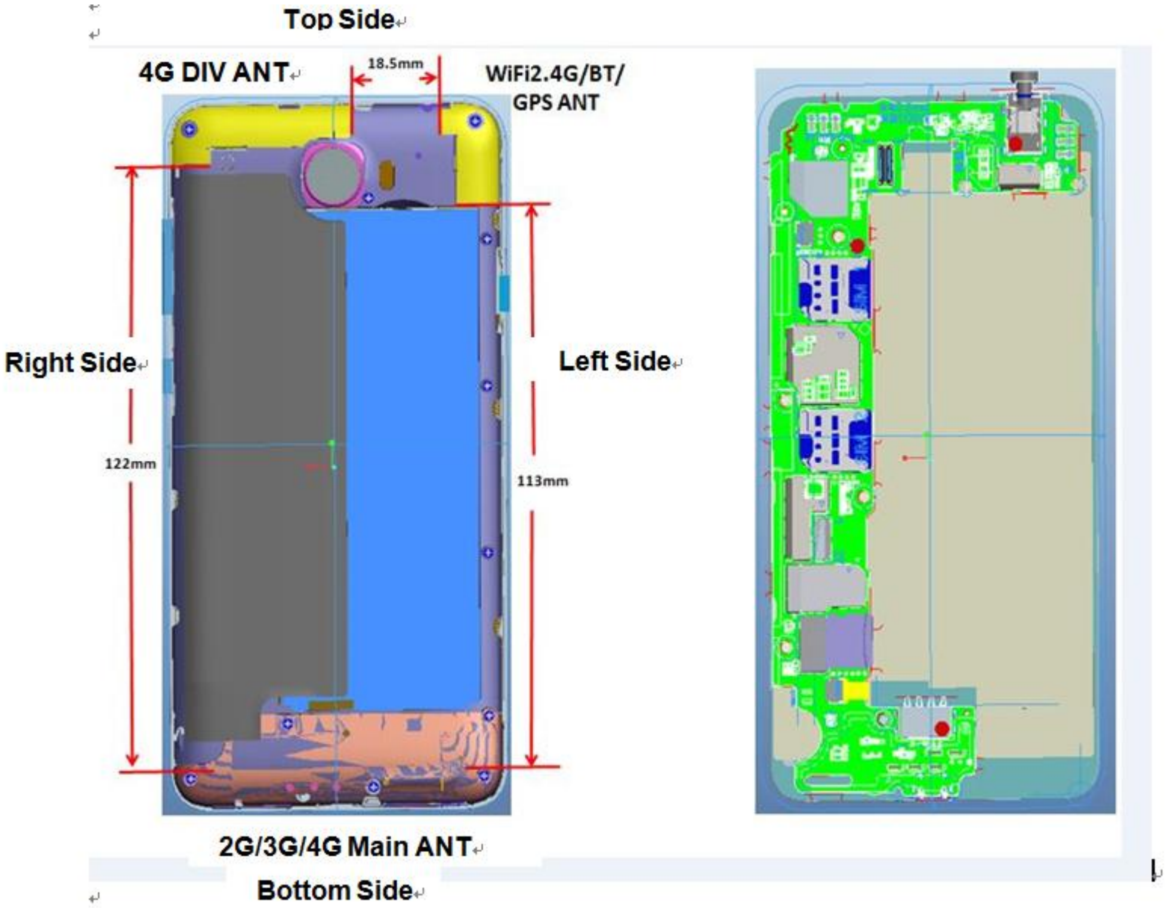
1) SAR is measured for 2.4 GHz 802.11b DSSS using the initial test position procedure.

2) As the highest *reported* SAR for DSSS 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.

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 v06.

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



Mode	Exposure Condition	Front Side	Back Side	Left Side	Right Side	Top Side	Bottom Side
Main antenna	Hotspot	Yes	Yes	Yes	Yes	No	Yes
WiFi 2.4G antenna	Hotspot	Yes	Yes	Yes	No	Yes	No

Table 24: Sides for Hotspot SAR testing

Note:

1)The Diversity antenna does not support Tx function.

2) Per KDB 941225 D06 and KDB 648474 D04, particular DUT edges were not required to be evaluated for Hotspot SAR if the antenna-to-edge distance is greater than 2.5cm.

7.3.1 Stand-alone SAR test exclusion

Per FCC KDB 447498D01v06

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

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

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

When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion.

Mode	Position	P_{max} (dBm)*	P_{max} (mW)	Distance (mm)	f (GHz)	Calculation Result	SAR Exclusion threshold	SAR test exclusion
BT	Body-Worn	8.00	6.31	15	2.480	0.66	3.00	Yes

Table 25: Standalone SAR test exclusion for BT

Note:

1)* - maximum possible output power declared by manufacturer

2) Held to ear configurations are not applicable to Bluetooth for this device.

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

(max. power of channel, including tune-up tolerance, mW)/(min. test separation distance, mm)] •

[√f(GHz)/x] W/kg for test separation distances ⩽ 50 mm,where x = 7.5 for 1-g SAR and x = 18.75 for 10-g SAR.

When the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion

Mode	Position	P_{max} (dBm)*	P_{max} (mW)	Distance (mm)	f (GHz)	X	Estimated SAR (W/Kg)*
BT	Body-worn	8.00	6.31	15	2.480	7.50	0.088

Table 26: Estimated SAR calculation for BT

Note:

1) * - maximum possible output power declared by manufacturer

2) Held to ear configurations are not applicable to Bluetooth and therefore were not considered for simultaneous transmission.

7.3.2 Simultaneous Transmission Possibilities

The Simultaneous Transmission Possibilities of this device are as below:

No.	Configuration	Head	Body-worn	Hotspot
1	GSM(Voice) + BT	No	Yes	No
2	GSM(Data) + BT	No	No	No
3	GSM(Voice)+ WiFi 2.4G	Yes	Yes	No
4	GSM(Data) + WiFi 2.4G	No	No	Yes
5	LTE(Data)* + BT	No	Yes	No
6	LTE(Data)* + WiFi 2.4G	Yes	Yes	Yes

Table 27: Simultaneous Transmission Possibilities

Note:

1) WiFi 2.4G and BT can't transmit simultaneously.

2) The device does not support VoLTE or WiFi VOIP function.

3) The device does not support DTM function. Body-worn accessory testing is typically associated with voice operations. Therefore, GSM voice was evaluated for body-worn SAR.

4) Held to ear configurations are not applicable to Bluetooth for this device.

5) * VOIP 3rd party applications may possibly be installed and used by the end user.

7.3.3 SAR Summation Scenario

Test Position		Main antenna SAR_{Max}			WiFi/BT antenna SAR_{Max}		Σ1-g SAR (1.6W/kg Limit)	SPLSR	Volume scan
		GSM850	GSM1900	LTE Band VII	WiFi 2.4G	BT			
Head	Left touch	0.801	0.246	0.132	0.464	/	1.264	N/A	N/A
	Left tilt	0.428	0.212	0.034	0.370	/	0.798	N/A	N/A
	Right touch	0.681	0.517	0.106	1.366	/	2.047	See 7.3.4	See 7.3.5
	Right tilt	0.420	0.235	0.033	0.762	/	1.182	N/A	N/A
Body-worn	Front side	0.721	0.229	0.270	0.092	0.088	0.813	N/A	N/A
	Back side	0.797	0.194	0.380	0.092	0.088	0.889	N/A	N/A
Hotspot 10mm	Front side	1.114	0.544	0.464	0.218	/	1.333	N/A	N/A
	Back side	1.459	0.933	0.865	0.218	/	1.677	See 7.3.4	N/A
	Left side	1.343	0.185	0.124	0.218	/	**1.561**	N/A	N/A
	Right side	1.079	0.442	0.046	/	/	1.079	N/A	N/A
	Top side	/	/	/	0.218	/	0.218	N/A	N/A
	Bottom side	0.178	0.545	1.028	/	/	1.028	N/A	N/A

Table 28: SAR Simultaneous Tx Combination of Main antenna and WiFi/BT.

Test Position	Main antenna SAR_{Max}			WiFi/BT antenna SAR_{Max}	Σ1-g SAR (1.6W/kg Limit)	SPLSR	Volume scan
	GSM850	GSM1900	LTE Band VII	WiFi 2.4G			
Right touch	0.681	/	/	1.366	2.047	0.045	See 7.3.5
	/	0.517	/	1.366	1.883	0.031	Not Required
	/	/	0.081	1.366	1.447	N/A	Not Required
Back side 10mm	1.459	/	/	0.218	1.677	0.036	Not Required
	/	0.933	/	0.218	1.151	N/A	Not Required
	/	/	0.865	0.218	1.083	N/A	Not Required

Table 29: SAR Simultaneous Tx Combination of Main Antenna and WiFi 2.4G

7.3.4 SPLSR Evaluation Analysis

According to KDB447498 D01v06, When the sum of SAR is larger than the limit, SAR test exclusion is determined by the SAR to peak location separation ratio(SPLSR).When the SAR to peak location ratio for each pair of antennas is ≤1-g 0.04 and 10-g 0.10， simultaneous SAR evaluation is not required. When SAR is measured for both antennas in the pair, the peak location separation distance is computed by the following fomula:

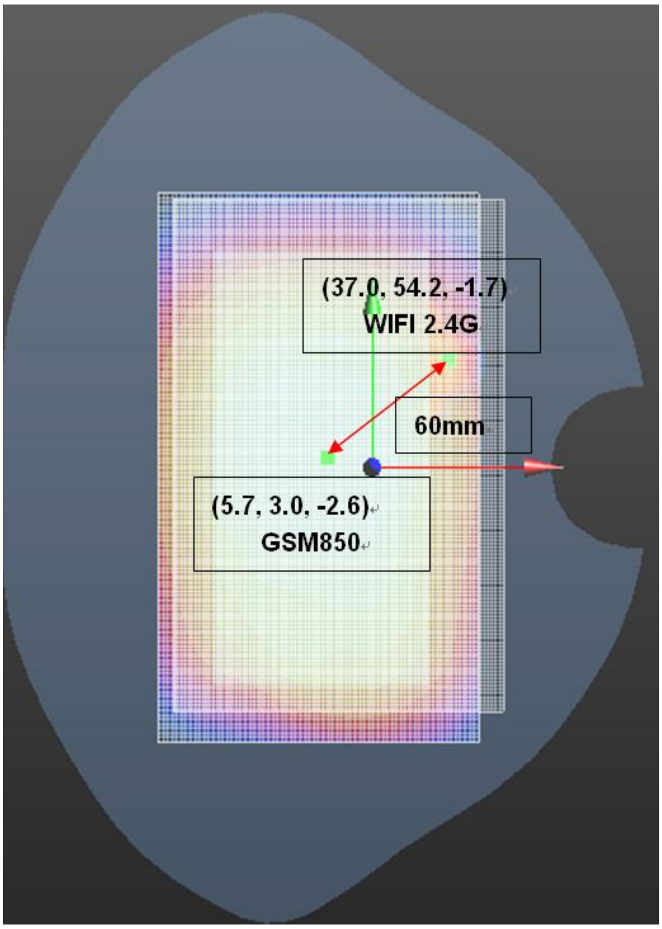
$$\text{Distance}_{Tx1\text{-}Tx2} = R_i = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2 + (z_1 - z_2)^2}$$

$$\text{SPLS Ratio} = (SAR_1 + SAR_2)^{1.5}/R_i$$

When standalone test exclusion applies, SAR is estimated; the peak location is assumed to be at the feed-point or geometric center of the antenna.

1) The sum of aggregate 1-g SAR was above 1.6W/kg for Back side 10mm configuration with GSM850 and WiFi 2.4G.

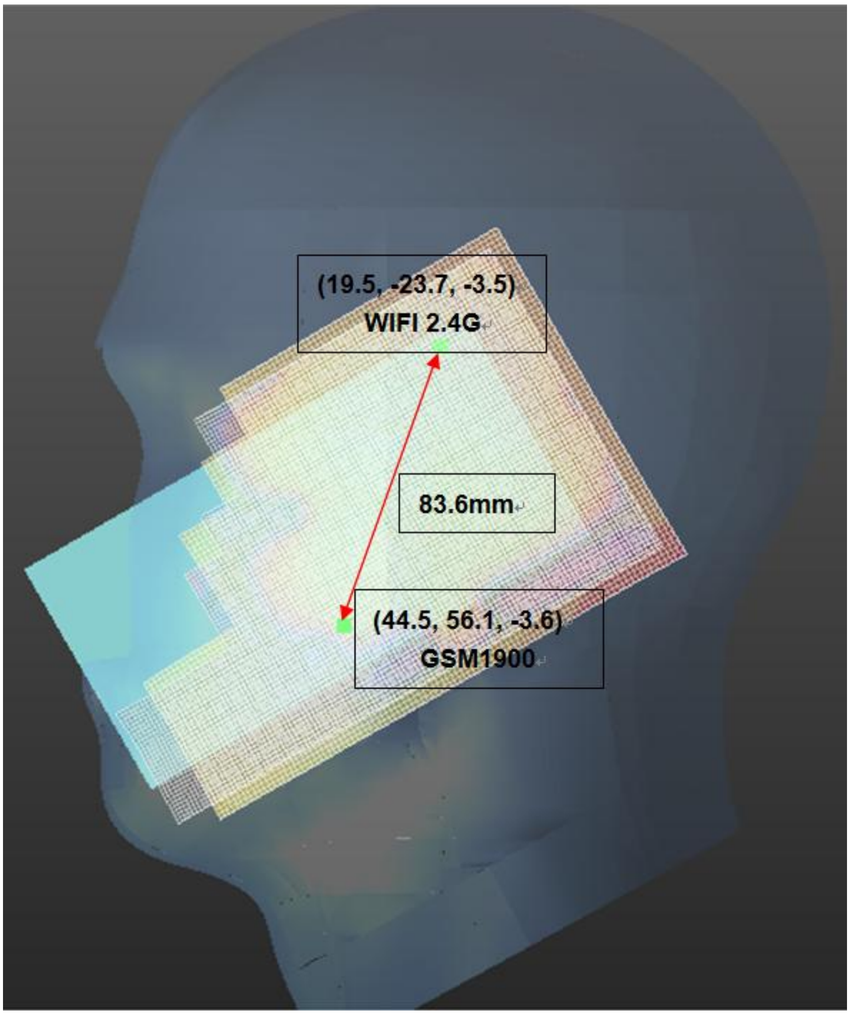
   The Peak SAR location plot is as below:



The SAR to peak location ratio calculation is as below:

Test Position	GSM850 (W/kg)	WIFI 2.4G (W/kg)	Ri(mm)	SPLSR	Ratio Limit	Simultaneous SAR
Back side 10mm	1.459	0.218	60.0	0.036	0.04	Not required

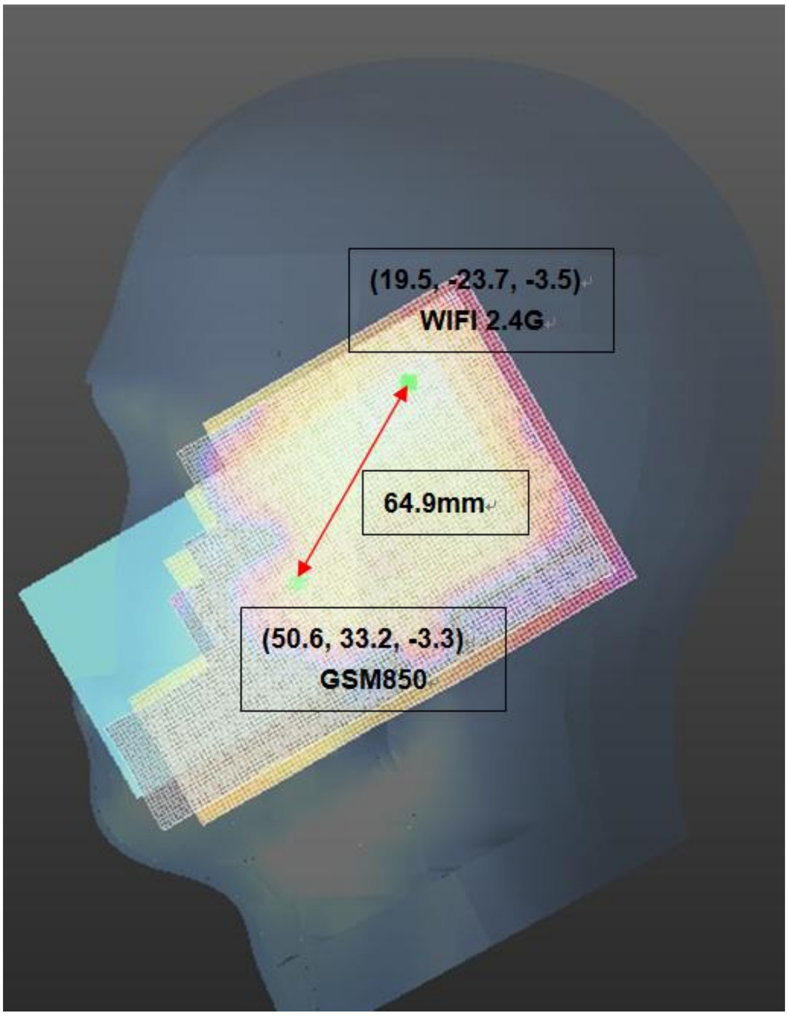
2) The sum of aggregate 1-g SAR was above 1.6W/kg for Right touch configuration with GSM1900 and WiFi 2.4G.
   The Peak SAR location plot is as below:



The SAR to peak location ratio calculation is as below:

Test Position	GSM1900 (W/kg)	WIFI 2.4G (W/kg)	Ri(mm)	SPLSR	Ratio Limit	Simultaneous SAR
Right touch	0.517	1.366	83.6	0.031	0.04	Not required

3) The sum of aggregate 1-g SAR was above 1.6W/kg for Right touch configuration with GSM850 and WiFi 2.4G.
   The Peak SAR location plot is as below:



The SAR to peak location ratio calculation is as below:

Test Position	GSM850 (W/kg)	WIFI 2.4G (W/kg)	Ri(mm)	SPLSR	Ratio Limit	Simultaneous SAR
Right touch	0.681	1.366	64.9	0.045	0.04	Required

Per KDB447498D01, Simultaneous transmission SAR measurement is required for Right touch configuration of GSM850 and WiFi 2.4G.

7.3.5 Volume Scan Simultaneous Transmission SAR test

Per KDB447498D01, the antennas in all antenna pairs that do not qualify for simultaneous transmission SAR test exclusion must be tested for SAR compliance, according to the enlarged zoom scan and volume scan post-processing procedures in KDB Publication 865664 D01. SAR plots for the enlarged zoom scans and post-processed volume scan, showing the peak SAR locations, are also provided in the SAR report and appendix to support the measurement configurations per KDB Publication 865664 D02:
The volume scan is used for assess overlapping SAR distributions for antennas transmitting in different frequency bands. It is equivalent to an oversized zoom scan used in standalone measurements. The measurement volume will be used to enclose all simultaneous transmitting antennas. For antennas transmitting simultaneously in different frequency bands, the volume scan is measured separately in each frequency band. In order to sum correctly to compute the 1g aggregate SAR, the EUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing. When all volume scan were completed, the DASY software, SEMCAD postprocessor can combine and subsequently superpose these measurement data to calculating the multiband SAR.
Per KDB865664D01, the entire SAR distribution in the enlarged zoom scan should be scaled before applying the volume scan post-processing procedures to determine the aggregate SAR distribution and 1-g SAR. For SPEAG DASY SAR test system, the scaling factor can be directly input into the SEMCAD test software and be applied to the measured points in the enlarged zoom scan before interpolation and extrapolation.

7.3.5.1 Enlarged zoom scan measurement

The enlarged zoom scan measurement procedures in KDB865664 are implemented in the same SAR system:
1) A larger measurement volume is used to enclose all antennas and radiating structures of the test device.
2) The most stringent and conservative spatial resolution required for measurement, interpolation and extrapolation is applied to all the enlarged zoom scans.
3) The tested device is fixed on the phantom when the liquids are changed so that the summation of the SAR distributions is as accurate as possible.
3) If the battery of the device needs to be recharged, the charger cable is attached to the DUT when it remains positioned on the phantom.

7.3.5.2 Volume scan post-processing procedure

The volume scan post-processing procedure is applied to assessing the multi-band SAR.
The entire SAR distribution in the enlarged zoom scan is scaled before applying the volume scan post-processing procedures to determine the aggregate SAR distribution and 1-g SAR. For SPEAG DASY5 SAR test system, the scaling factor can be directly input into the SEMCAD test software and be applied to the measured points in the enlarged zoom scan before interpolation and extrapolation(See the figure below):

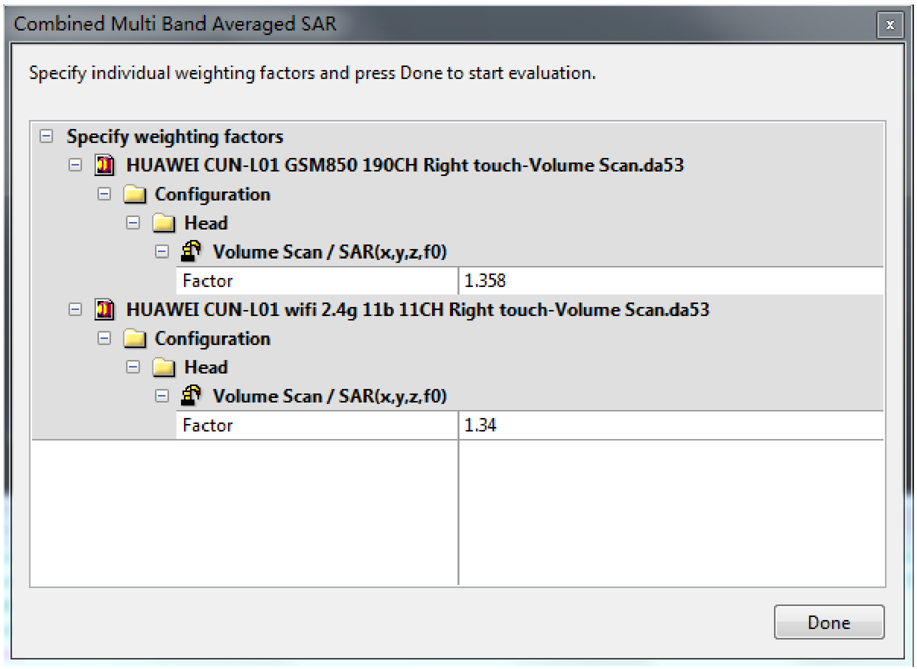


Figure : the scaling factor for Volume scan (DASY system)

Then the Multi Band simultaneous transmission SAR Result is obtained as below:

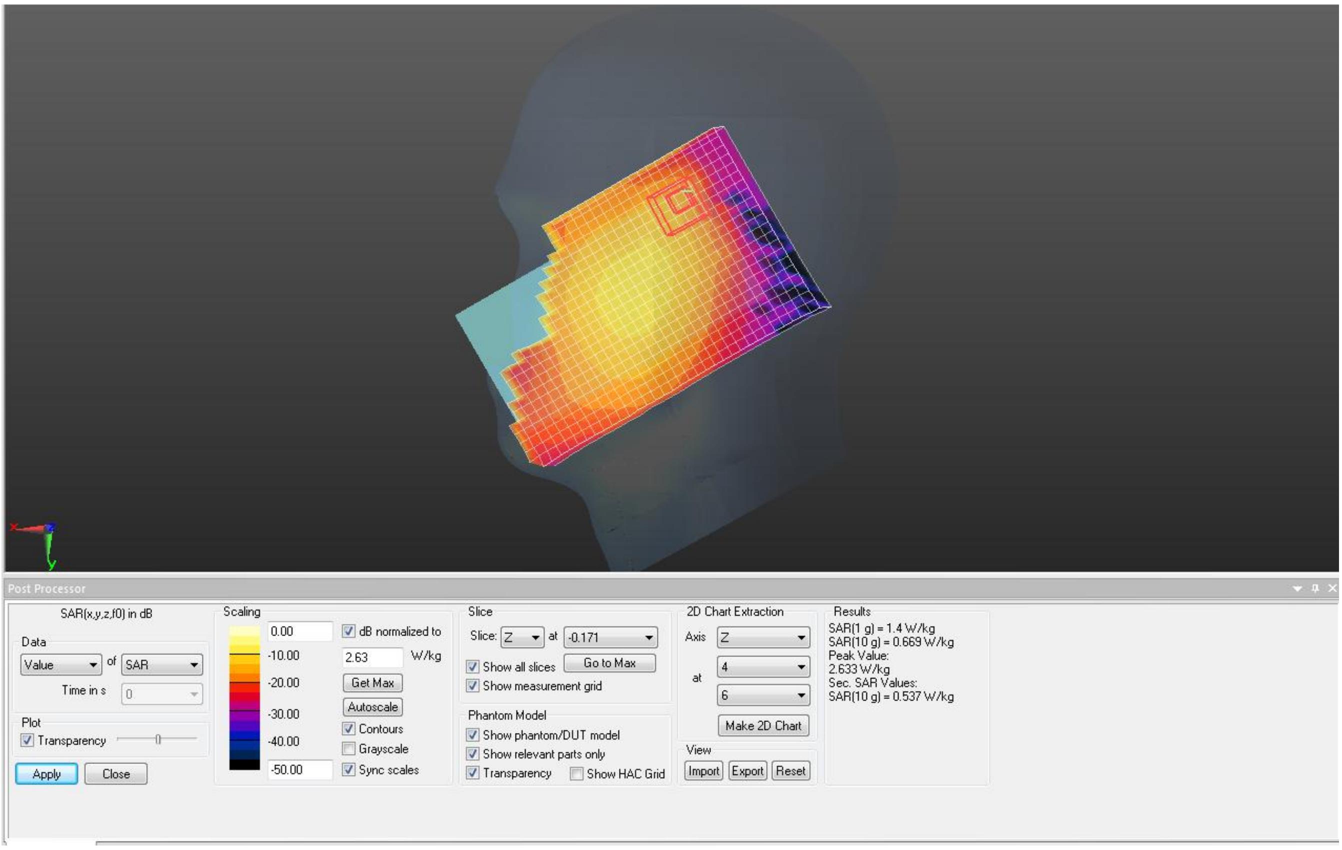


Figure : The volume scan simultaneous transmission SAR test result

So the Volume scan simultaneous transmission SAR for Right touch configuration with GSM850 and WiFi 2.4G is as below.

Band	Test Position	Test channel /Freq.(MHz)	Test Mode	Volum scan Measured 1-g SAR (W/kg)	Scaling factor	Multi Band scaled 1g simultaneous transmission SAR(W/kg)	Limit (W/kg)	Note
GSM 850	Right Hand Touched	190/836.6	GSM	0.465	1.358	**1.400**	1.6	Pass
2.4G WiFi	Right Hand Touched	11/2462	802.11 b	1.010	1.340			

Table 30: Volume scan simultaneous transmission SAR test results

7.3.6 Simultaneous Transmission Conlcusion

The above volume scan Simultaneous Transmission SAR is sufficient to determine that simultaneous transmission cases will not exceed the SAR limit per KDB 447498 D01v06.

Appendix A. System Check Plots

(Pls See Appendix A.)

Appendix B. SAR Measurement Plots

(Pls See Appendix B.)

Appendix C. Calibration Certificate

(Pls See Appendix C.)

Appendix D. Photo documentation

(Pls See Appendix D.)

End