FCC SAR Test Report

FCC ID: BEJNT-15U70P

Report No.	:	BTL-FCC SAR-1-2012T054
Equipment	:	Notebook Computers
Model Name	:	15U70P
Brand Name	:	LG
Applicant	:	LG Electronics USA
Address	:	111 Sylvan Avenue, North Building, Englewood Cliffs, New Jersey 07632, United States
Date of Receipt	:	December. 21, 2020
Date of Test	:	December. 28, 2020 ~ February. 19, 2021
Issued Date	:	February. 19, 2021

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

Prepared by :

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0659

Approved by :

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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.	2021/1/20
R01	Revised the WLAN Antenna Information. Revised the Appendix B.	2021/2/4
R02	Revised antenna location photo. Add note in conducted power results Add note in simultaneous transmission.	2021/2/8
R03	Add channel 12/13 test results.	2021/2/19

1. GENERAL INFORMATION

1.1. General Description Of Eut

Equipment	Notebook Computers	
Brand Name	LG	
Model Name	15U70P	
Model No.	15U70P* ("*" can be “0-9” or “A-Z”), 15UD70P, 15UG70P, 15UB70P	
Model Name difference	The model is only differ in model name for just marketing use only.	
Battery Information	Brand:LG Model:LBV7227E Rating: 7.74V/ 80Wh/ 10336mAh	
WiFi Module	Intel / AX201NGW	
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	

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-1-2012T054) 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 (± %)		Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (1g)	Standard Uncertainty (10g)	Vi 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		Rectangula	$\sqrt{3}$	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 %	∞
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 %	∞
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:

Ant.	Brand	Model	Type	Frequency Range (MHz)	Gain (dBi)
Main	High-Tek	DQ60ACQD044 (0ACQD019045N)	PIFA	2400-2500	-1.23
				5150-5250	2.46
				5250-5350	1.70
				5470-5725	0.22
				5725-5850	-0.07
Aux	High-Tek	DQ60ACQD044 (0ACQD019045N)	PIFA	2400-2500	-1.01
				5150-5350	-0.95
				5250-5350	1.13
				5470-5725	0.54
				5725-5850	1.65

2.4 The Maximum SAR 1g Values

Band	Mode	Highest Body Reported SAR-1g(W/kg)
FHSS	**Bluetooth_DH5**	**0.126**
DTS	**Wi-Fi 2.4G**	**0.478**
UNII	**Wi-Fi 5.2 & 5.3G**	**0.722**
	Wi-Fi 5.6G	**0.754**
	Wi-Fi 5.8G	**0.905**

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. = 18ºC, Max. = 25ºC
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

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

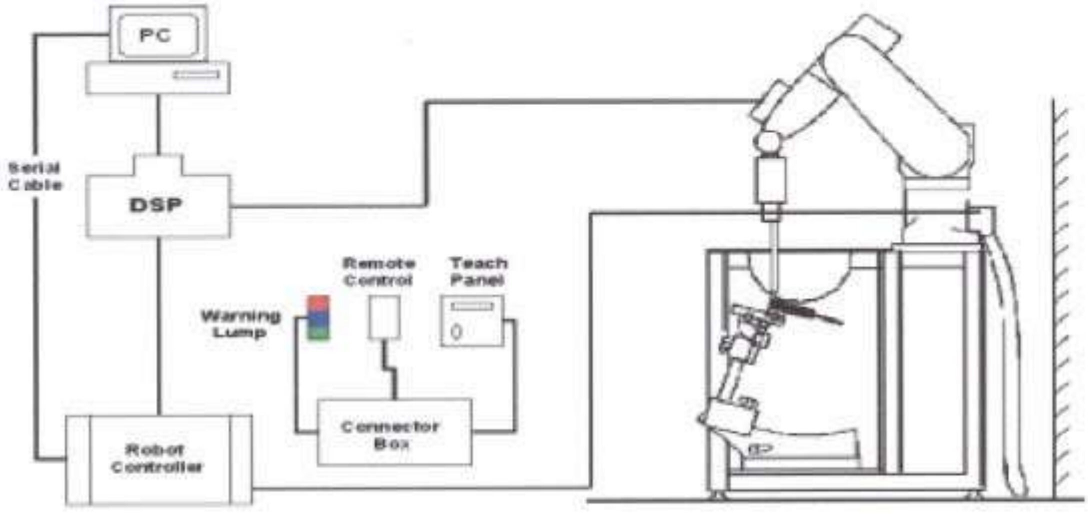
3. SAR MEASUREMENTS SYSTEM CONFIGURATION

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

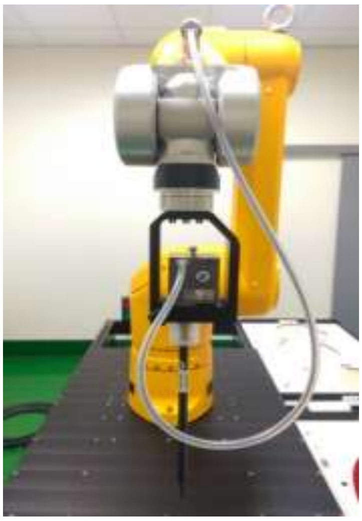


3.2. DASY5 E-field Probe System

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 µW/g to > 100 mW/g Linearity: ± 0.2dB
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 ±10%. The spherical isotropy was evaluated and found to be better than ± 0.25dB. 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 bellow 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.

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

Where: Δt = Exposure time (30 seconds),

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

ΔT = Temperature increase due to RF exposure.

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

Where: σ = Simulated tissue conductivity,

ρ = Tissue density (kg/m3).

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 extension is fully compatible with the Twin SAM, ELI4 and SAM v6.0 Phantoms.

Material: POM, Acrylic glass, Foam

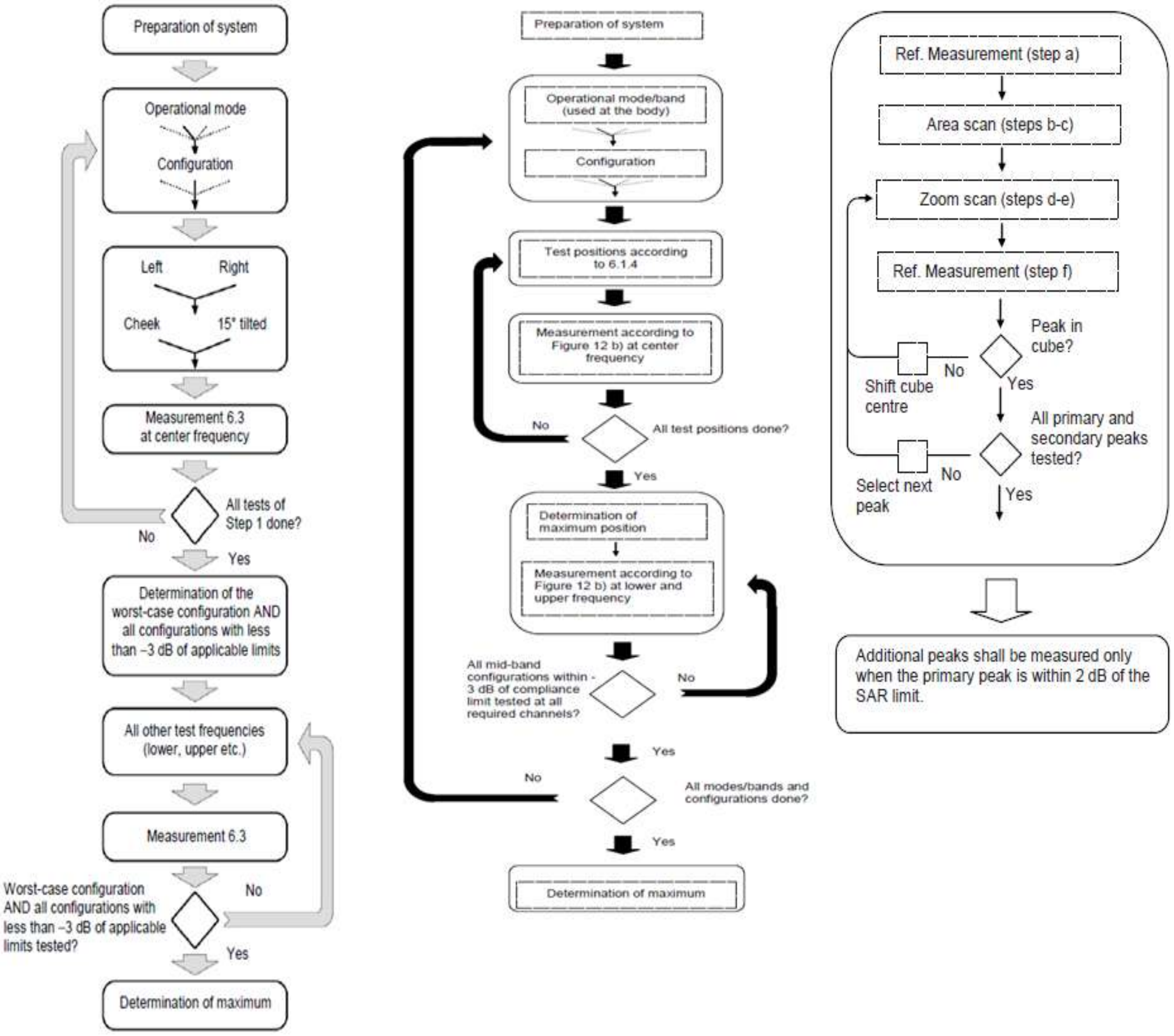
3.2.3.2 Phantom

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	
Aailable	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	
Aailable	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:

Vi = Ui + Ui2 · cf / dcpi

With	Vi = compensated signal of channel i	(i = x, y, z)
	Ui = input signal of channel i	(i = x, y, z)
	cf = crest factor of exciting field	(DASY parameter)
	dcpi = diode compression point	(DASY parameter)

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

E-field probes: Ei = (Vi / Normi · ConvF)1/2

H-field probes: Hi = (Vi)1/2 · (ai0 + ai1 f + ai2f2) / f

With V_i = compensated signal of channel i (i = x, y, z)

Normi = sensor sensitivity of channel i (i = x, y, z)
[mV/(V/m)^2] for E-field Probes

ConvF = sensitivity enhancement in solution

aij = sensor sensitivity factors for H-field probes

f = carrier frequency [GHz]

Ei = electric field strength of channel i in V/m

Hi = magnetic field strength of channel i in A/m

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

Etot = (EX2+ EY2+ EZ2)1/2

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

SAR = (Etot) 2 · σ / (ρ· 1000)

With SAR = local specific absorption rate in mW/g

Etot = total field strength in V/m
= conductivity in [mho/m] or [Siemens/m]
= 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.

Ppwe = Etot2 / 3770 or Ppwe = Htot2 · 37.7

With Ppwe = equivalent power density of a plane wave in mW/cm
Etot = total field strength in V/m
Htot = 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 ±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 (εr)	Targeted Conductivity (σ)	Targeted Permittivity (εr)	Deviation Conductivity (σ) (%)	Deviation Permittivity (εr) (%)	Limit (%) ±5
2020/12/28	Head	2450	1.82	38.44	1.80	39.20	1.11	-1.95	±5
2020/12/29	Head	5200	4.59	35.49	4.66	36.00	-1.48	-1.42	±5
2020/12/29	Head	5300	4.71	35.25	4.76	35.90	-1.01	-1.81	±5
2020/12/30	Head	5600	5.06	34.49	5.07	35.50	-0.30	-2.86	±5
2020/12/30	Head	5800	5.30	34.05	5.27	35.30	0.65	-3.53	±5
2021/2/19	Head	2450	1.81	38.28	1.80	39.20	0.33	-2.35	±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

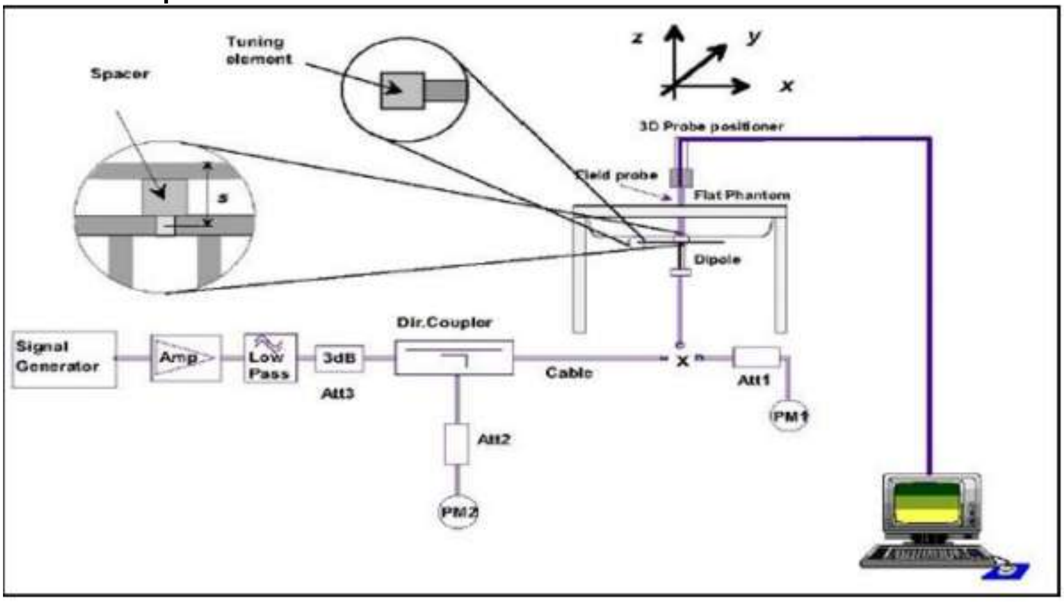
5.1. Description of System Check

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 (±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					
2020/12/28	D2450V2	973	Head	1g SAR	51.9	52.0	0.19	± 10
2020/12/29	D5GHzV2 (5.2GHz)	1221	Head	1g SAR	76.8	69.8	-9.11	± 10
2020/12/29	D5GHzV2 (5.3GHz)	1221	Head	1g SAR	79.0	72.5	-8.23	± 10
2020/12/30	D5GHzV2 (5.6GHz)	1221	Head	1g SAR	80.3	76.3	-4.98	± 10
2020/12/30	D5GHzV2 (5.8GHz)	1221	Head	1g SAR	76.9	69.8	-9.23	± 10
2021/2/19	D2450V2	973	Head	1g SAR	51.9	48.8	-5.97	± 10

6. OPERATIONAL CONDITIONS DURING TEST

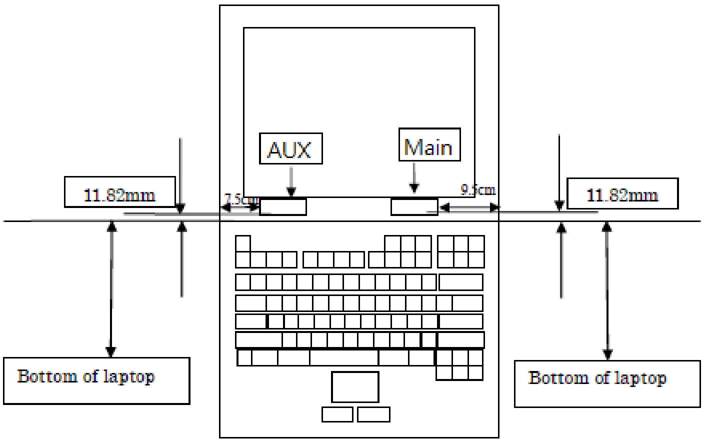
6.1. General Description of Test Procedures

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**
Main	Bottom	11.82	Yes
Aux	Bottom	11.82	Yes

6.4. Test Configuration

6.4.1.Body test configuration

The SAR Exclusion Threshold in KDB 447498 D01can 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<50mm 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 ≤50mm and for transmission frequencies between 100MHz and 6GHz. When the minimum test separation distance is<5mm, a distance of 5mm according to 5) in section 4.1 is applied to determine SAR test exclusion.

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

a) at 100 MHz to1500 MHz

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

b) at >1500MHz and ≤6GHz

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

6.5 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	Bottom	Bottom
Main	2.4GHz	2437	16.00	40.00	11.82	**5.28**
	5.2GHz	5210	16.00	40.00	11.82	**7.72**
	5.3GHz	5290	16.00	40.00	11.82	**7.78**
	5.6GHz	5530	16.00	40.00	11.82	**7.96**
	5.8GHz	5775	16.00	40.00	11.82	**8.13**
Aux	2.4GHz	2462	16.00	40.00	11.82	**5.31**
	5.2GHz	5210	16.00	40.00	11.82	**7.72**
	5.3GHz	5290	16.00	40.00	11.82	**7.78**
	5.6GHz	5610	16.00	40.00	11.82	**8.02**
	5.8GHz	5775	16.00	40.00	11.82	**8.13**
	Bluetooth	2480	10.00	10.00	11.82	**1.33**

6.6 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	Bottom	Bottom
Main	2.4GHz	2437	16.00	40.00	11.82	**<50mm**
	5.2GHz	5210	16.00	40.00	11.82	**<50mm**
	5.3GHz	5290	16.00	40.00	11.82	**<50mm**
	5.6GHz	5530	16.00	40.00	11.82	**<50mm**
	5.8GHz	5775	16.00	40.00	11.82	**<50mm**
Aux	2.4GHz	2462	16.00	40.00	11.82	**<50mm**
	5.2GHz	5210	16.00	40.00	11.82	**<50mm**
	5.3GHz	5290	16.00	40.00	11.82	**<50mm**
	5.6GHz	5610	16.00	40.00	11.82	**<50mm**
	5.8GHz	5775	16.00	40.00	11.82	**<50mm**
	Bluetooth	2480	10.00	10.00	11.82	**<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	802.11 ax20	802.11 ax40
Duty cycle	100%					
Crest factor	1					

RLAN 5G

Mode	802.11a	802.11n HT20	802.11n HT40	802.11 ac20	802.11 ac40	802.11 ac80	802.11 ac160
	802.11 ax20	802.11 ax40	802.11 ax80	802.11 ax160			
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 Power (dBm)	AVG Power (dBm)
BR	DH5	0	2402	10.00	9.86
		39	2441	10.00	9.96
		78	2480	10.00	9.96
EDR	2DH5	0	2402	9.00	Not Required
		39	2441	9.00	
		78	2480	9.00	
	3DH5	0	2402	9.00	
		39	2441	9.00	
		78	2480	9.00	
BLE		0	2402	7.00	Not Required
		19	2440	7.00	
		39	2480	7.00	

Note:

1. 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)	
						Main	Aux
2.4G	802.11b	1	2412	1	16.00	15.97	
		6	2437	1	16.00	15.97	
		11	2462	1	16.00	15.96	
		12	2467	1	16.00	15.94	
		13	2472	1	16.00	12.74	
	802.11g	1-13	2412-2462	6	16.00	Not Required	
	802.11n20	1-13	2412-2462	HT0	16.00		
	802.11n40	3-1	2422-2452	HT0	16.00		
	802.11ax20	1-13	2412-2462	HE0	16.00		
	802.11ax40	3-11	2422-2452	HE0	16.00		
	802.11b	1	2412	1	16.00		15.94
		6	2437	1	16.00		15.93
		11	2462	1	16.00		15.88
		12	2467	1	16.00		15.75
		13	2472	1	16.00		12.64
	802.11g	1-13	2412-2462	6	16.00	Not Required	
	802.11n20	1-13	2412-2462	HT0	16.00		
	802.11n40	3-1	2422-2452	HT0	16.00		
	802.11ax20	1-13	2412-2462	HE0	16.00		
	802.11ax40	3-11	2422-2452	HE0	16.00		

Note:

1. As per FCC OET KDB 248227 D01, conducted output power and SAR testing are not required for 802.11g/n20/n40/ax20/ax40 channels when the highest reported SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2W/kg.

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8.3. Conducted power measurements of 5G UNII_1

Band	Mode	Channel	Frequency (MHz)	Data Rate	Max Tune-Up Power (dBm)	AVG Power (dBm)	
						Main	Aux
UNII_1	802.11a	36-48	5180-5240	6	16.00	Not Required	
	802.11 n20	36-48	5180-5240	HT0	16.00		
	802.11 n40	38-46	5190-5230	HT0	16.00		
	802.11 ac80	42	5210	VHT0	16.00		
	802.11 ax20	36-48	5180-5240	HE0	16.00		
	802.11 ax40	38-46	5190-5230	HE0	16.00		
	802.11 ax80	42	5210	HE0	16.00		
UNII_1	802.11a	36-48	5180-5240	6	16.00	Not Required	
	802.11 n20	36-48	5180-5240	HT0	16.00		
	802.11 n40	38-46	5190-5230	HT0	16.00		
	802.11 ac80	42	5210	VHT0	16.00		
	802.11 ax20	36-48	5180-5240	HE0	16.00		
	802.11 ax40	38-46	5190-5230	HE0	16.00		
	802.11 ax80	42	5210	HE0	16.00		

Note:
1. 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).
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 then ax).

8.4. Conducted power measurements of 5G UNII_2a

Band	Mode	Channel	Frequency (MHz)	Data Rate	Max Tune-Up Power (dBm)	AVG Power (dBm)	
						Main	Aux
UNII_2a	802.11a	52-64	5260-5320	6	16.00	Not Required	
	802.11 n20	52-64	5260-5320	HT0	16.00		
	802.11 n40	54-62	5270-5310	HT0	16.00		
	802.11 ac80	58	5290	VHT0	16.00	15.94	
	802.11 ac160	50	5250	VHT0	15.00	Not Required	
	802.11 ax20	52-64	5260-5320	HE0	16.00		
	802.11 ax40	54-62	5270-5310	HE0	16.00		
	802.11 ax80	58	5290	HE0	16.00		
	802.11 ax160	50	5250	HE0	15.00		
UNII_2a	802.11a	52-64	5260-5320	6	16.00	Not Required	
	802.11 n20	52-64	5260-5320	HT0	16.00		
	802.11 n40	54-62	5270-5310	HT0	16.00		
	802.11 ac80	58	5290	VHT0	16.00		15.92
	802.11 ac160	50	5250	VHT0	15.00	Not Required	
	802.11 ax20	52-64	5260-5320	HE0	16.00		
	802.11 ax40	54-62	5270-5310	HE0	16.00		
	802.11 ax80	58	5290	HE0	16.00		
	802.11 ax160	50	5250	HE0	15.00		

Note:
1. 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).
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 then ax).
3. Largest channel bandwidth is worse than lowest order modulation

8.5. Conducted power measurements of 5G UNII_2c

Band	Mode	Channel	Frequency (MHz)	Data Rate	Max Tune-Up Power (dBm)	AVG Power (dBm)	
						Main	Aux
UNII_2c	802.11a	100-128	5500-5640	6	16.00	Not Required	
	802.11 n20	100-128	5500-5640	HT0	16.00		
	802.11 n40	102-126	5510-5630	HT0	16.00		
	802.11 ac80	106	5530	VHT0	16.00	15.89	
	802.11 ac80	122	5610	VHT0	16.00	15.83	
	802.11 ac160	114	5570	VHT0	15.00	Not Required	
	802.11 ax20	100-128	5500-5640	HE0	16.00		
	802.11 ax40	102-126	5510-5630	HE0	16.00		
	802.11 ax80	106-122	5530-5610	HE0	16.00		
	802.11 ax160	114	5570	HE0	15.00		
UNII_2c	802.11a	100-128	5500-5640	6	16.00	Not Required	
	802.11 n20	100-128	5500-5640	HT0	16.00		
	802.11 n40	102-126	5510-5630	HT0	16.00		
	802.11 ac80	106	5530	VHT0	16.00		15.92
	802.11 ac80	122	5610	VHT0	16.00		15.96
	802.11 ac160	114	5570	VHT0	15.00	Not Required	
	802.11 ax20	100-128	5500-5640	HE0	16.00		
	802.11 ax40	102-126	5510-5630	HE0	16.00		
	802.11 ax80	106-122	5530-5610	HE0	16.00		
	802.11 ax160	114	5570	HE0	15.00		

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 then ax).
3. Largest channel bandwidth is worse than lowest order modulation.

8.6. Conducted power measurements of 5G UNII_3

Band	Mode	Channel	Frequency (MHz)	Data Rate	Max Tune-Up Power (dBm)	AVG Power (dBm)	
						Main	Aux
UNII_3	802.11a	132-165	5660-5825	6	16.00	Not Required	
	802.11 n20	132-165	5660-5825	HT0	16.00		
	802.11 n40	134-159	5670	HT0	16.00		
	802.11 ac80	155	5775	VHT0	16.00	15.90	
	802.11 ax20	132-165	5660-5825	HE0	16.00	Not Required	
	802.11 ax40	134-159	5670-5795	HE0	16.00		
	802.11 ax80	155	5775	HE0	16.00		
UNII_3	802.11a	132-165	5660-5825	6	16.00	Not Required	
	802.11 n20	132-165	5660-5825	HT0	16.00		
	802.11 n40	151	5755	HT0	16.00		15.79
		159	5795	HT0	16.00		15.85
	802.11 ac80	155	5775	VHT0	16.00		15.99
	802.11 ax20	132-165	5660-5825	HE0	16.00	Not Required	
	802.11 ax40	134-159	5670-5795	HE0	16.00		
	802.11 ax80	155	5530-5690	HE0	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 then ax)
3. Largest channel bandwidth is worse than lowest order modulation.

8.7. SARTEST RESULTS

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 > 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.

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 Section7.1.4 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 than1.2W/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 _separation distance=0 cm

Mode	Channel	Test Position	Ant	Max une-up (dBm)	AVG Power (dBm)	Area Scan	SAR 1g	Reported SAR 1g	Note
802.11b	6	Bottom	Main	16.00	15.97	0.392	0.405	**0.408**	
	12	Bottom	Main	16.00	15.94	0.304	0.288	0.292	
	13	Bottom	Main	13.00	12.74	0.132	0.119	0.126	
802.11b	1	Bottom	Aux	16.00	15.94	0.506	0.471	**0.478**	
	12	Bottom	Aux	16.00	15.75	0.371	0.356	0.377	
	13	Bottom	Aux	13.00	12.64	0.155	0.129	0.140	

SAR test results of Bluetooth _separation distance=0 cm

Mode	Channel	Test Position	Ant	Max une-up (dBm)	AVG Power (dBm)	Area Scan	SAR 1g	Reported SAR 1g	Note
Bluetooth	78	Bottom	Aux	10.00	9.96	0.106	0.125	**0.126**	

SAR test results of 5G WiFi_separation distance=0 cm

Band	Mode	Channel	Test Position	Ant	Max une-up (dBm)	AVG Power (dBm)	Area Scan	SAR 1g	Reported SAR 1g	Note
UNII 1&2a	802.11 ac80	58	Bottom	Main	16.00	15.94	0.493	0.712	**0.722**	
		58	Bottom	Aux	16.00	15.92	0.321	0.469	**0.478**	
UNII 2c	802.11 ac80	106	Bottom	Main	16.00	15.89	0.512	0.735	**0.754**	
		122	Bottom	Aux	16.00	15.96	0.537	0.733	**0.740**	
UNII 3	802.11 ac80	155	Bottom	Main	16.00	15.90	0.517	0.774	**0.792**	
		155	Bottom	Aux	16.00	15.99	0.611	0.830	0.832	
	802.11 n40	159	Bottom	Aux	16.00	15.85	0.642	0.874	**0.905**	1
	802.11 n40	159	Bottom	Aux	16.00	15.85	0.657	0.855	0.885	2

Note:
1. Highest reported SAR is > 0.8 W/kg. Added second highest power channel for this test position
2. 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 ≤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 = 0.874 W/kg, therefore second times repeat SAR is required.
Repeat SAR = 0.855W/kg < 1.45W/kg
SAR variation= 2.174% < 20%

10. SIMULTANEOUS TRANSMISSION CONDITIONS

10.1 Stand-alone SAR test exclusion

SAR compliance for simultaneous transmission must be considered when the maximum duration of overlapping transmissions, including network hand-offs, is greater than 30 seconds. This device contains multiple transmitters that may operate simultaneously, and therefore requires a simultaneous transmission analysis.

The Simultaneous Transmission Possibilities of this device are as below:

No.	Configuration
1	WLAN 2.4G(Main)+BT
2	RLAN 5G(Main)+BT
3	WLAN 2.4G(Main)+ WLAN 2.4G(Aux)
4	RLAN 5G(Main)+ RLAN 5G(Aux)
5	RLAN 5G(Main)+ RLAN 5G(Aux)+BT

10.2 Simultaneous transmission conditions

KDB 447498 D01 General RF Exposure Guidance v06, introduces a new formula for calculating the SAR to Peak Location Ratio (SPLSR) between pairs of simultaneously transmitting antennas:

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

Where:

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

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

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

A new threshold of 0.04 is also introduced in the KDB. Thus, in order for a pair of simultaneous transmitting antennas with the sum of 1-g SAR > 1.6 W/kg to qualify for exemption from Simultaneous Transmission SAR measurements, it has to satisfy the condition of:

$(SAR_1 + SAR_2)^{1.5} / R_i \leq 0.04$

10.3 Simultaneous transmission conditions

Test Position / SAR1g(W/kg)	Bottom
WLAN 2.4G WiFi_Main	0.408
WLAN 2.4G WiFi_Aux	0.478
UNII_1 & 2a WiFi_Main	0.722
UNII_1 & 2a WiFi_Aux	0.478
UNII_2c WiFi_Main	0.754
UNII_2c WiFi_Aux	0.740
UNII_3 WiFi_Main	0.792
UNII_3 WiFi_Aux	0.905
Bluetooth_DH5	0.126
WLAN 2.4G_Main+WLAN 2.4G_Aux MAX∑SAR1g	0.886
WLAN 2.4G+BT MAX∑SAR1g	0.534
RLAN 5G_Main+ RLAN 5G_Aux MAX∑SAR1g	1.697

Note:

1. MAX. $\sum SAR_{1g}$= 1.697 W/Kg>1.6 W/Kg, so Peak location SAR are required.
2. Test tool can't support mimo with different mode, so we select worse case to evaluation simultaneous transmission

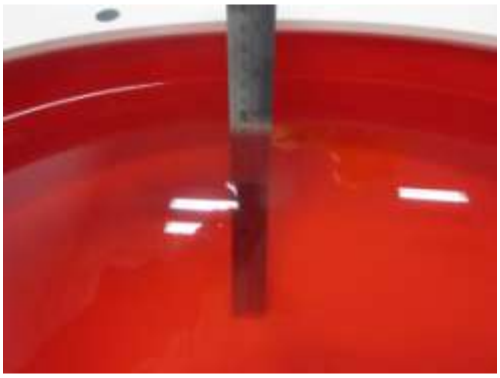
11. TEST LAYOUT

Specific Absorption Rate Test Layout

Liquid depth in the flat Phantom (≥15cm depth)

HSL(2450MHz)

HSL(5GHz)



Appendix A. SAR Plots of System Verification

(Pls See BTL-FCC SAR-1-2012T054_Appendix A.)

Appendix B. SAR Plots of SAR Measurement

(Pls See BTL-FCC SAR-1-2012T054_Appendix B.)

Appendix C. Calibration Certificate

(Pls See BTL-FCC SAR-1-2012T054_Appendix C.)

Appendix D. Photographs of the Test Set-Up

(Pls See BTL-FCC SAR-1-2012T054_Appendix D.)

Appendix E. SAR SPLSR

(Pls See BTL-FCC SAR-1-2012T054_Appendix E.)

End of Test Report