

FCC SAR Test Report

FCC ID: PPD-QCNFA425

Report No. : BTL-FCC SAR-1-2102T061
Equipment : Single Stream 802.11a/b/g/n/ac + BT 4.1 M.2 1216 Type Card
Model Name : QCNFA425
Brand Name : Qualcomm Atheros
Applicant : Qualcomm Atheros, Inc.
Address : 1700 Technology Dr, San Jose, California 95110, United States
Date of Receipt : February. 8, 2021
Date of Test : February. 20, 2021 ~ March. 12, 2021
Issued Date : May. 27, 2021

The above equipment has been tested and found in compliance with the requirement of the above standards by BTL Inc.

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Declaration

BTL represents to the client that testing is done in accordance with standard procedures as applicable and that test instruments used has been calibrated with standards traceable to international standard(s) and/or national standard(s).

BTL's reports apply only to the specific samples tested under conditions. It is manufacture's responsibility to ensure that additional production units of this model are manufactured with the identical electrical and mechanical components. **BTL** shall have no liability for any declarations, inferences or generalizations drawn by the client or others from **BTL** issued reports.

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BTL's laboratory quality assurance procedures are in compliance with the **ISO/IEC 17025** requirements, and accredited by the conformity assessment authorities listed in this test report.

BTL is not responsible for the sampling stage, so the results only apply to the sample as received.

The information, data and test plan are provided by manufacturer which may affect the validity of results, so it is manufacturer's responsibility to ensure that the apparatus meets the essential requirements of applied standards and in all the possible configurations as representative of its intended use.

Limitation

For the use of the authority's logo is limited unless the Test Standard(s)/Scope(s)/Item(s) mentioned in this test report is (are) included in the conformity assessment authorities acceptance respective.

Please note that the measurement uncertainty is provided for informational purpose only and are not use in determining the Pass/Fail results.

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REPORT ISSUED HISTORY

Report Version	Description	Issued Date
R00	Original Issue.	2021/4/15
R01	Revised TCB command	2021/5/8
R02	Revised TCB command	2021/5/21
R03	Revised TCB command	2021/5/27

1. GENERAL INFORMATION

1.1. GENERAL DESCRIPTION OF EUT

Equipment	Single Stream 802.11a/b/g/n/ac + BT 4.1 M.2 1216 Type Card	
Brand Name	Qualcomm Atheros	
Model Name	QCNFA425	
Battery Information	Brand:dynabook Model:4588105-2S Rating:7.6V / 6000mAh / 45.6Wh	
Host	dynabook/ SATELLITE PRO C40-H	
Series Model	SATELLITE PRO C50-H, SATELLITE PRO C40-G, SATELLITE PRO C50-G	
Frequency Range	WLAN 2.4 GHz Band:	2400 MHz ~ 2483.5 MHz
	RLAN 5 GHz Band:	5150 MHz ~ 5250 MHz 5250 MHz ~ 5350 MHz 5470 MHz ~ 5725 MHz 5725 MHz ~ 5850 MHz
	Bluetooth:	2400 MHz ~ 2483.5 MHz
Standard(s)	KDB447498 D01 General RF Exposure Guidance v06 KDB248227 D01 802.11 Wi-Fi SAR v02r02 KDB865664 D01 SAR measurement 100 MHz to 6 GHz v01r04 KDB865664 D02 SAR Reporting v01r02 KDB616217 D04 SAR for laptop and Tablets ANSI Std C95.1:2019 Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz – 300 GHz.	

The above equipment has been tested and found compliance with the requirement of the relative standards by BTL Inc.

The test data, data evaluation, and equipment configuration contained in our test report (Ref No. BTL-FCC SAR-1-2102T061) were obtained utilizing the test procedures, test instruments, test sites that has been accredited by the Authority of TAF according to the ISO-17025 quality assessment standard and technical standard(s).

2. RF EMISSIONS MEASUREMENT

2.1. TEST FACILITY

The test facilities used to collect the test data in this report is **SAR Test room** at the location of No. 68-1, Ln. 169, Sec.2, Datong Rd., Xizhi Dist., New Taipei City 221, Taiwan.

2.2. MEASUREMENT UNCERTAINTY

Uncertainty Budget for Frequency range of 300 MHz to 3 GHz

Error Description	Uncertainty Value (\pm %)		Probability Distribution	Divisor	C _i (1g)	C _i (10g)	Standard Uncertainty (1g)	Standard Uncertainty (10g)	V _i V _{eff}
Measurement System									
Probe Calibration	6.05		Normal	1	1	1	± 6.05 %	± 6.05 %	∞
Axial Isotropy	4.7		Rectangular	$\sqrt{3}$	0.7	0.7	± 1.9 %	± 1.9 %	∞
Hemispherical Isotropy	9.6		Rectangular	$\sqrt{3}$	0.7	0.7	± 3.9 %	± 3.9 %	∞
Boundary Effects	1		Rectangular	$\sqrt{3}$	1	1	± 0.6 %	± 0.6 %	∞
Linearity	4.7		Rectangular	$\sqrt{3}$	1	1	± 2.7 %	± 2.7 %	∞
Detection Limits	1		Rectangular	$\sqrt{3}$	1	1	± 0.6 %	± 0.6 %	∞
Modulation response	2.4		Rectangular	$\sqrt{3}$	1	1	± 1.4 %	± 1.4 %	∞
Readout Electronics	0.3		Normal	1	1	1	± 0.3 %	± 0.3 %	∞
Response Time	0.8		Rectangular	$\sqrt{3}$	1	1	± 0.5 %	± 0.5 %	∞
Integration Time	2.6		Rectangular	$\sqrt{3}$	1	1	± 1.5 %	± 1.5 %	∞
RF Ambient – Noise	3		Rectangular	$\sqrt{3}$	1	1	± 1.7 %	± 1.7 %	∞
RF Ambient– Reflections	3		Rectangular	$\sqrt{3}$	1	1	± 1.7 %	± 1.7 %	∞
Probe Positioner	0.4		Rectangular	$\sqrt{3}$	1	1	± 0.2 %	± 0.2 %	∞
Probe Positioning	2.9		Rectangular	$\sqrt{3}$	1	1	± 1.7 %	± 1.7 %	∞
Post-processing	4		Rectangular	$\sqrt{3}$	1	1	± 2.3 %	± 2.3 %	∞
Max.SAR Evaluation	2		Rectangular	$\sqrt{3}$	1	1	± 1.15 %	± 1.15 %	∞
Test Sample Related									
Device Positioning	1.6	1.8	Normal	1	1	1	± 1.6 %	± 1.8 %	145
Device Holder	1.5	1.7	Normal	1	1	1	± 1.5 %	± 1.7 %	5
Power Drift	5.0		Rectangular	$\sqrt{3}$	1	1	± 2.9 %	± 2.9 %	∞
Phantom and Setup									
Phantom Production Tolerances	6.1		Rectangular	$\sqrt{3}$	1	1	3.52	3.52	∞
SAR correction	1.9		Rectangular	$\sqrt{3}$	1	0.84	1.10	1.10	
Liquid Conductivity (mea.)	2.4		Rectangular	$\sqrt{3}$	0.78	0.71	1.08	1.08	∞
Liquid Permittivity (mea.)	2.4		Rectangular	$\sqrt{3}$	0.26	0.26	0.36	0.36	∞
Temp. unc. - Conductivity	3.4		Rectangular	$\sqrt{3}$	0.78	0.71	1.53	1.53	∞
Temp. unc. - Permittivity	0.4		Rectangular	$\sqrt{3}$	0.23	0.26	0.05	0.05	∞
Combined Standard Uncertainty (K = 1)							± 10.42 %	± 10.48 %	361
Expanded Uncertainty (K = 2)							± 20.84 %	± 20.97 %	

Uncertainty Budget for Frequency range of 3 GHz to 6 GHz

Error Description	Uncertainty Value (± %)		Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (1g)	Standard Uncertainty (10g)	Vi V _{eff}
Measurement System									
Probe Calibration	6.65		Normal	1	1	1	± 6.65 %	± 6.65 %	∞
Axial Isotropy	4.7		Rectangular	$\sqrt{3}$	0.7	0.7	± 1.9 %	± 1.9 %	∞
Hemispherical Isotropy	9.6		Rectangular	$\sqrt{3}$	0.7	0.7	± 3.9 %	± 3.9 %	∞
Boundary Effects	2		Rectangular	$\sqrt{3}$	1	1	± 1.2 %	± 1.2 %	∞
Linearity	4.7		Rectangular	$\sqrt{3}$	1	1	± 2.7 %	± 2.7 %	∞
Detection Limits	1		Rectangular	$\sqrt{3}$	1	1	± 0.6 %	± 0.6 %	∞
Modulation response	2.4		Rectangular	$\sqrt{3}$	1	1	± 1.4 %	± 1.4 %	∞
Readout Electronics	0.3		Normal	1	1	1	± 0.3 %	± 0.3 %	∞
Response Time	0.8		Rectangular	$\sqrt{3}$	1	1	± 0.5 %	± 0.5 %	∞
Integration Time	2.6		Rectangular	$\sqrt{3}$	1	1	± 1.5 %	± 1.5 %	∞
RF Ambient – Noise	3		Rectangular	$\sqrt{3}$	1	1	± 1.7 %	± 1.7 %	∞
RF Ambient– Reflections	3		Rectangular	$\sqrt{3}$	1	1	± 1.7 %	± 1.7 %	∞
Probe Positioner	0.4		Rectangular	$\sqrt{3}$	1	1	± 0.2 %	± 0.2 %	∞
Probe Positioning	6.7		Rectangular	$\sqrt{3}$	1	1	± 3.9 %	± 3.9 %	∞
Post-processing	4		Rectangular	$\sqrt{3}$	1	1	± 2.3 %	± 2.3 %	∞
Max.SAR Evaluation	4		Rectangular	$\sqrt{3}$	1	1	± 2.3 %	± 2.3 %	∞
Test Sample Related									
Device Positioning	1.6	1.8	Normal	1	1	1	± 1.6 %	± 1.8 %	145
Device Holder	1.5	1.7	Normal	1	1	1	± 1.5 %	± 1.7 %	5
Power Drift	5.0		Rectangular	$\sqrt{3}$	1	1	± 2.9 %	± 2.9 %	∞
Phantom and Setup									
Phantom Production Tolerances	6.6		Rectangular	$\sqrt{3}$	1	1	3.81	3.81	∞
SAR correction	1.9		Rectangular	$\sqrt{3}$	1	0.84	1.10	0.92	
Liquid Conductivity (mea.)	2.4		Rectangular	$\sqrt{3}$	0.78	0.71	1.08	0.98	∞
Liquid Permittivity (mea.)	2.4		Rectangular	$\sqrt{3}$	0.26	0.26	0.36	0.36	∞
Temp. unc. - Conductivity	3.4		Rectangular	$\sqrt{3}$	0.78	0.71	1.53	1.39	∞
Temp. unc. - Permittivity	0.4		Rectangular	$\sqrt{3}$	0.23	0.26	0.05	0.06	∞
Combined Standard Uncertainty (K = 1)							± 11.65 %	± 11.66 %	361
Expanded Uncertainty (K = 2)							± 23.29 %	± 23.33 %	

2.3 WLAN ANTENNA INFORMATION:

Antenna SPEC-SLEingB219790280 374

Ant.	Brand	Model	Type	Frequency Range (MHz)	Gain (dBi)
Main	SLEing	SLEingB219790280	Folded Dipole	2400-2500	1.22
				5150-5250	1.74
				5250-5350	1.72
				5470-5725	1.30
				5725-5850	1.84
Aux	SLEing	SLEingB219790374	Folded Dipole	2400-2500	1.74
				5150-5250	1.36
				5250-5350	1.57
				5470-5725	1.37
				5725-5850	1.62

Antenna SPEC-SLEingB219790388 491

Ant.	Brand	Model	Type	Frequency Range (MHz)	Gain (dBi)
Main	SLEing	SLEingB219790388	Folded Dipole	2400-2500	0.84
				5150-5250	1.69
				5250-5350	1.24
				5470-5725	1.72
				5725-5850	1.54
Aux	SLEing	SLEingB219790491	Folded Dipole	2400-2500	1.64
				5150-5250	-0.91
				5250-5350	-0.91
				5470-5725	1.85
				5725-5850	1.85

2.4 THE MAXIMUM SAR 1G VALUES

Band	Mode	Highest Body Reported SAR-1g(W/kg)
DTS	Wi-Fi 2.4G	1.091
UNII	Wi-Fi 5.2 & 5.3G	1.285
	Wi-Fi 5.6G	1.397
	Wi-Fi 5.8G	1.379

Note:

- 1) The device is in compliance with Specific Absorption Rate(SAR)for general population uncontrolled exposure limits according to the FCC rule §2.1093, the ANSI C95.1:2019/IEEE C95.1:2019, the NCRP Report Number 86 for uncontrolled environment and had been tested in accordance with the measurement methods and procedures specified in IEEE Std 1528-2013 .

2.5 LABORATORY ENVIRONMENT

Temperature	Min. = 18°C, Max. = 25°C
Relative humidity	Min. = 30%, Max. = 70%
Ground system resistance	< 0.5Ω
Ambient noise is checked and found very low and in compliance with requirement of standards. Reflection of surrounding objects is minimized and in compliance with requirement of standards.	

2.6 MAIN TEST INSTRUMENTS

Item	Equipment	Manufacturer	Model	Serial No.	Cal. Date	Cal. Interval
1	Data Acquisition Electronics	Speag	DAE4	1486	June. 04, 2020	1 Year
2	E-field Probe	Speag	EX3DV4	7369	May. 29, 2020	1 Year
3	System Validation Dipole	Speag	D2450V2	973	Sep. 21, 2018	3 Year
4	System Validation Dipole	Speag	D5GHzV2	1221	Sep. 28, 2018	3 Year
5	ELI4 Phantom	Speag	ELI4 Phantom V5.0	1240	N/A	N/A
6	ENA Network Analyzer	Agilent	E5071C	MY46524658	Apr. 07, 2020	1 Year
7	EXG Vector Signal Generator	Agilent	N5172B	MY53051229	Jun. 20, 2020	1 Year
8	Spectrum Analyzer	Keysight	N9010A	MY54200240	Jun. 11, 2020	1 Year
9	Power Meter	Anritsu	ML2495A	1128008	Jun. 11, 2020	1 Year
10	Power Sensor	Anritsu	MA2411B	1126001	Jun. 11, 2020	1 Year
11	Dielectric Probe Kit	Agilent	85070E	2593	N/A	N/A
12	Low pass filter	Mini-Circuits	SLP-2950+	M108294	N/A	N/A
13	Power Amplifier	Mini-Circuits	ZVE-2W-272+	N650001538	N/A	N/A
14	Power Amplifier	Mini-Circuits	ZVE-8G+	N628801631	N/A	N/A
15	Thermometer	PA	O-230PK	N/A	Apr. 09, 2020	1 Year

Remark: "N/A" denotes no model name, serial No. or calibration specified.

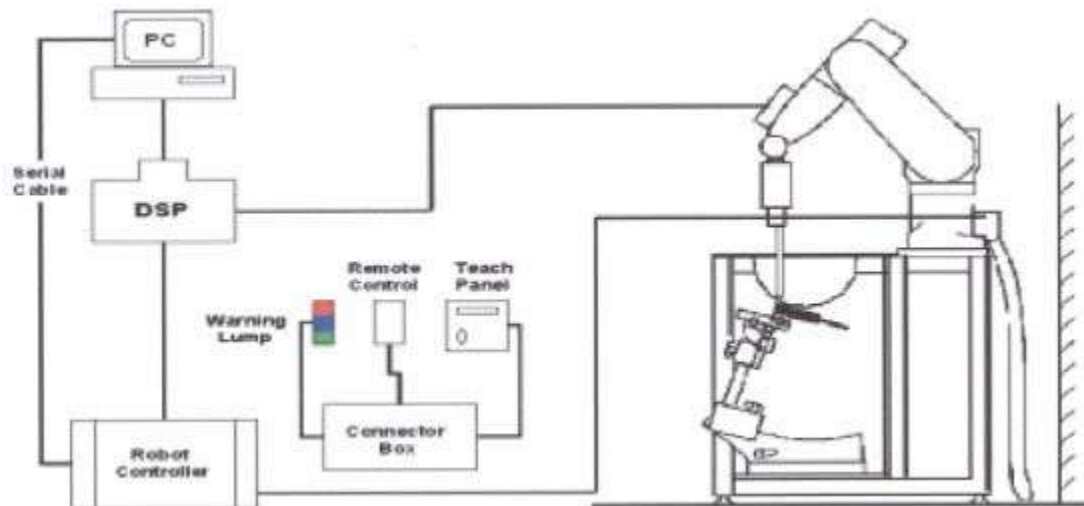
3. SAR MEASUREMENTS SYSTEM CONFIGURATION

3.1. SAR MEASUREMENT SET-UP

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

1. A standard high precision 6-axis robot (Stäubli RX family) with controller and software. An arm extension for accommodating the data acquisition electronics (DAE).
2. 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.
3. 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.
4. A unit to operate the optical surface detector which is connected to the EOC.
5. 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.
6. 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.
8. Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.
9. The generic twin phantom enabling the testing of left-hand and right-hand usage.
10. The device holder for handheld mobile phones.
11. Tissue simulating liquid mixed according to the given recipes.
12. System validation dipoles allowing to validate the proper functioning of the system.

3.1.1. TEST SETUP LAYOUT

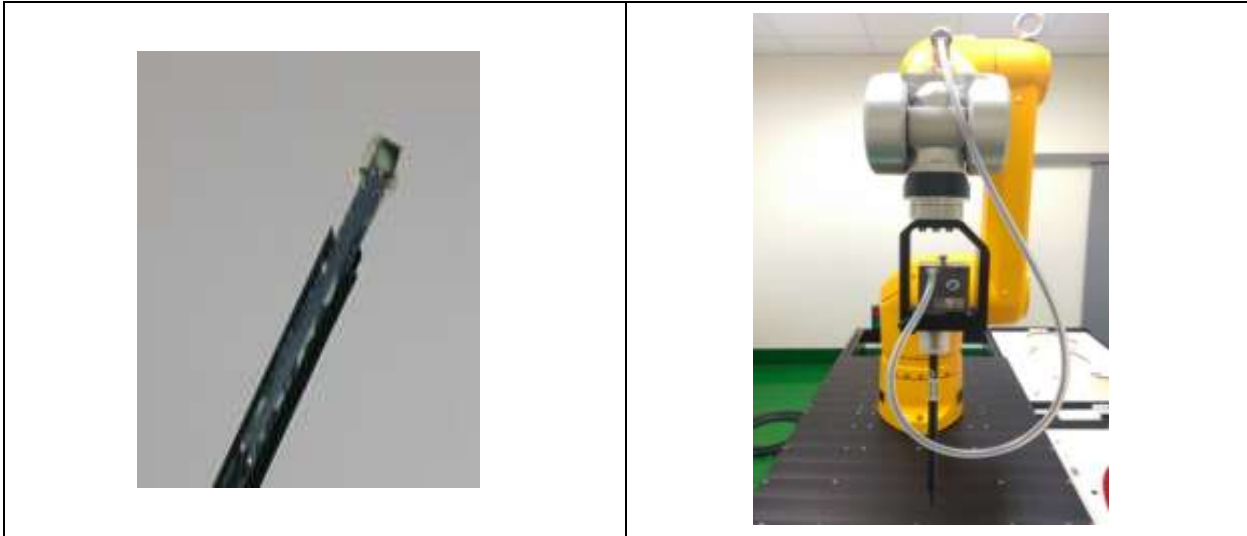


3.2. DASY5 E-FIELD PROBE SYSTEM

The SAR measurements were conducted with the dosimetric probe EX3DV4 (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation.

3.2.1. EX3DV4 PROBE SPECIFICATION

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 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 μ W/g to > 100 mW/g Linearity: ± 0.2 dB
Dimensions	Overall length: 330 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Distance from probe tip to dipole centers: 1.0 mm



EX3DV4 E-field Probe

3.2.2. E-FIELD PROBE CALIBRATION

Each probe is calibrated according to a dosimetric assessment procedure with accuracy better than $\pm 10\%$. The spherical isotropy was evaluated and found to be better than $\pm 0.25\text{dB}$. The sensitivity parameters (NormX, NormY, NormZ), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested.

The free space E-field from amplified probe outputs is determined in a test chamber. This is performed in a TEM cell for frequencies below 1 GHz, and in a wave guide above 1 GHz for free space. For the free space calibration, the probe is placed in the volumetric center of the cavity and at the proper orientation with the field. The probe is then rotated 360 degrees.

E-field temperature correlation calibration is performed in a flat phantom filled with the appropriate simulated brain tissue. The measured free space E-field in the medium correlates to temperature rise in a dielectric medium. For temperature correlation calibration a RF transparent thermistor-based temperature probe is used in conjunction with the E-field probe.

$$\text{SAR} = C \frac{\Delta T}{\Delta t}$$

Where: Δt = Exposure time (30 seconds),

C = Heat capacity of tissue (brain or muscle),

ΔT = Temperature increase due to RF exposure.

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

Where: σ = Simulated tissue conductivity,

ρ = Tissue density (kg/m^3).


3.2.3. OTHER TEST EQUIPMENT


3.2.3.1. DEVICE HOLDER FOR TRANSMITTERS

Construction: Simple but effective and easy-to-use extension for Mounting Device that facilitates the testing of larger devices according to IEC 62209-2 (e.g., laptops, cameras, etc.) It is lightweight and fits easily on the upper part of the Mounting Device in place of the phone positioner. The extensor is fully compatible with the Twin SAM, ELI4 and SAM v6.0 Phantoms.

Material: POM, Acrylic glass, Foam

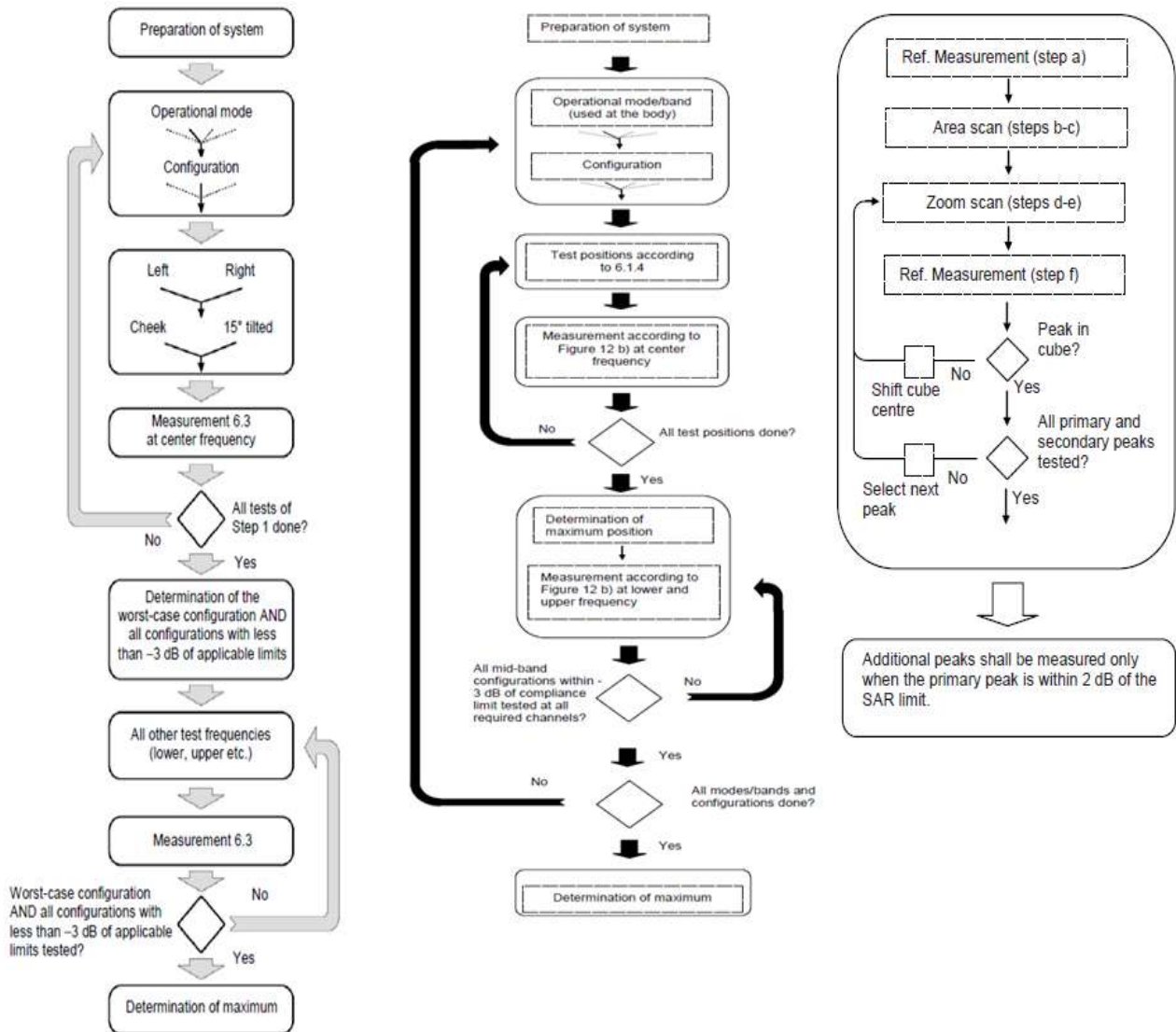
3.2.3.2 PHANTOM

Model	ELI4 Phantom	
Construction	Phantom for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.	
Shell Thickness	2±0.1 mm	
Filling Volume	Approx. 30 liters	
Dimensions	Length: 600 mm ; Width: 190mm Height: adjustable feet	
Available	Special	

Model	Twin SAM	
Construction	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot.	
Shell Thickness	2 ± 0.2 mm	
Filling Volume	Approx. 25 liters	
Dimensions	Length:1000mm; Width: 500mm Height: adjustable feet	
Available	Special	

3.2.4. SCANNING PROCEDURE

The SAR test against the head and body-worn phantom was carried out as follow:



After an area scan has been done at a fixed distance of 1.4mm from the surface of the phantom on the source side, a 3D scan is set up around the location of the maximum spot SAR. First, a point within the scan area is visited by the probe and a SAR reading taken at the start of testing. At the end of testing, the probe is returned to the same point and a second reading is taken. Comparison between these start and end readings enables the power drift during measurement to be assessed.

Above is the scanning procedure flow chart and table from the IEEE1528 standard.

This is the procedure for which all compliant testing should be carried out to ensure that all variations of the device position and transmission behavior are tested.

3.2.5. DATA STORAGE AND EVALUATION

3.2.5.1 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.

3.2.6. 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	Normi, a _{i0} , a _{i1} , a _{i2}
	Conversion factor	ConvF _i
	Diode compression point	Dcp _i
Device parameters:	Frequency	f
	Crest factor	cf
Media parameters:	Conductivity	
	Density	

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:

$$\text{E-field probes: } E_i = (V_i / \text{Norm}_i \cdot \text{ConvF})^{1/2}$$

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

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):

$$E_{\text{tot}} = (E_x^2 + E_y^2 + E_z^2)^{1/2}$$

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

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

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/cm³

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.

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

With P_{pwe} = equivalent power density of a plane wave in mW/cm

E_{tot} = total field strength in V/m
 H_{tot} = total magnetic field strength in A/m

4. TISSUE-EQUIVALENT LIQUID

4.1. TISSUE-EQUIVALENT LIQUID INGREDIENTS

The liquid is consisted of water, salt and Glycol, Sugar, Preventol and Cellulose. The liquid has previously been proven to be suited for worst-case. The measured conductivity and relative permittivity should be within $\pm 5\%$ of the target values. The below table shows the detail solution. It's satisfying the latest tissue dielectric parameters requirements proposed by the IEC 62209.

Composition of the Tissue Equivalent Matter

Tissue Type	Bactericide	DGBE	HEC	NaCl	Sucrose	Triton X-100	Water	Diethylene Glycol Mono-hexylether
Head 2450	-	45.0	-	0.1	-	-	54.9	-
Head 5G	-	-	-	-	-	17.2	65.5	17.3

4.2. TISSUE-EQUIVALENT LIQUID PROPERTIES

Dielectric Performance of Tissue Simulating Liquid

Tissue Verification									
Date	Tissue Type	Frequency (MHz)	Conductivity (σ)	Permittivity (ϵ_r)	Targeted Conductivity (σ)	Targeted Permittivity (ϵ_r)	Deviation Conductivity (σ) (%)	Deviation Permittivity (ϵ_r) (%)	Limit (%) ± 5
2021/2/20	Head	2402	1.79	38.56	1.76	39.29	1.88	-1.86	± 5
2021/2/20	Head	2412	1.80	38.52	1.77	39.27	1.92	-1.91	± 5
2021/2/20	Head	2422	1.81	38.48	1.78	39.25	2.08	-1.96	± 5
2021/2/20	Head	2437	1.83	38.42	1.79	39.22	2.24	-2.04	± 5
2021/2/20	Head	2441	1.83	38.40	1.79	39.21	2.29	-2.06	± 5
2021/2/20	Head	2450	1.84	38.37	1.80	39.20	2.39	-2.12	± 5
2021/2/20	Head	2452	1.85	38.36	1.80	39.19	2.39	-2.12	± 5
2021/2/20	Head	2462	1.86	38.32	1.81	39.18	2.43	-2.19	± 5
2021/2/20	Head	2480	1.88	38.25	1.83	39.16	2.40	-2.33	± 5
2021/3/11	Head	5180	4.67	37.00	4.64	36.02	0.69	2.73	± 5
2021/3/11	Head	5200	4.70	36.95	4.66	36.00	0.75	2.64	± 5
2021/3/11	Head	5220	4.72	36.90	4.68	35.98	0.88	2.57	± 5
2021/3/11	Head	5240	4.75	36.86	4.70	35.96	1.00	2.49	± 5
2021/3/11	Head	5260	4.77	36.81	4.72	35.94	1.10	2.41	± 5
2021/3/11	Head	5280	4.80	36.76	4.74	35.92	1.24	2.33	± 5
2021/3/11	Head	5300	4.83	36.71	4.76	35.90	1.37	2.25	± 5
2021/3/11	Head	5320	4.85	36.65	4.78	35.88	1.44	2.16	± 5
2021/3/11	Head	5500	5.06	36.13	4.96	35.60	2.04	1.48	± 5
2021/3/11	Head	5520	5.09	36.13	4.98	35.58	2.09	1.55	± 5
2021/3/11	Head	5540	5.11	36.08	5.00	35.56	2.14	1.46	± 5
2021/3/11	Head	5560	5.13	36.03	5.03	35.54	2.15	1.38	± 5
2021/3/11	Head	5580	5.16	35.98	5.05	35.52	2.16	1.29	± 5
2021/3/11	Head	5600	5.18	35.93	5.07	35.50	2.17	1.21	± 5
2021/3/11	Head	5620	5.21	35.88	5.09	35.48	2.28	1.13	± 5
2021/3/11	Head	5640	5.23	35.83	5.11	35.46	2.39	1.05	± 5
2021/3/11	Head	5660	5.26	35.79	5.13	35.44	2.48	0.98	± 5
2021/3/11	Head	5680	5.28	35.74	5.15	35.42	2.54	0.91	± 5
2021/3/11	Head	5700	5.31	35.70	5.17	35.40	2.61	0.84	± 5
2021/3/11	Head	5720	5.33	35.65	5.19	35.38	2.74	0.77	± 5
2021/3/11	Head	5745	5.37	35.60	5.22	35.35	2.91	0.69	± 5
2021/3/11	Head	5765	5.39	35.55	5.24	35.33	3.00	0.63	± 5
2021/3/11	Head	5785	5.42	35.52	5.26	35.31	3.10	0.58	± 5
2021/3/11	Head	5800	5.44	35.49	5.27	35.30	3.15	0.53	± 5
2021/3/11	Head	5805	5.44	35.48	5.28	35.29	3.20	0.52	± 5
2021/3/11	Head	5825	5.47	35.43	5.30	35.27	3.32	0.46	± 5
2021/3/12	Head	2402	1.81	38.40	1.76	39.29	3.19	-2.26	± 5
2021/3/12	Head	2412	1.83	38.37	1.77	39.27	3.34	-2.30	± 5
2021/3/12	Head	2422	1.84	38.33	1.78	39.25	3.55	-2.35	± 5
2021/3/12	Head	2437	1.86	38.27	1.79	39.22	3.80	-2.43	± 5
2021/3/12	Head	2441	1.86	38.26	1.79	39.21	3.85	-2.44	± 5
2021/3/12	Head	2450	1.87	38.23	1.80	39.20	4.00	-2.48	± 5
2021/3/12	Head	2452	1.87	38.22	1.80	39.19	4.00	-2.47	± 5
2021/3/12	Head	2462	1.89	38.20	1.81	39.18	4.03	-2.51	± 5
2021/3/12	Head	2480	1.90	38.15	1.83	39.16	3.88	-2.57	± 5

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) According to FCC TCB workshop April, 2019 RF Exposure Procedures Update (Effective February 19, 2019, FCC has permitted the use of single head-tissue simulating liquid specified in IEEE 62209-1- for all SAR tests.

5. SYSTEM CHECK

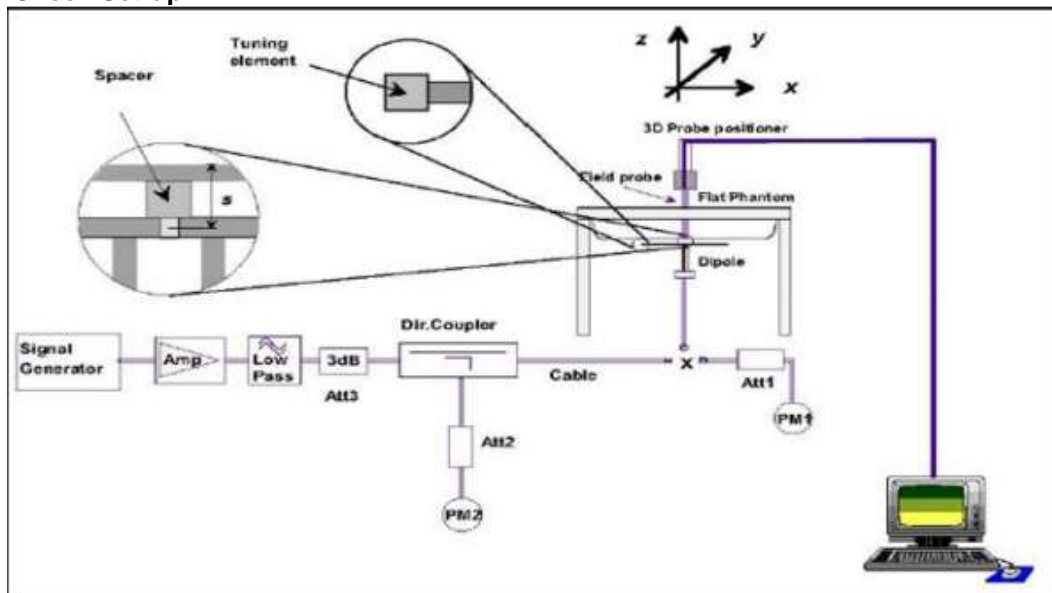
5.1. DESCRIPTION OF SYSTEM CHECK

The manufacturer calibrates the probes annually. Dielectric parameters of the tissue simulants were measured every day using the dielectric probe kit and the network analyzer. A system check measurement was made following the determination of the dielectric parameters of the simulant, using the dipole validation kit. A power level of 250 mW (below 3GHz) or 100mW (3-6GHz), which was placed under the flat section of the twin SAM phantom. The system check results (dielectric parameters and SAR values) are given in the 6.2.

System check results have to be equal or near the values determined during dipole calibration with the relevant liquids and test system ($\pm 10\%$).

System check is performed regularly on all frequency bands where tests are performed with the DASY5 system.

System Check Set-up



5.2. DESCRIPTION OF SYSTEM CHECK

System Check in Tissue Simulating Liquid

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.

Date	System Dipole			Parameters	Target [W/kg]	Measured [W/kg]	Deviation [%]	Limited [%]
	Type	Serial No.	Liquid					
2021/2/20	D2450V2	973	Head	1g SAR	51.9	52.8	1.73	± 10
2021/3/11	D5GHzV2 (5.2GHz)	1221	Head	1g SAR	76.8	78.6	2.34	± 10
2021/3/11	D5GHzV2 (5.3GHz)	1221	Head	1g SAR	79.0	80.3	1.65	± 10
2021/3/11	D5GHzV2 (5.6GHz)	1221	Head	1g SAR	80.3	86.7	7.97	± 10
2021/3/11	D5GHzV2 (5.8GHz)	1221	Head	1g SAR	76.9	83.5	8.58	± 10
2021/3/12	D2450V2	973	Head	1g SAR	51.9	51.2	-1.35	± 10

6. OPERATIONAL CONDITIONS DURING TEST

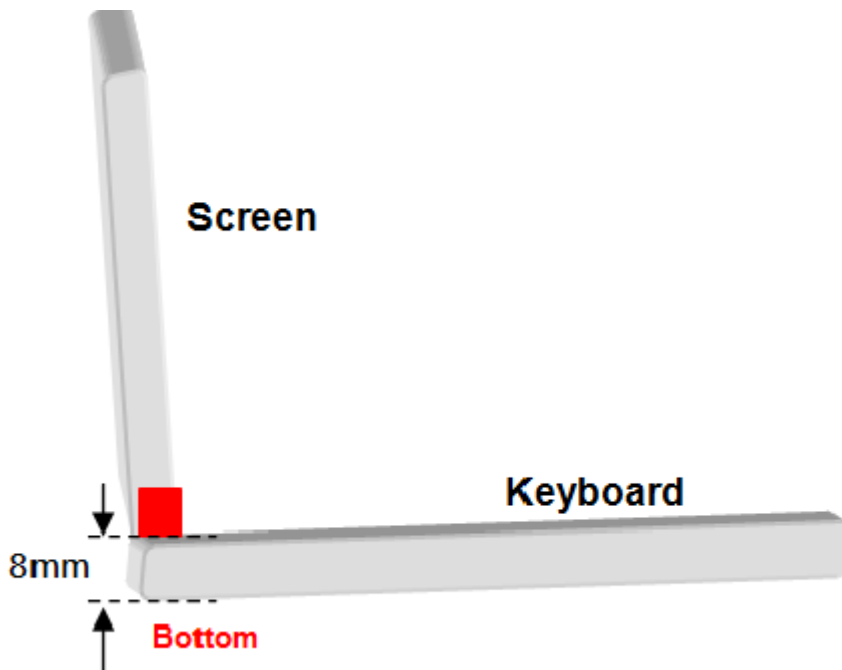
6.1. GENERAL DESCRIPTION OF TEST PROCEDURES

Connection to the EUT is established via air interface with base station An, and the EUT is Set to maximum output power by base station. The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power output. The antenna connected to the output of the base station simulator shall be placed at least 50cm away from the EUT. The signal transmitted by the simulator to the antenna feeding point shall be lower than the output power level of the EUT by at least 30dB.

6.2. TEST POSITION OF PORTABLE DEVICES

This DUT was tested in 1 different positions. They are bottom as illustrated below, which recommended by EN62209-2:

6.3. TEST POSITION ANTENNA LOCATION



Minimum Separation Distance			
Antenna	Position	Distance (mm)	Evaluation Test
Aux	Bottom	8	Yes

6.4. TEST POSITION

6.4.1. BODY TEST CONFIGURATION

The SAR Exclusion Threshold in KDB 447498 D01 can be applied to determine SAR test exclusion for adjacent edge configurations. The closest distance from the antenna to an EUT edge is used to determine if SAR testing is required for the adjacent edges, with the adjacent edge positioned adjacent the phantom and the edge containing the antenna positioned perpendicular to the phantom.

SAR test reduction and exclusion guidance

(1) The SAR exclusion threshold for distances < 50 mm is defined by the following equation:

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

The test exclusions are applicable only when the minimum test separation distance is ≤ 50 mm and for transmission frequencies between 100 MHz and 6 GHz. When the minimum test separation distance is < 5 mm, a distance of 5 mm according to 5) in section 4.1 is applied to determine SAR test exclusion.

(2) The SAR exclusion threshold for distances > 50 mm is defined by the following equation, as illustrated in KDB 447498 D01 Appendix B:

a) at 100 MHz to 1500 MHz

$$[\text{Power allowed at numeric Threshold at 50 mm in step 1}) + (\text{test separation distance} - 50 \text{ mm}) \cdot (f_{\text{(MHz)}}/150)] \text{ mW}$$

b) at > 1500 MHz and ≤ 6 GHz

$$[\text{Power allowed at numeric Threshold at 50 mm in step 1}) + (\text{test separation distance} - 50 \text{ mm}) \cdot 10] \text{ mW}$$

6.3 SAR EXCLUSION CALCULATIONS FOR WI-FI ANTENNA < 50MM FROM THE USER

According to KDB 447498 v06 in section 4.3.1, if the calculated threshold value is > 3 then SAR testing is required.

Antenna	Band	Frequency (MHz)	Output Power		Separation Distances(mm)	Calculated Threshold Value
			dBm	mW		
Aux	2.4GHz	2412	20.50	112.20	8.00	21.78
	5.2GHz	5210	18.00	63.10	8.00	18.00
	5.3GHz	5260	18.00	63.10	8.00	18.09
	5.6GHz	5700	18.00	63.10	8.00	18.83
	5.8GHz	5785	18.00	63.10	8.00	18.97
	Bluetooth	2480	7.00	5.01	8.00	0.99
	BLE	2480	4.50	2.82	8.00	0.56

6.4 SAR EXCLUSION CALCULATIONS FOR WI-FI ANTENNA > 50MM FROM THE USER

According to KDB 447498 v06, if the calculated Power threshold is less than the output power then SAR testing is required.

Antenna	Band	Frequency (MHz)	Output Power		Separation Distances(mm)	Calculated Threshold Value
			dBm	mW		
Aux	2.4GHz	2412	20.50	112.20	8.00	<50mm
	5.2GHz	5210	18.00	63.10	8.00	<50mm
	5.3GHz	5260	18.00	63.10	8.00	<50mm
	5.6GHz	5700	18.00	63.10	8.00	<50mm
	5.8GHz	5785	18.00	63.10	8.00	<50mm
	Bluetooth	2480	7.00	5.01	8.00	<50mm
	BLE	2480	4.50	2.82	8.00	<50mm

7. SAR MEASUREMENT VARIABILITY AND UNCERTAINTY

7.1. SAR MEASUREMENT VARIABILITY

Per KDB865664 D01 SAR measurement 100 MHz to 6 GHz, 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 8.2.

7.2. TEST CONFIGURATION

7.2.1. WIFI TEST CONFIGURATION

For WLAN SAR testing, WLAN engineering testing software installed on the DUT can provide continuous transmitting RF signal.

WLAN 2.4G

Mode	802.11b	802.11g	802.11n HT20	802.11n HT40
Duty cycle	100%			
Crest factor	1			

WLAN 5G

Mode	802.11a	802.11n HT20	802.11n HT40	802.11 ac20	802.11 ac40	802.11 ac80
Duty cycle	100%					
Crest factor	1					

For WiFi SAR testing, a communication link is set up with the test mode 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 248227 D01 are applied.

7.2.2 WLAN 2.4G SAR TEST REQUIREMENTS

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 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.

2.4 GHz 802.11g/n OFDM SAR Test Exclusion Requirements

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

- 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.

SAR Test Requirements for OFDM configurations

When SAR measurement is required for 2.4 GHz 802.11g/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.

7.2.3 WLAN 5G SAR TEST REQUIREMENTS**U-NII-1 and U-NII-2A Band**

For devices that operate in both U-NII-1 and U-NII-2A bands, when the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements. If the highest reported SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band for that configuration (802.11 mode and exposure condition); otherwise, both bands are tested independently for SAR. When different maximum output power is specified for the bands, begin SAR measurement in the band with higher specified maximum output power. The highest reported SAR for the tested configuration is adjusted by the ratio of lower to higher specified maximum output power for the two bands. When the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for the band with lower maximum output power in that test configuration; otherwise, both bands are tested independently for SAR.

U-NII-2C, U-NII-3 Bands

The frequency range covered by these bands is 380 MHz (5.47 – 5.85 GHz), which requires a minimum of at least two SAR probe calibration frequency points to support SAR measurements. When Terminal Doppler Weather Radar (TDWR) restriction applies, the channels at 5.60 – 5.65 GHz in U-NII-2C band must be disabled with acceptable mechanisms and documented in the equipment certification. Unless band gap channels are permanently disabled, they must be considered for SAR testing. To maintain SAR measurement accuracy and to facilitate test reduction, the channels in U-NII-2C band above 5.65 GHz may be grouped with the 5.8 GHz channels in U-NII-3 or §15.247 band to enable two SAR probe calibration frequency points to cover the bands, including the band gap channels.¹¹ When band gap channels are supported and the bands are not aggregated for SAR testing, band gap channels must be considered independently in each band according to the normally required OFDM SAR measurement and probe calibration frequency points requirements.

7.2.4 OFDM TRANSMISSION MODE AND SAR TEST CHANNEL SELECTION

For the 2.4GHz and 5GHz 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, or 802.11g and 802.11n, with the same channel bandwidth, modulation, and data rate, etc.), the lower order 802.11 mode (i.e. 802.11a then 802.11n and 802.11ac, or 802.11g then 802.11n) is used for SAR measurement. When the maximum output power are the same for multiple test channels, either according to the default or additional power measurement requirements, SAR is measured using the channel closest to the middle of the frequency band or aggregated band. When there are multiple channels with the same maximum output power, SAR is measured using the higher number channel.

7.2.5 INITIAL TEST CONFIGURATION PROCEDURE

For OFDM, in both 2.4G and 5GHz bands, an initial test configuration is determined for each frequency band and aggregated band, according to the transmission mode with the highest maximum output power specified for SAR measurements. When the same maximum output power is specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration(s) with the largest channel bandwidth, lowest order modulation, and lowest data rate. If the average RF output powers of the highest identical transmission modes are within 0.25 dB of each other, mid channel of the transmission mode with highest average RF output powers is the initial test channel. Otherwise, the channel of the transmission mode with the highest average RF output power will be the initial test configuration. When the reported SAR is ≤ 0.8 W/kg, no additional measurements on other test channels are required. Otherwise, SAR is evaluated using the subsequent highest average RF output channel until the reported SAR result is ≤ 1.2 W/kg or all channels are measured. When there are multiple untested channels having the same subsequent highest average RF output power, the channel with higher frequency from the lowest 802.11 mode is considered for SAR measurement.

8. CONDUCTED POWER RESULTS

8.1. CONDUCTED POWER MEASUREMENT RESULTS OF BLUETOOTH

Band	Mode	Channel	Frequency (MHz)	Max Tune-Up Power (dBm)	AVG Power (dBm)
BR	DH5	0	2402	7.00	Not Required
		39	2441	7.00	
		78	2480	7.00	
EDR	2DH5	0	2402	7.00	
		39	2441	7.00	
		78	2480	7.00	
	3DH5	0	2402	7.00	
		39	2441	7.00	
		78	2480	7.00	
BLE		0	2402	4.50	
		19	2440	4.50	
		39	2480	4.50	

Note:

- As per FCC OET KDB 447498 D01, conducted output power and SAR testing are not required for 2DH5,3DH5 and BLE channels when the Max power is under 10 dBm and the separation distance is 5mm.

8.2. CONDUCTED POWER MEASUREMENT RESULTS OF 2.4G BAND

Band	Mode	Channel	Frequency (MHz)	Data Rate	Max Tune-Up Power (dBm)	AVG Power (dBm)
2.4G	802.11b	1	2412	1	20.50	19.33
		6	2437	1	20.50	19.21
		11	2462	1	20.50	19.42
		12	2467	1	19.50	18.50
		13	2472	1	17.50	16.48
	802.11g	1-10	2412-2457	6	20.50	Not Required
	802.11g	11-13	2462-2472	6	7.50	
	802.11n20	1-10	2412-2457	HTO	20.50	
	802.11n20	11-13	2462-2472	HTO	7.50	
	802.11n40	3-4	2422-2427	HTO	18.00	
	802.11n40	5-8	2432-2447	HTO	19.50	
	802.11n40	9-11	2452-2462	HTO	7.50	

Note:

- As per FCC OET KDB 248227 D01, conducted output power and SAR testing are not required for 802.11g/n20/n40 channels when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is $\leq 1.2W/kg$.

8.3. CONDUCTED POWER MEASUREMENTS OF 5G UNII_1

Band	Mode	Channel	Frequency (MHz)	Data Rate	Max Tune-Up Power (dBm)	AVG Power (dBm)
UNII_1	802.11a	36	5180	6	16.50	14.51
		40	5200		18.00	16.17
		44	5220		18.00	16.31
		48	5240		18.00	16.23
	802.11 n20	36-48	5180-5240	HT0	18.00	Not Required
	802.11 n40	38-46	5190-5230	HT0	17.00	
	802.11 ac80	42	5210	VHT0	13.50	

Note:

- When the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements. If the highest reported SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band (see §B.5.2 in this document).
- The initial test configuration for 2.4 GHz and 5 GHz OFDM transmission modes is determined by the 802.11 configuration with the highest maximum output power specified for production units, including tune-up tolerance, in each standalone and aggregated frequency band. SAR for the initial test configuration is measured using the highest maximum output power channel determined by the default power measurement procedures. When multiple transmission modes (802.11a/g/n/ac) have the same specified maximum output power, largest channel bandwidth, lowest order modulation and lowest data rate, lowest order 802.11 mode is selected (i.e. a, g, n, ac).

8.4. CONDUCTED POWER MEASUREMENTS OF 5G UNII_2A

Band	Mode	Channel	Frequency (MHz)	Data Rate	Max Tune-Up Power (dBm)	AVG Power (dBm)
UNII_2a	802.11a	52	5260	6	18.00	16.34
		56	5280		18.00	16.35
		60	5300		18.00	16.86
		64	5320		16.00	14.60
	802.11 n20	52-64	5260-5320	HT0	18.00	Not Required
	802.11 n40	54-62	5270-5310	HT0	17.00	
	802.11 ac80	58	5290	VHT0	14.00	

Note:

- When the same maximum output power is specified for both bands, begin SAR measurement in U-NII-2A band by applying the OFDM SAR requirements. If the highest reported SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band (see §B.5.2 in this document).
- The initial test configuration for 2.4 GHz and 5 GHz OFDM transmission modes is determined by the 802.11 configuration with the highest maximum output power specified for production units, including tune-up tolerance, in each standalone and aggregated frequency band. SAR for the initial test configuration is measured using the highest maximum output power channel determined by the default power measurement procedures. When multiple transmission modes (802.11a/g/n/ac/ax) have the same specified maximum output power, largest channel bandwidth, lowest order modulation and lowest data rate, lowest order 802.11 mode is selected (i.e. a, g, n, ac).

8.5. CONDUCTED POWER MEASUREMENTS OF 5G UNII_2C

Band	Mode	Channel	Frequency (MHz)	Data Rate	Max Tune-Up Power (dBm)	AVG Power (dBm)		
UNII_2c	802.11a	100	5500	6	16.00	14.08		
		104	5520		18.00	16.61		
		108	5540		18.00	16.24		
		112	5560		18.00	16.02		
		116	5580		18.00	16.41		
		120	5600		18.00	16.01		
		124	5620		18.00	16.37		
		128	5640		18.00	16.58		
		132	5660		18.00	16.80		
		136	5680		18.00	16.82		
		140	5700		16.00	14.12		
		802.11 n20	100-140		5500-5700	HT0	18.00	Not Required
		802.11 n40	102-134		5510-5590	HT0	17.00	
802.11 ac80	106-138	5530-5690	VHT0	16.00				

Note:

1. When band gap channels between U-NII-2C and U-NII-3 band are supported channels in U-NII-2C band below 5.65 GHz are considered as one band and channels above 5.65 GHz, together with channels in 5.8 GHz U-NII-3 or §15.247 band, are considered as a separate band
2. The initial test configuration for 2.4 GHz and 5 GHz OFDM transmission modes is determined by the 802.11 configuration with the highest maximum output power specified for production units, including tune-up tolerance, in each standalone and aggregated frequency band. SAR for the initial test configuration is measured using the highest maximum output power channel determined by the default power measurement procedures. When multiple transmission modes (802.11a/g/n/ac/ax) have the same specified maximum output power, largest channel bandwidth, lowest order modulation and lowest data rate, lowest order 802.11 mode is selected (i.e. a, g, n, ac).

8.6. CONDUCTED POWER MEASUREMENTS OF 5G UNII_3

Band	Mode	Channel	Frequency (MHz)	Data Rate	Max Tune-Up Power (dBm)	AVG Power (dBm)
UNII_3	802.11a	149	5745	6	16.00	14.02
		153	5765		18.00	16.94
		157	5785		18.00	16.91
		161	5805		18.00	16.74
		165	5825		18.00	16.08
	802.11 n20	149-165	5745-5825	HT0	18.00	Not Required
	802.11 n40	151-159	5755-5795	HT0	17.00	
	802.11 ac80	155	5775	VHT0	15.50	

Note:

1. When band gap channels between U-NII-2C and U-NII-3 band are supported channels in U-NII-2C band below 5.65 GHz are considered as one band and channels above 5.65 GHz, together with channels in 5.8 GHz U-NII-3 or §15.247 band, are considered as a separate band
2. The initial test configuration for 2.4 GHz and 5 GHz OFDM transmission modes is determined by the 802.11 configuration with the highest maximum output power specified for production units, including tune-up tolerance, in each standalone and aggregated frequency band. SAR for the initial test configuration is measured using the highest maximum output power channel determined by the default power measurement procedures. When multiple transmission modes (802.11a/g/n/ac/ax) have the same specified maximum output power, largest channel bandwidth, lowest order modulation and lowest data rate, lowest order 802.11 mode is selected (i.e. a, g, n, ac)

8.7. SAR TEST PROCEDURE

General Notes:

1. Per KDB447498 D01, all measurement SAR results are scaled to the maximum tune-up tolerance limit to demonstrate compliant.
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: ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz. When the maximum output power variation across the required test channels is $> \frac{1}{2}$ 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 ≥ 0.8 W/kg; if the deviation among the repeated measurement is $\leq 20\%$, and the measured SAR < 1.45 W/kg, only one repeated measurement is required.

WLAN Notes:

1. For exposure conditions with multiple test positions, such as handset operating next to the ear, devices with hotspot mode, 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 positions in an exposure condition. The test position with the highest extrapolated (peak) SAR is used as the initial test position. When the reported SAR of the initial test position is ≤ 0.4 W/kg, further SAR measurement is not required for the other (remaining) test positions. Otherwise, SAR is evaluated at the subsequent highest peak SAR position until the reported SAR result is ≤ 0.8 W/kg or all test positions are measured.
2. Justification for test configurations for WLAN per KDB Publication 248227 for 2.4GHz WIFI single transmission chain operations, the highest measured maximum output power Channel for DSSS was selected for SAR measurement. SAR for OFDM modes (2.4GHz 802.11g/n) was not required due to the maximum allowed powers and the highest reported DSSS SAR. See Section 7.1.4 for more information.
3. Justification for test configurations for WLAN per KDB Publication 248227 for 5GHz WIFI single transmission chain operations, the initial test configuration was selected according to the transmission mode with the highest maximum allowed power. Other transmission mode was not investigated since the highest reported SAR for initial test configuration adjusted by the ratio of maximum output powers is less than 1.2 W/kg. See Section 7.1.4 for more information.

9. SAR TEST RESULTS

9.1. BODY SAR TEST RESULTS

SAR test results of 2.4G WiFi

Mode	Channel	Test Position	Distance(mm)	Max une-up (dBm)	AVG Power (dBm)	Area Scan	SAR 1g	Reported SAR 1g	Note
802.11b	1	Bottom	0	20.50	19.33	0.842	0.805	1.054	1
	6	Bottom	0	20.50	19.21	0.876	0.802	1.079	1
	11	Bottom	0	20.50	19.42	0.900	0.851	1.091	
	12	Bottom	0	19.50	18.50	0.656	0.747	0.940	
	13	Bottom	0	17.50	16.48	0.411	0.460	0.582	
	11	Bottom	0	20.50	19.42	0.764	0.731	0.937	3
	11	Bottom	0	20.50	19.42	0.882	0.781	1.002	2

Note:

- Highest reported SAR is > 0.8 W/kg. Added second highest power channel for this test position
- Repeated measurements are required only when the measured SAR is ≥ 0.80 W/kg. If the measured SAR values are < 1.45 W/kg with $\leq 20\%$ variation, only one repeated measurement is required to reaffirm that the results are not expected to have substantial variations, which may introduce significant compliance concerns. (Per KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04)
 Original SAR = 0.851 W/kg, therefore second times repeat SAR is required.
 Repeat SAR = 0.781W/kg < 1.45W/kg
 SAR variation= - 8.226% < 20%
- The result used an other antenna to spot check for worst channel of the original antenna that the SAR result can be meet and compliant.

SAR test results of 5G WiFi

Band	Mode	Channel	Distance(mm)	Test Position	Max une-up (dBm)	AVG Power (dBm)	Area Scan	SAR 1g	Reported SAR 1g	Note
UNII 1&2a	802.11a	36	0	Bottom	16.50	14.51	0.342	0.449	0.710	1
		40	0	Bottom	18.00	16.17	0.581	0.693	1.056	1
		44	0	Bottom	18.00	16.31	0.631	0.748	1.104	1
		48	0	Bottom	18.00	16.23	0.684	0.797	1.198	1
		52	0	Bottom	18.00	16.34	0.964	0.812	1.190	1
		56	0	Bottom	18.00	16.35	1.060	0.879	1.285	1
		60	0	Bottom	18.00	16.86	0.949	0.976	1.269	
UNII 2c	802.11a	64	0	Bottom	16.00	14.60	0.644	0.666	0.919	1
		100	0	Bottom	16.00	14.08	0.583	0.614	0.955	1
		104	0	Bottom	18.00	16.61	0.835	0.994	1.369	1
		108	0	Bottom	18.00	16.24	0.694	0.840	1.260	1
		112	0	Bottom	18.00	16.02	0.673	0.826	1.303	1
		116	0	Bottom	18.00	16.41	0.730	0.870	1.255	1
		120	0	Bottom	18.00	16.01	0.709	0.868	1.373	1
		124	0	Bottom	18.00	16.37	0.796	0.931	1.355	1
		128	0	Bottom	18.00	16.58	0.827	0.983	1.363	1
		132	0	Bottom	18.00	16.80	0.883	1.050	1.384	1
		136	0	Bottom	18.00	16.82	0.880	1.050	1.378	
UNII 3	802.11a	140	0	Bottom	16.00	14.12	0.544	0.556	0.857	1
		149	0	Bottom	16.00	14.02	0.593	0.748	1.180	
		153	0	Bottom	18.00	16.94	0.901	1.080	1.379	
		157	0	Bottom	18.00	16.91	0.865	1.050	1.350	1
		161	0	Bottom	18.00	16.74	0.685	0.867	1.159	1
UNII 2c	802.11a	165	0	Bottom	18.00	16.08	0.684	0.797	1.240	1
		132	0	Bottom	18.00	16.80	0.868	1.060	1.397	2
		132	0	Bottom	18.00	16.80	0.827	1.000	1.318	3

Note:

- Highest reported SAR is > 0.8 W/kg. Added second highest power channel for this test position
- Repeated measurements are required only when the measured SAR is ≥ 0.80 W/kg. If the measured SAR values are < 1.45 W/kg with $\leq 20\%$ variation, only one repeated measurement is required to reaffirm that the results are not expected to have substantial variations, which may introduce significant compliance concerns. (Per KDB 865664 D01 SAR measurement 100 MHz to 6 GHz v01r04)
 Original SAR = 1.050 W/kg, therefore second times repeat SAR is required.
 Repeat SAR = 1.060 W/kg < 1.45W/kg
 SAR variation= 0.952% < 20%
- The result used an other antenna to spot check for worst channel of the original antenna that the SAR result can be meet and compliant.

10. TEST LAYOUT

Specific Absorption Rate Test Layout

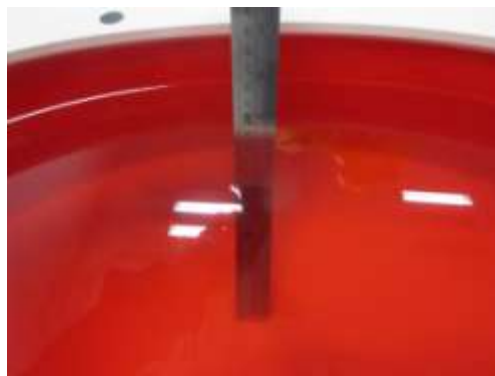


Liquid depth in the flat Phantom ($\geq 15\text{cm}$ depth)

HSL(2450MHz)



HSL(5GHz)



Appendix A. SAR Plots of System Verification

(Pls See BTL-FCC SAR-1-2102T061_Appendix A.)

Appendix B. SAR Plots of SAR Measurement

(Pls See BTL-FCC SAR-1-2102T061_Appendix B.)

Appendix C. Calibration Certificate

(Pls See BTL-FCC SAR-1-2102T061_Appendix C.)

Appendix D. Photographs of the Test Set-Up

(Pls See BTL-FCC SAR-1-2102T061_Appendix D.)

End of Test Report