FCC SAR Test Report

FCC ID: ACJ-EAH-AZ100R, ACJ-EAH-AZ100L

Project No.	:	2408C031
Equipment	:	Digital Wireless Stereo Earphones
Brand Name	:	Technics
Test Model	:	EAH-AZ100
Series Model	:	N/A
Date of Receipt	:	Aug. 16, 2024
Date of Test	:	Aug. 30, 2024 ~ Sep. 18, 2024
Issued Date	:	Oct. 11, 2024
Report Version	:	R00
Test Sample	:	Engineering Sample No.: DG2024081622
Standard(s)	:	Please refer to page 2.
Applicant	:	Panasonic Corporation of North America
Address	:	Two Riverfront Plaza, Newark, New Jersey 07102-5490 United States
Manufacturer	:	Panasonic Entertainment & Communication Co., Ltd.
Address	:	1-10-12 Yagumo-higashi-machi, Moriguchi City, Osaka 570-0021, Japan
Factory	:	Panasonic System Networks Malaysia Sdn. Bhd.
Address	:	PLO No.1, Kawasan Perindustrian Senai, K B No. 104, 81400 Senai, Johor Darul Takzim. Malaysia

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

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Standard(s)	:	**IEEE Std C95.1:2019** IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 kHz to 300 GHz. **EN IEC/IEEE 62209-1528:2021** Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices - Part 1528: Human models, instrumentation, and procedures (Frequency range of 4 MHz to 10 GHz) **KDB447498 D04** Interim General RF Exposure Guidance v01 **KDB865664 D01** SAR measurement 100 MHz to 6 GHz v01r04 **KDB865664 D02** SAR Reporting v01r02

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 assumes no responsibility for the data provided by the customer, any statements, inferences or generalizations drawn by the customer or others from the reports issued by BTL.

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BTL's laboratory quality assurance procedures are in compliance with the ISO/IEC 17025: 2017 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 No.	Version	Description	Issued Date	Note
BTL-FCC SAR-1-2408C031	R00	Original Report.	Oct. 11, 2024	Valid

1. GENERAL INFORMATION

1.1 STATEMENT OF COMPLIANCE

Mode	Highest Reported Head SAR-1g (W/kg)
BT	0.185
BLE	0.380

Note: 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 C95.1:1992/IEEE C95.1:1991, the NCRP Report Number 86 for uncontrolled environment, and had been tested in accordance with the measurement methods and procedures specified in EN IEC/IEEE 62209-1528:2021.

1.2 LABORATORY ENVIRONMENT

Temperature	Min. = 20ºC, Max. = 24ºC
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.	

1.3 GENERAL DESCRIPTION OF EUT

Equipment	Digital Wireless Stereo Earphones				
Brand Name	Technics				
Test Model	EAH-AZ100				
Series Model	N/A				
Model Difference(s)	N/A				
Hardware Version	Engineering Prototype				
Software Version	SW0.098[JNZ1ZA]				
Modulation	BT(GFSK/π/4-DQPSK/8-DPSK)				
Operation Frequency Range(s)	Band	TX (MHz)	RX (MHz)		
	Bluetooth	2400~2483.5			
Test Channels (low-mid-high)	0-39-78 (BT)				
	0-19-39 (BLE)				
Antenna Information	Brand	Model Name	Type	Connector	Gain (dBi)
	N/A	N/A	FPC	N/A	-2.0
Other Information					
Battery	Model Name	1454			
	Power Rating	DC 3.7V 85mAh 0.32Wh			

Note: The antenna gain is provided by the manufacturer.

1.4 MAIN TEST INSTRUMENTS

Item	Equipment	Manufacturer	Model	Serial No.	Cal. Date	Cal. Interval
1	Data Acquisition Electronics	Speag	DAE4	1390	Nov. 20, 2023	1 Year
2	E-field Probe	Speag	EX3DV4	7693	Oct. 31, 2023	1 Year
3	System Validation Dipole	Speag	D2450V2	919	Apr. 22, 2024	3 Years
4	Twin Sam Phantom	Speag	Twin Sam Phantom V5.0	1896	N/A	N/A
5	Power Amplifier	Mini-Circuits	ZHL-42W+	QA1333003	Jun. 29, 2024	1 Year
6	DC Source metter	Iteck	IT6154	0061041267682 01001	Jun. 29, 2024	1 Year
7	Vector Network Analyzer	Agilent	E5071C	MY46102965	Jan. 20, 2024	1 Year
8	Signal Generator	Keysight	N5173B	MY59101420	Jan. 20, 2024	1 Year
9	Smart Power Sensor	R&S	NRP18S	101333	Jun. 01, 2024	1 Year
10	Smart Power Sensor	R&S	NRP-Z21	102209	Jan. 20, 2024	1 Year
11	3.5mm Economy Calibration Kit	Agilent	85052D	MY43252246	Nov. 10, 2023	1 Year
12	Dielectric Assessment Kit	Speag	DAK-3.5	1226	Jan. 24, 2022	3 Years
13	Coupler	Woken	0110A05601O-10	COM5BNW1A2	Jan. 20, 2024	1 Year
14	Digital Themometer	TES	TES-1310	210706071	Nov. 03, 2023	1 Year

Note:
1. “N/A” denotes no model name, serial No. or calibration specified.
2.
1) Per KDB865664 D01 requirements for dipole calibration, the test laboratory has adopted three-year extended calibration interval. Each measured dipole is expected to evaluate with the following criteria at least on annual interval in Appendix C.
a) There is no physical damage on the dipole;
b) System check with specific dipole is within 10% of calibrated value;
c) The most recent return-loss result, measured at least annually, deviates by no more than 20% from the previous measurement;
d) The most recent measurement of the real or imaginary parts of the impedance, measured at least annually is within 5Ω from the previous measurement.
2) Network analyzer probe calibration against air, distilled water and a short block performed before measuring liquid parameters.

2. RF EMISSIONS MEASUREMENT

2.1 TEST FACILITY

The test facilities used to collect the test data in this report is SAR room at the location of Room 108, Building 2, No.1, Yile Road, Songshan Lake Zone, Dongguan City, Guangdong, People's Republic of China.
BTL's Registration Number for FCC: 747969.
BTL's Designation Number for FCC: CN1377.

2.2 MEASUREMENT UNCERTAINTY

Uncertainty Budget for Frequency range of 300 MHz to 3 GHz

Symbol	Input quantity *Xi* (source of uncertainty)	Unc. Value	Prob. Dist.	Div.	ci (1g)	ci (10g)	Std.Unc. (1g) (±%)	Std.Unc. (10g) (±%)
Measurement system errors								
CF	Probe calibration(±%)	12.0	N	2	1	1	6.0	6.0
***CF*drift**	Probe calibration drift(±%)	1.7	R	$\sqrt{3}$	1	1	1.0	1.0
LIN	Probe linearity and detection limit(±%)	4.7	R	$\sqrt{3}$	1	1	2.7	2.7
BBS	Broadband signal(±%)	3.0	R	$\sqrt{3}$	1	1	1.7	1.7
ISO	Probe isotropy(±%)	7.6	R	$\sqrt{3}$	1	1	4.4	4.4
DAE	Other probe and data acquisition errors(±%)	0.7	N	1	1	1	0.7	0.7
AMB	RF ambient and noise(±%)	1.8	N	1	1	1	1.8	1.8
D*xyz*	Probe positioning errors(±mm)	0.006	N	1	0.14	0.14	0.08	0.08
DAT	Data processing errors(±%)	1.2	N	1	1	1	1.2	1.2
Phantom and device (DUT or validation antenna) errors								
***LIQ*(*σ*)**	Conductivity (meas.)(±%)	2.5	N	1	0.78	0.71	2.0	1.8
***LIQ*(*Tc*)**	Conductivity (temp.)(±%)	3.3	R	$\sqrt{3}$	0.78	0.71	1.5	1.4
EPS	Phantom Permittivity(±%)	14	R	$\sqrt{3}$	0	0	0.0	0.0
DIS	Distance DUT - TSL(±%)	2	N	1	2	2	4.0	4.0
Dxyz	Device Positioning(±%)	0.5	N	1	1	1	0.5	0.5
H	Device Holder(±%)	1	N	1	1	1	1.0	1.0
MOD	DUT Modulationm(±%)	2.4	R	$\sqrt{3}$	1	1	1.4	1.4
TAS	Time-average SAR(±%)	1.7	R	$\sqrt{3}$	1	1	1.0	1.0
***RF*drift**	DUT drift(±%)	1.6	N	1	1	1	1.6	1.6
VAL	Val Antenna Unc.(±%)	0	N	1	1	1	0.0	0.0
***P*in**	Unc. Input Power(±%)	0	N	1	1	1	0.0	0.0
Corrections to the SAR result								
***C*(*εφ*,*σ*)**	Deviation to Target(±%)	1.9	N	1	1	0.84	1.9	1.6
***C*(*R*)**	SAR scaling(±%)	0	R	$\sqrt{3}$	1	1	0.0	0.0
***u*(D*SAR*)**	Combined uncertainty						10.2	10.1
	Coverage Factor for 95%						k=2	k=2
U	Expanded uncertainty					*U* =	20.4	20.2
a Other probability distributions and divisors may be used if they better represent available knowledge of the quantities concerned.								

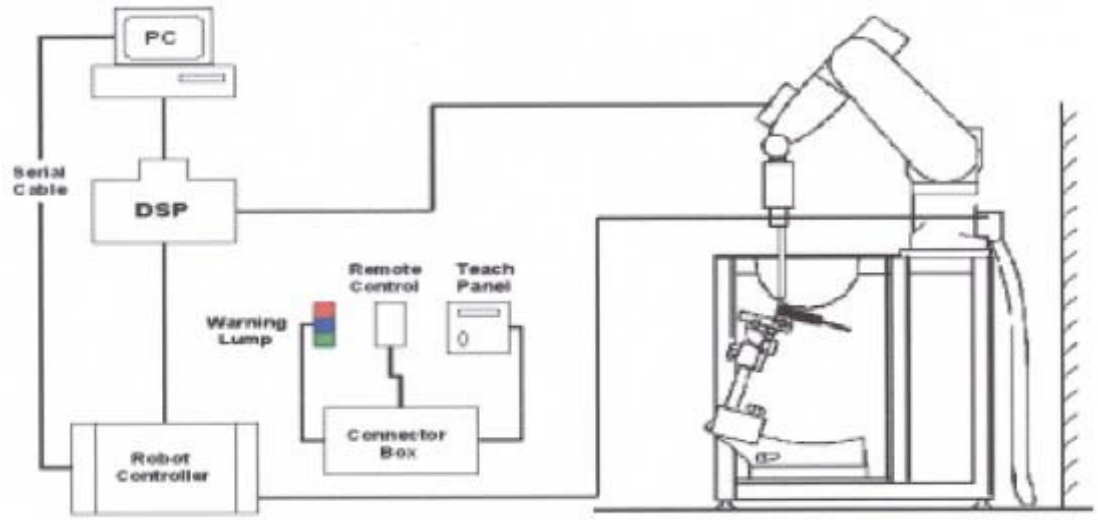
3. SAR MEASUREMENTS SYSTEM CONFIGURATION

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. TheDASY5 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 PROBE SPECIFICATION

EX3DV4

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

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 thermostat-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 (e.g., laptops, cameras, etc.) It is light weight 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, ELI and SAM v6.0 Phantoms.
Material: POM, Acrylic glass, Foam

3.2.3.2 Phantom

Model	Twin SAM	
Construction	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in EN IEC/IEEE 62209-1528. 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 DASY5 installation includes predefined files with recommended procedures for measurements and validation. They are read-only document files and destined as fully defined but unmeasured masks. All test positions (head or body-worn) are tested with the same configuration of test steps differing only in the grid definition for the different test positions.

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

The “surface check” measurement tests the optical surface detection system of the DASY5 system by repeatedly detecting the surface with the optical and mechanical surface detector and comparing the results. The output gives the detecting heights of both systems, the difference between the two systems and the standard deviation of the detection repeatability. Air bubbles or refraction in the liquid due to separation of the sugar-water mixture gives poor repeatability (above ± 0.1mm). To prevent wrong results tests are only executed when the liquid is free of air bubbles. The difference between the optical surface detection and the actual surface depends on the probe and is specified with each probe. (It does not depend on the surface reflectivity or the probe angle to the surface within ± 30°.)

- Area Scan

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

- Zoom Scan

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

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

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

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

3.2.5 SPATIAL PEAK SAR EVALUATION

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

- The data between the dipole center of the probe and the surface of the phantom are extrapolated. This data cannot be measured since the center of the dipole is 2.7 mm away from the tip of the probe and the distance between the surface and the lowest measuring point is about 1 mm (see probe calibration sheet). The extrapolated data from a cube measurement can be visualized by selecting “Graph Evaluated”.
- The maximum interpolated value is searched with a straight-forward algorithm. Around this maximum the SAR - values averaged over the spatial volumes (1g or 10 g) are computed using the 3d-spline interpolation algorithm. If the volume cannot be evaluated (i.e., if a part of the grid was cut off by the boundary of the measurement area) the evaluation will be started on the corners of the bottom plane of the cube.
- All neighboring volumes are evaluated until no neighboring volume with a higher average value is found.

Extrapolation

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

Interpolation

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

Volume Averaging

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

Advanced Extrapolation

DASY5 uses the advanced extrapolation option which is able to compensate boundary effects on E-field probes.

3.2.6 DATA STORAGE AND EVALUATION

3.2.6.1 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 “DAE”. 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.

3.2.7 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 multi meter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

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

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

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

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

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

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

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

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

$Norm_i$ = sensor sensitivity of channel i (i = x, y, z)

[mV/(V/m)^2] for E-field Probes

ConvF = sensitivity enhancement in solution

aij = sensor sensitivity factors for H-field probes

f = carrier frequency [GHz]

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

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

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

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

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

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

With SAR = local specific absorption rate in mW/g

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

= conductivity in [mho/m] or [Siemens/m]

= equivalent tissue density in g/cm^3

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

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

With P_{pwe} = equivalent power density of a plane wave in mW/cm^2

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

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

4. SYSTEM VERIFICATION PROCEDURE

4.1 TISSUE VERIFICATION

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

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

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

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

Tissue Verification									
Tissue Type	Frequency (MHz)	Liquid Temp. (℃)	Conductivity (σ)	Permittivity (εr)	Targeted Conductivity (σ)	Targeted Permittivity (εr)	Deviation Conductivity (σ) (%)	Deviation Permittivity (εr) (%)	Date
Head	2450	22.4	1.857	39.899	1.80	39.2	3.17	1.78	Sep. 18, 2024

Note:
1)The dielectric parameters of the tissue-equivalent liquid should be measured under similar ambient conditions and within 2 °C of the conditions expected during the SAR evaluation to satisfy protocol requirements.
2)KDB 865664 was ensured to be applied for probe calibration frequencies greater than or equal to 50MHz of the EUT frequencies.
3)The above measured tissue parameters were used in the DASY software to perform interpolation via the DASY software to determine actual dielectric parameters at the test frequencies. The SAR test plots may slightly differ from the table above since the DASY rounds to three significant digits.

4.2 SYSTEM CHECK

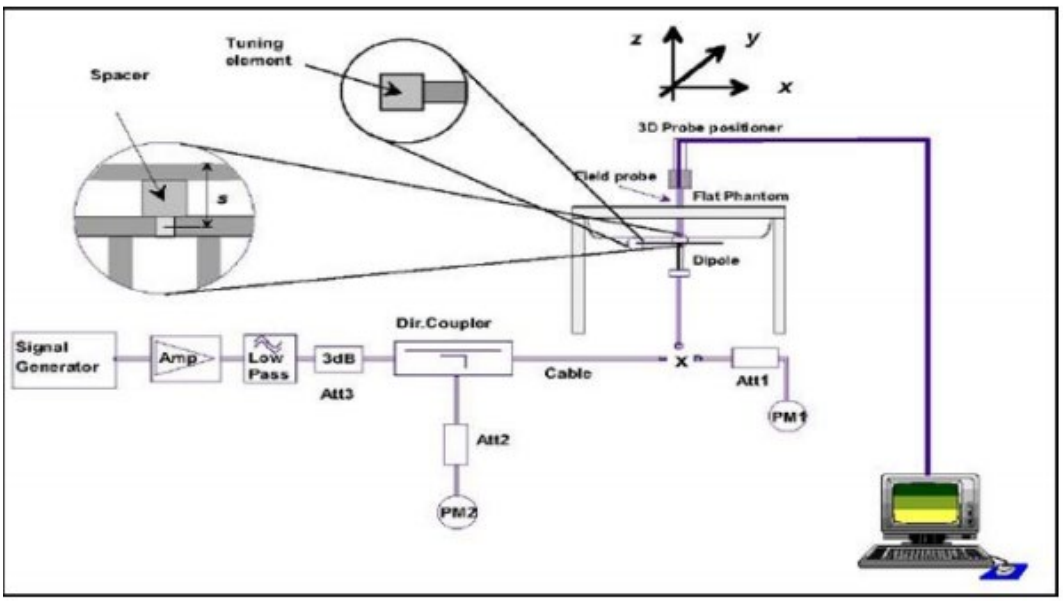
The system check is performed for verifying the accuracy of the complete measurement system and performance of the software. The system check is performed with tissue equivalent material according to EN IEC/IEEE 62209-1528 (described above). The following table shows system check results for all frequency bands and tissue liquids used during the tests.

System Check	Date	Frequency (MHz)	Targeted SAR 1g (W/kg)	Measured SAR 1g (W/kg)	normalized SAR 1g (W/kg)	Deviation 1g (%)	Dipole S/N
Head	Sep. 18, 2024	2450	52.10	12.80	51.20	-1.73	919

4.3 SYSTEM CHECK PROCEDURE

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

System check results have to be equal or near the values determined during dipole calibration (target SAR in table above) with the relevant liquids and test system (±10 %).



5. SAR MEASUREMENT VARIABILITY AND UNCERTAINTY

5.1 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.

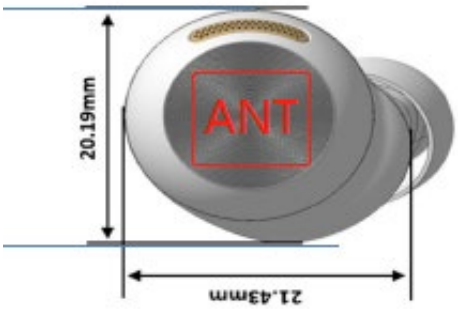
The same procedures should be adapted for measurements according to extremity and occupational exposure limits by applying a factor of 2.5 for extremity exposure and a factor of 5 for occupational exposure to the corresponding SAR thresholds.

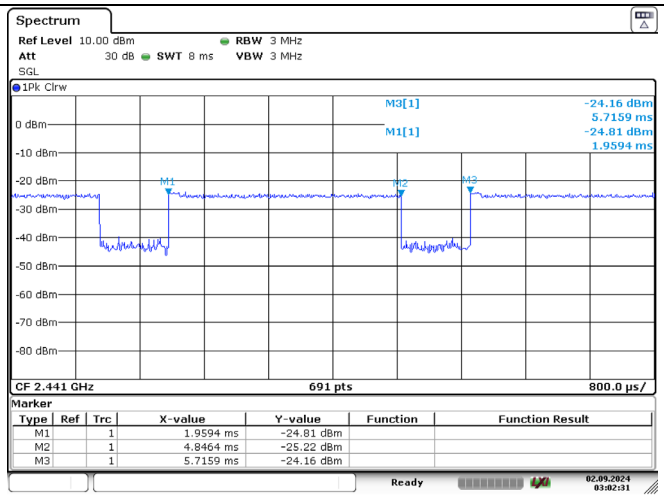
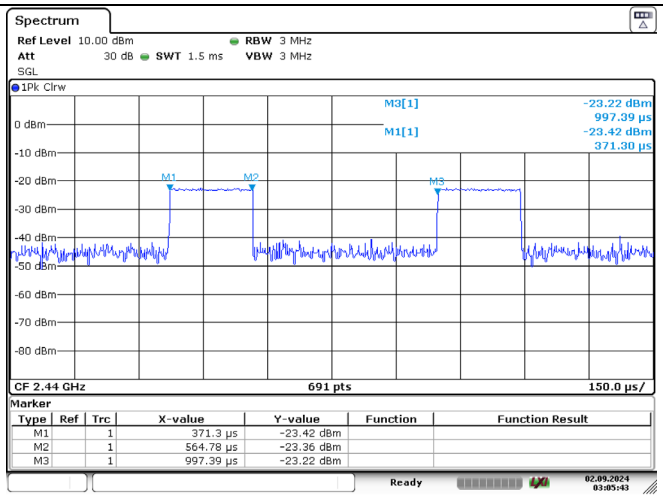
The detailed repeated measurement results are shown in Section 7.2.

6. OPERATIONAL CONDITIONS DURING TEST

6.1 TEST POSITION

The location of the antennas inside EUT is shown as below:



Duty Cycle	Duty Cycle
BT	BLE
76.85%	30.90%
	

7. TEST RESULT

7.1 CONDUCTED POWER RESULTS

7.1.1 CONDUCTED POWER MEASUREMENTS

Left Earphone

BT	Average Conducted Power(dBm)			
	Max. Tune up	CH0	CH39	CH78
		2402MHz	2441MHz	2480MHz
DH5	10.00	8.49	8.50	8.84
2DH5	10.00	8.82	8.82	8.66
3DH5	10.00	**8.86**	**8.52**	**8.70**

BT	Average Conducted Power(dBm)			
	Max. Tune up	CH0	CH19	CH39
		2402MHz	2440MHz	2480MHz
BLE(1M)	10.00	8.53	8.92	8.68
BLE(2M)	10.00	**8.95**	**8.79**	**8.76**

Right Earphone

BT	Average Conducted Power(dBm)			
	Max. Tune up	CH0	CH39	CH78
		2402MHz	2441MHz	2480MHz
DH5	10.00	8.65	8.55	8.48
2DH5	10.00	8.81	8.73	8.81
3DH5	10.00	**8.85**	**8.69**	**8.84**

BT	Average Conducted Power(dBm)			
	Max. Tune up	CH0	CH19	CH39
		2402MHz	2440MHz	2480MHz
BLE(1M)	10.00	8.66	8.64	8.82
BLE(2M)	10.00	**8.76**	**8.73**	**8.83**

Note:
1) The Average conducted power of BT is measured with RMS detector.
2) The tested channel results are marks in bold.

7.2 SAR TEST RESULTS

General Notes:
1) Per KDB447498 D04, all measurement SAR results are scaled to the maximum tune-up tolerance limit to demonstrate compliant.
2) Per KDB447498 D04, 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 for more information.

7.2.1 SAR MEASUREMENT RESULT

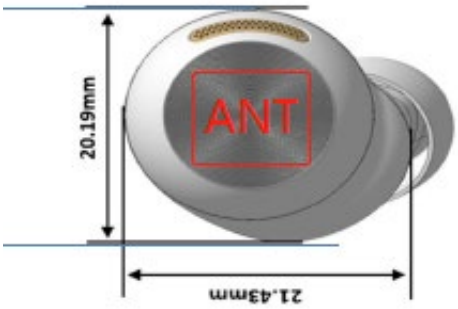
Test No.	Band	Channel	Test Position	Separation Distance (mm)	Data Rate	Maximum Tune-up (dBm)	Conducted Power (dBm)	Duty Cycle (%)	Power Drift (dB)	SAR 1g (W/kg)	SAR 10g (W/kg)	Reported 1g SAR (W/kg)
B01	BT 3DH5	0	Front Face_Left Earphone	0	3M	10.00	8.86	76.85	0.02	0.003	0.001	0.005
B02	BT 3DH5	0	Rear Face1_Left Earphone	0	3M	10.00	8.86	76.85	0	0.023	0.006	0.038
B03	BT 3DH5	0	Rear Face2_Left Earphone	0	3M	10.00	8.86	76.85	0.02	0.059	0.022	0.099
B04	BT 3DH5	0	Rear Face3_Left Earphone	0	3M	10.00	8.86	76.85	0.06	0.079	0.030	0.134
B05	BT 3DH5	39	Rear Face3_Left Earphone	0	3M	10.00	8.52	76.85	0.04	**0.101**	**0.038**	**0.185**
B06	BT 3DH5	78	Rear Face3_Left Earphone	0	3M	10.00	8.70	76.85	0.06	0.087	0.032	0.152
B08	BT 3DH5	0	Front Face_Right Earphone	0	3M	10.00	8.85	76.85	0.07	0.007	0.002	0.012
B09	BT 3DH5	0	Rear Face1_Right Earphone	0	3M	10.00	8.85	76.85	0	0.011	0.002	0.018
B10	BT 3DH5	0	Rear Face2_Right Earphone	0	3M	10.00	8.85	76.85	-0.19	0.044	0.013	0.075
B11	BT 3DH5	0	Rear Face3_Right Earphone	0	3M	10.00	8.85	76.85	-0.12	0.051	0.017	0.086
B12	BT 3DH5	39	Rear Face3_Right Earphone	0	3M	10.00	8.69	76.85	0.04	**0.102**	**0.039**	**0.179**
B13	BT 3DH5	78	Rear Face3_Right Earphone	0	3M	10.00	8.84	76.85	-0.07	0.101	0.038	0.172
B15	BLE 2M	0	Front Face_Left Earphone	0	2M	10.00	8.95	30.90	0.19	0.006	0.001	0.026
B16	BLE 2M	0	Rear Face1_Left Earphone	0	2M	10.00	8.95	30.90	0	0.018	0.005	0.074
B17	BLE 2M	0	Rear Face2_Left Earphone	0	2M	10.00	8.95	30.90	0.02	0.053	0.019	0.217
B18	BLE 2M	0	Rear Face3_Left Earphone	0	2M	10.00	8.95	30.90	0.09	0.064	0.024	0.265
B19	BLE 2M	19	Rear Face3_Left Earphone	0	2M	10.00	8.79	30.90	0.19	**0.080**	**0.030**	**0.343**
B20	BLE 2M	39	Rear Face3_Left Earphone	0	2M	10.00	8.76	30.90	0.02	0.063	0.022	0.272
B22	BLE 2M	39	Front Face_Right Earphone	0	2M	10.00	8.83	30.90	0.05	0.011	0.003	0.045
B23	BLE 2M	39	Rear Face1_Right Earphone	0	2M	10.00	8.83	30.90	0.07	0.033	0.012	0.139
B24	BLE 2M	39	Rear Face2_Right Earphone	0	2M	10.00	8.83	30.90	-0.06	0.068	0.025	0.287
B25	BLE 2M	39	Rear Face3_Right Earphone	0	2M	10.00	8.83	30.90	-0.03	**0.090**	**0.034**	**0.380**
B26	BLE 2M	0	Rear Face3_Right Earphone	0	2M	10.00	8.76	30.90	0.03	0.041	0.015	0.177
B27	BLE 2M	19	Rear Face3_Right Earphone	0	2M	10.00	8.73	30.90	0.04	0.082	0.031	0.356

Note: The value with boldface is the maximum SAR Value of each test band.

7.3 MULTIPLE TRANSMITTER EVALUATION

The following tables list information which is relevant for the decision if a simultaneous transmit evaluation is necessary according to FCC KDB447498 D04 Interim General RF Exposure Guidance v01.

The location of the antennas inside the EUT is shown as below:

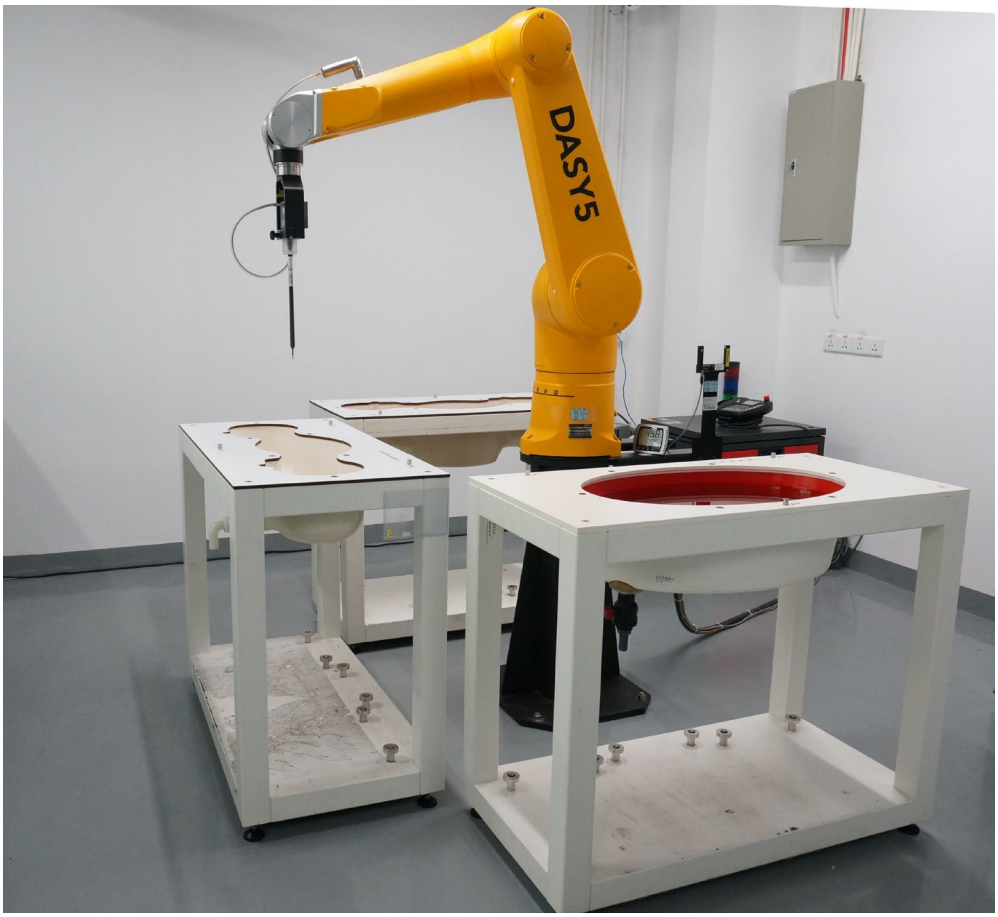


Note: The EUT only has one antenna and does not have synchronous transmission function.

APPENDIX

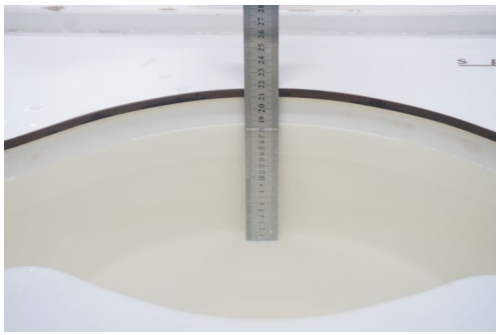
1. TEST LAYOUT

Specific Absorption Rate Test Layout



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

HSL_2300MHz-2700MHz_Body_18.3cm



Appendix A. SAR Plots of System Verification

(Pls See BTL-FCC SAR-1-2408C031_Appendix A.)

Appendix B. SAR Plots of SAR Measurement

(Pls See BTL-FCC SAR-1-2408C031_Appendix B.)

Appendix C. Calibration Certificate

(Pls See BTL-FCC SAR-1-2408C031_Appendix C.)

Appendix D. Photographs of the Test Set-Up

(Pls See BTL-FCC SAR-1-2408C031_Appendix D.)

End of Test Report