FCC SAR Test Report

FCC ID: 2AG5OPB-701-B

Project No.	:	2007T023
Equipment	:	Pebblebee Found
Model Name	:	PB-701-B
Applicant	:	PB Inc.
Address	:	PO Box 2962 Renton Washington United States 98056

Date of Receipt	:	Jul, 10 . 2020
Date of Test	:	Jul, 10. 2020
Issued Date	:	Sep, 20. 2020
Tested by	:	BTL Inc.

PREPARED BY : (Peter Chen)

APPROVED BY : (Scott Hsu)

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Testing Laboratory
0659

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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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.

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REPORT ISSUED HISTORY

Report Version	Description	Issued Date
R00	Original Issue	Jul, 16. 2020
R01	Revised bluetooth power, Revised bluetooth test result, Add simultaneous transmission	Sep, 11. 2020
R02	Revised antenna gain,Revised simultaneous transmission	Sep, 17. 2020
R03	Revised system check	Sep, 22. 2020

1 GENERAL SUMMARY

Equipment	Pebblebee Found
Model Name	PB-701-B
Brand Name	Found
Manufacturer	Goldtek Technology Co., Ltd.
Address	16F., No.166, Jian 1st Rd., Zhonghe Dist., New Taipei City 235, Taiwan (R.O.C.)
Standard(s)	**ANSI Std C95.1-1992** Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz - 300 GHz.(IEEE Std C95.1-1991) **IEEE Std 1528-2013** Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques **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 **KDB941225 D07** UMPC Mini Tablet **KDB690783 D01** SAR Listings on Grants v01r03 **KDB941225 D05** SAR for LTE Devices v02r05

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-1-2007T023) were obtained utilizing the test procedures, test instruments, test sites that has been accredited by the Authority of TAF according to the ISO/IEC 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 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

Note: Per KDB865664 D01 SAR Measurement 100 MHz to 6 GHz, when the highest measured 1-g SAR within a frequency band is < 1.5 W/kg, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval. The equivalent ratio (1.5/1.6) is applied to extremity and occupational exposure conditions.

3 GENERAL INFORMATION

3.1 STATEMENT OF COMPLIANCE

Equipment Class	Mode	Highest Body SAR-1g (W/kg)
PCE	LTE Cat-M1 B2	0.413
	LTE Cat-M1 B4	0.223
	LTE Cat-M1 B12	0.279
Bluetooth	BLE	0.117

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 C95.1:1992/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 IEEE Std 1528-2013 .

3.2 GENERAL DESCRIPTION OF EUT

Equipment	Pebblebee Found	
Model Name	PB-701-B		
Operation Frequency Range(s)	Band	TX (MHz)	RX (MHz)
	LTE Cat-M1 B2	1850 - 1910	
	LTE Cat-M1 B4	1710 - 1755	
	LTE Cat-M1 B12	699 - 716	
	BLE	2400 - 2500	

Antenna Information				
Brand	Model	Antenna type	Band	Gain(dBi)
Wieson	ARY197-1757-003-00	PIFA	Cat-M1 Band 2	-4.37
			Cat-M1 Band 4	-6.53
			Cat-M1 Band 12	-8.46
			BLE	-2.57

3.3 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.	

3.4 MAIN TEST INSTRUMENTS

Item	Equipment	Manufacturer	Model	Serial No.	Cal. Date	Cal. Interval
1	Data Acquisition Electronics	Speag	DAE4	1486	Jun. 04, 2020	1 Year
2	E-field Probe	Speag	EX3DV4	7369	May. 29, 2020	1 Year
3	System Validation Dipole	Speag	D750V3	1145	Jun. 12, 2019	3 Year
4	System Validation Dipole	Speag	D1750V2	1101	Jun. 7, 2018	3 Year
5	System Validation Dipole	Speag	D1900V2	5d208	Jun. 11, 2019	3 Year
6	System Validation Dipole	Speag	D2450V2	973	Sep. 21, 2018	3 Year
7	ELI4 Phantom	Speag	ELI4 Phantom V5.0	1240	N/A	N/A
8	ENA Network Analyzer	Agilent	E5071C	MY46524658	Apr. 07, 2020	1 Year
9	EXA Spectrum Analyzer	Keysight	N9010A	MY54200240	Jul. 25, 2019	1 Year
10	Power Meter	Anritsu	ML2487A	6K00004714	Jun. 20, 2019	1 Year
11	Power Sensor	Anritsu	MA2491A	1725282	Jun. 20, 2019	1 Year
12	Dielectric Probe Kit	Agilent	85070E	2593	N/A	N/A
13	Low pass filter	Mini-Circuits	SLP-2950+	M108294	N/A	N/A
14	Power Amplifier	Mini-Circuits	ZVE-2W-272+	N650001538	N/A	N/A
15	Power Amplifier	Mini-Circuits	ZVE-8G+	N628801631	N/A	N/A

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

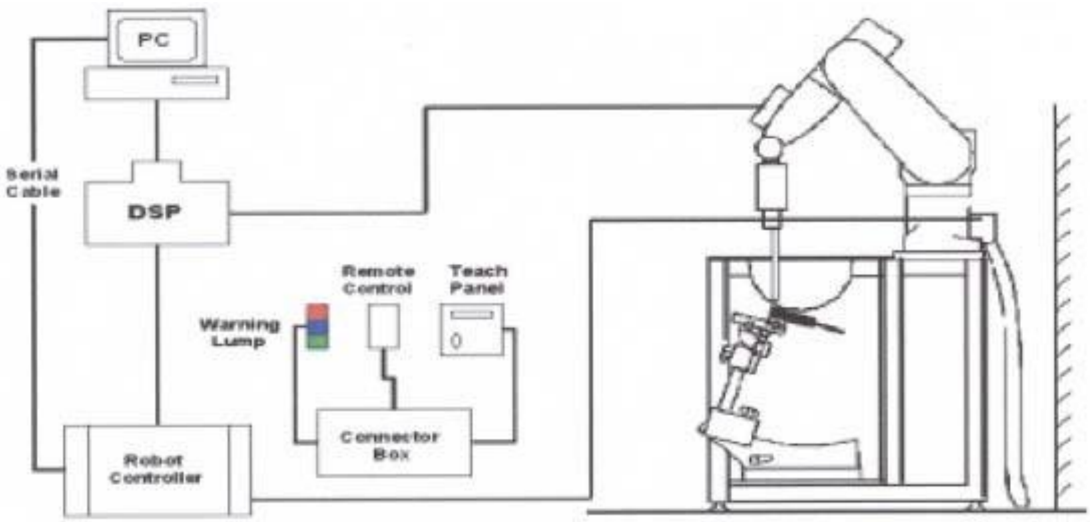
4 SAR MEASUREMENTS SYSTEM CONFIGURATION

4.1 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.

4.1.1 TEST SETUP LAYOUT

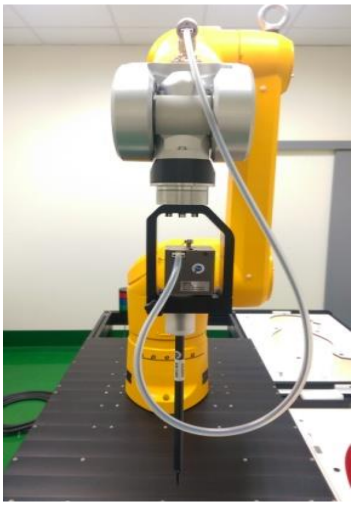


4.2 DASY5 E-FIELD PROBE SYSTEM

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

4.2.1 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

4.2.2 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.

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

Where: Δt = Exposure time (30 seconds),

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

ΔT = Temperature increase due to RF exposure.

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

Where: σ = Simulated tissue conductivity,

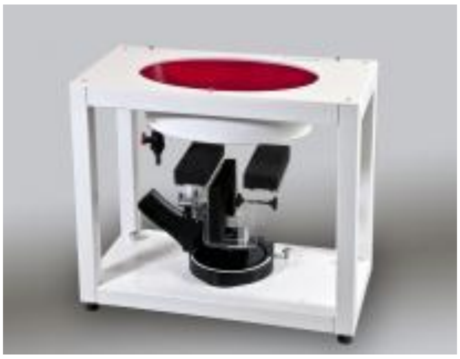
ρ = Tissue density (kg/m3).

4.2.3 OTHER TEST EQUIPMENT

4.2.3.1. 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, ELI4and SAM v6.0Phantoms.
Material: POM, Acrylic glass, Foam

4.2.3.2 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	

4.2.4 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 in x- and y- dimension(2-4 GHz) and 10mm in x- and y- dimension(4-6GHz). If a finer resolution is needed, the grid spacing can be reduced. Grid spacing and orientation have no influence on the SAR result. For special applications where the standard scan method does not find the peak SAR within the grid, e.g. mobile phones with flip cover, the grid can be adapted in orientation.

- 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 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

4.2.5 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.

4.2.6 DATA STORAGE AND EVALUATION

4.2.6.1 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 “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/cm^2], [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.

4.2.7 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

5 SYSTEM VERIFICATION PROCEDURE

5.1 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 750	0.2	-	0.2	1.5	56.0	-	42.1	-
Head 1750	-	47.0	-	0.4	-	-	52.6	-
Head 1900	-	44.5	-	0.2	-	-	55.3	-
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	750	22.5	0.91	42.58	0.89	41.9	1.80	1.61	Jul. 10, 2020
Head	1750	22.0	1.32	41.29	1.37	40.1	-3.50	2.98	Jul. 10, 2020
Head	1900	22.0	1.42	40.57	1.40	40.0	1.21	1.43	Jul. 10, 2020
Head	2450	22.0	1.80	37.89	1.80	39.2	0.17	-3.32	Jul. 10, 2020

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.

5.2 SYSTEM CHECK

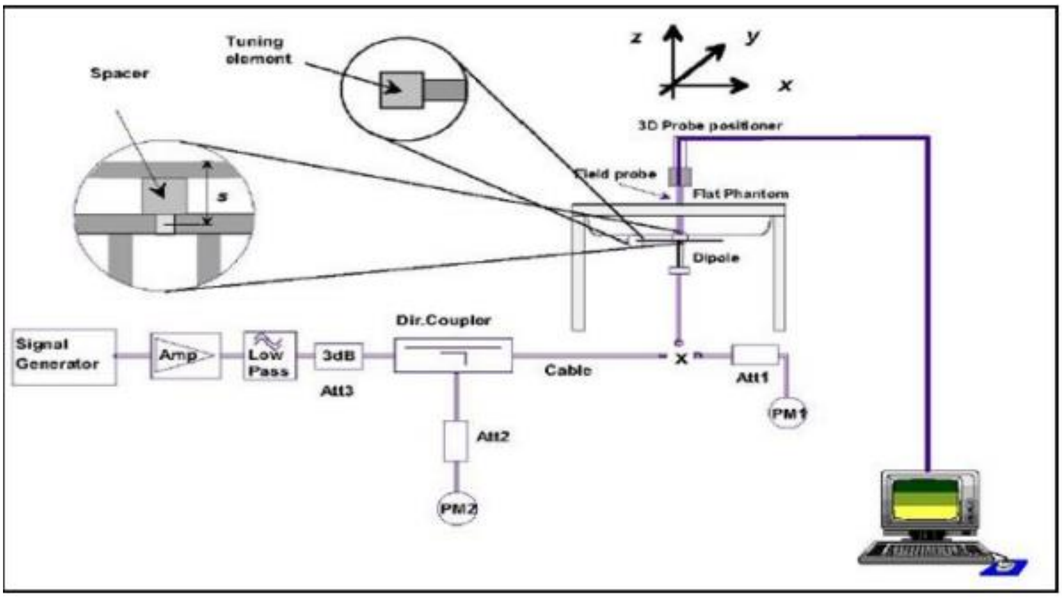
The system check is performed for verifying the accuracy of the complete measurement system and performance of the software. The system check is performed with tissue equivalent material according to IEEE P1528 (described above). The following table shows system check results for all frequency bands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

System Check	Date	Frequency (MHz)	Targeted SAR-1g (W/kg)	Measured SAR-1g (W/kg)	normalized SAR-1g (W/kg)	Deviation (%)	Dipole S/N
Head	Jul. 10, 2020	750	8.65	2.14	8.56	-1.04	1145
Head	Jul. 10, 2020	1750	37.00	9.48	37.92	2.49	1101
Head	Jul. 10, 2020	1900	39.50	10.30	41.20	4.30	5d208
Head	Jul. 10, 2020	2450	51.90	13.10	52.40	0.96	937

5.3 SYSTEM CHECK PROCEDURE

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

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 %).



6 SAR MEASUREMENT VARIABILITY AND UNCERTAINTY

6.1 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 OPERATIONAL CONDITIONS DURING TEST

7.1 TEST CONFIGURATION

SAR EVALUATION PROCEDURES FOR UMPC MINI-TABLET DEVICES
This document describes the SAR test requirements for certain small hand-held tablets and devices of similar form factors that are designed primarily for interactive hand-held use next to or near the body of users. This type of mini-tablets is normally optimized for mobile web access and multimedia use. The test procedures are applicable to devices with a display and overall diagonal dimension ≤ 20 cm (~7.9”). These devices are typically operated like a mini-tablet and are usually designed with certain UMPC features and operating characteristics; therefore, the term “UMPC Mini-Tablet” is used to identify the SAR test requirements for this category of devices. A composite test separation distance of 5 mm is applied to test UMPC mini-tablet transmitters and to maintain RF exposure conservativeness for the interactive operations associated with this type of devices. The same approach and concepts used for wireless routers (also known as hotspot mode) are applied to UMPC mini-tablet devices.1 Other than a smaller test separation distance of 5 mm, the same device test setup is used for UMPC mini-tablet devices and wireless routers. Combinations of voice, data, video, gaming and hotspot mode transmissions can be supported in various wireless modes, technologies and frequency bands for hand-held and near-body use conditions by this type of devices. Voice communication for UMPC mini-tablet devices, however, should be limited to speaker mode only. When next to the ear voice operations are supported, the handset and phablet procedures in KDB Publication 648474 D04 must be applied.

UMPC mini-tablet devices must be tested for 1-g SAR on all surfaces and side edges with a transmitting antenna located at ≤ 25 mm from that surface or edge, at 5 mm separation from a flat phantom, for the data modes, wireless technologies and frequency bands supported by the device to determine SAR compliance. When 1-g SAR is tested at 5 mm, 10-g SAR is not required. When voice mode applies (speaker mode only) and the exposure conditions are not adequately covered by the data mode SAR results, additional SAR tests for voice mode may be required; for example, when the maximum average output power levels are different for 1x RTT and EvDo or GSM and GPRS. When the maximum output power levels of transmitters used in hotspot mode are not higher than those tested using UMPC mini-tablet procedures the more conservative UMPC mini-tablet SAR results can be used to support hotspot mode. For simultaneous transmission conditions, the procedures described in KDB Publication 447498 D01 are used to determine 1-g SAR test exclusion and SAR test requirements. The simultaneous transmission configurations must be clearly described in the SAR report to support the test exclusion analysis and results.
Depending on the device form factor, antenna locations, operating configurations and exposure conditions, a test separation distance up to 10 mm may be considered for some devices; for example, certain game controllers and dual display smart phones. Under such circumstances, 10-g extremity SAR must also be measured at zero test separation for all measured 1-g (10 mm) SAR configurations to address hand exposure. A KDB inquiry is required to determine 10 mm is acceptable for measuring 1-g SAR.
1 See “SAR Evaluation Procedures for Portable Devices with Wireless Router Capabilities” in KDB Publication 941225 D06. 941225 D07 UMPC Mini Tablet v01r02 Page 2

Some UMPC mini-table devices may incorporated proximity sensing and power reduction mechanisms to address RF exposure and simultaneous transmission concerns. The proximity sensor triggering distance and coverage tests described in KDB Publication 616217 D04 for full size tablets should be applied to determine the non-reduced full power SAR test separation distance required for UMPC mini-tablets.
For larger tablets with a display or overall diagonal dimension > 20 cm, the SAR procedures in KDB Publication 616217 D04 are required. The use conditions for tablets with larger form factors or overall dimensions are different and often have additional features to control or restrict transmissions to support interactive use; therefore, the test considerations for UMPC mini-tablet devices may not fully apply to the full size tablets. As different tablet designs and use conditions continue to emerge, the SAR test requirements may need adjustments. A KDB inquiry is recommended to ensure the test configurations used are acceptable for evolving products.

7.2 TEST POSITION

7.2.1 BODY

The overall diagonal dimension of the display section of a tablet is 21.1cm>20cm, per FCC KDB 616217, the back surface and edges of the tablet should be tested for SAR compliance with the Tablet touching the phantom. SAR evaluation for the front surface of tablet display screens is generally not necessary. The SAR Exclusion Threshold in KDB 447498 D01 can be applied to determine SAR test exclusion for adjacent edge configurations. The closest distance from the antenna to an adjacent tablet 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:

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

When the minimum test separation distance is < 5 mm, a distance of 5 mm 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:

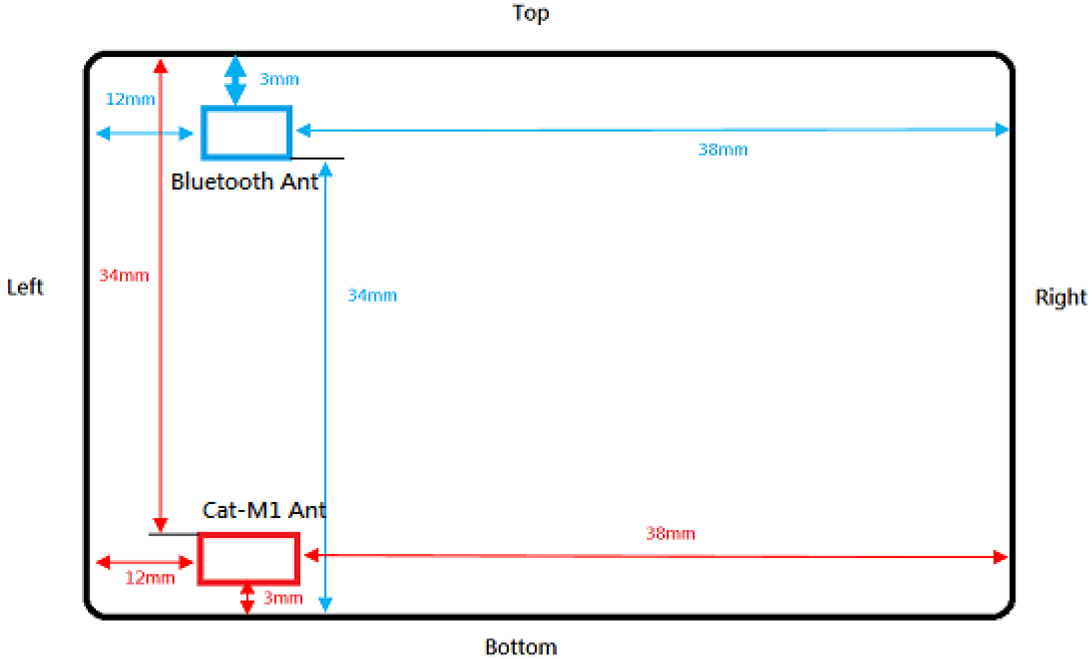
a) at 100 MHz to1500 MHz

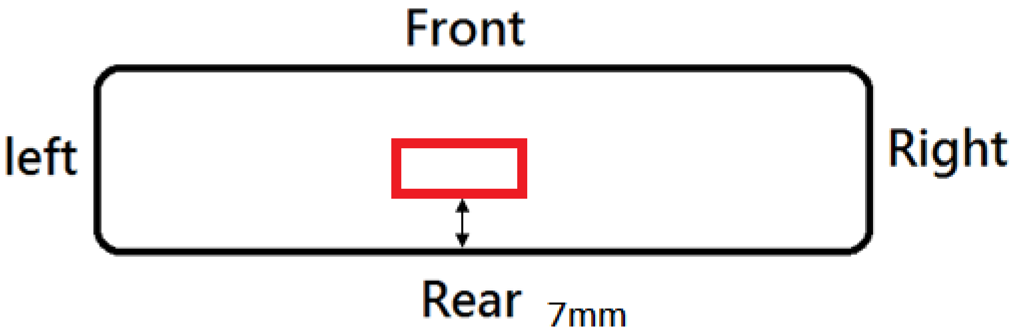
[Power allowed at numeric Threshold at 50 mm in step 1) + (test separation distance - 50 mm) · (f $_{(MHz)}$/150)] mW

b) at >1500MHz and ≤6GHz

[Power allowed at numeric Threshold at 50 mm in step 1) + (test separation distance - 50 mm) ·10] mW

The location of the antenna inside EUT is as below.





Antenna	Rear Face	Right Side	Left Side	Top Side	Bottom Side
Cat-M1	7mm	38mm	12mm	34mm	3mm
Bluetooth	7mm	38mm	12mm	3mm	34mm

The distance <50mm_WWAN

Mode	Position	Pmax (dBm)*	Pmax (mW)	Distance (mm)	f (GHz)	Calculation Result	SAR Exclusion threshold	Test Requirement (Yes/No)
Cat-M1 B2	Top	22.5	177.83	34	1.910	7.23	3	Yes
	Bottom	22.5	177.83	3	1.910	81.92	3	Yes
	Right	22.5	177.83	38	1.910	6.47	3	Yes
	Left	22.5	177.83	12	1.910	20.48	3	Yes
	Rear	22.5	177.83	7	1.910	35.11	3	Yes
Cat-M1 B4	Top	22.5	177.83	34	1.720	6.86	3	Yes
	Bottom	22.5	177.83	3	1.720	77.74	3	Yes
	Right	22.5	177.83	38	1.720	6.14	3	Yes
	Left	22.5	177.83	12	1.720	19.43	3	Yes
	Rear	22.5	177.83	7	1.720	33.32	3	Yes
Cat-M1 B12	Top	22.5	177.83	34	0.711	4.41	3	Yes
	Bottom	22.5	177.83	3	0.711	49.98	3	Yes
	Right	22.5	177.83	38	0.711	3.95	3	Yes
	Left	22.5	177.83	12	0.711	12.50	3	Yes
	Rear	22.5	177.83	7	0.711	21.42	3	Yes

The distance <50mm_WLAN

Mode	Position	Pmax (dBm)*	Pmax (mW)	Distance (mm)	f (GHz)	Calculation Result	SAR Exclusion threshold	Test Requirement (Yes/No)
BLE/2M	Top	10.00	10.00	3	2.402	5.17	3	Yes
	Bottom	10.00	10.00	34	2.402	0.46	3	No
	Right	10.00	10.00	38	2.402	0.41	3	No
	Left	10.00	10.00	12	2.402	1.29	3	No
	Rear	10.00	10.00	7	2.402	2.21	3	No

8 TEST RESULT

8.1 CONDUCTED POWER RESULTS

8.1.1 CONDUCTED POWER MEASUREMENTS OF UHF

Cat-M1 Band 2 Power Table

LTE B1/BW=5M		Average Conducted Power(dBm)				LTE B1/BW=10M		Average Conducted Power(dBm)			
Modula-tion	RB Size/ Offset	Max. Tune-up	Channel/Frequency(MHz)			Modula-tion	RB Size/ Offset	Max. Tune-up	Channel/Frequency(MHz)		
			18625/ 1852.5	18900/ 1880	19175/ 1907.5				18650/ 1855	18900/ 1880	19150/ 1905
QPSK	1/0	22.5	20.1	20.3	20.7	QPSK	1/0	22.5	20.2	20.3	20.7
	6/0	22.5	20.0	20.3	20.6		6/0	22.5	20.1	20.3	20.7
16QAM	1/0	22.5	19.6	19.7	20.4	16QAM	1/0	22.5	19.7	19.8	20.5
	6/0	22.5	19.6	19.7	20.5		6/0	22.5	19.7	19.7	20.5
LTE B1/BW=15M		Average Conducted Power(dBm)				LTE B1/BW=20M		Average Conducted Power(dBm)			
Modula-tion	RB Size/ Offset	Max. Tune-up	Channel/Frequency(MHz)			Modula-tion	RB Size/ Offset	Max. Tune-up	Channel/Frequency(MHz)		
			18675/ 1857.5	18900/ 1880	19125/ 1902.5				18700/ 1860	18900/ 1880	19100/ 1900
QPSK	1/0	22.5	20.2	20.4	20.8	QPSK	1/0	22.5	20.3	20.4	20.8
	6/0	22.5	20.1	20.4	20.7		6/0	22.5	20.2	20.4	20.8
16QAM	1/0	22.5	19.7	19.8	20.5	16QAM	1/0	22.5	19.8	19.9	20.6
	6/0	22.5	19.7	19.8	20.6		6/0	22.5	19.8	19.8	20.6

Cat-M1 Band 4 Power Table

LTE B1/BW=5M		Average Conducted Power(dBm)				LTE B1/BW=10M		Average Conducted Power(dBm)			
Modula-tion	RB Size/ Offset	Max. Tune-up	Channel/Frequency(MHz)			Modula-tion	RB Size/ Offset	Max. Tune-up	Channel/Frequency(MHz)		
			19975/ 1712.5	20175/ 1732.5	20375/ 1752.5				20000/ 1715	20175/ 1732.5	20350/ 1750
QPSK	1/0	22.5	21.2	21.0	20.6	QPSK	1/0	22.5	21.3	21.0	20.7
	6/0	22.5	21.1	20.9	20.5		6/0	22.5	21.2	20.9	20.6
16QAM	1/0	22.5	20.8	20.5	20.1	16QAM	1/0	22.5	20.8	20.6	20.2
	6/0	22.5	20.7	20.4	20.1		6/0	22.5	20.8	20.4	20.1
LTE B1/BW=15M		Average Conducted Power(dBm)				LTE B1/BW=20M		Average Conducted Power(dBm)			
Modula-tion	RB Size/ Offset	Max. Tune-up	Channel/Frequency(MHz)			Modula-tion	RB Size/ Offset	Max. Tune-up	Channel/Frequency(MHz)		
			20025/ 1717.5	20175/ 1732.5	20325/ 1747.5				20050/ 1720	20175/ 1732.5	20300/ 1745
QPSK	1/0	22.5	21.3	21.1	20.7	QPSK	1/0	22.5	21.4	21.1	20.8
	6/0	22.5	21.2	21.0	20.6		6/0	22.5	21.3	21.0	20.7
16QAM	1/0	22.5	20.9	20.6	20.2	16QAM	1/0	22.5	20.9	20.7	20.3
	6/0	22.5	20.8	20.5	20.2		6/0	22.5	20.9	20.5	20.2

Cat-M1 Band 12 Power Table

LTE B1/BW=5M		Average Conducted Power(dBm)				LTE B1/BW=10M		Average Conducted Power(dBm)			
Modula -tion	RB Size/ Offset	Max. Tune-up	Channel/Frequency(MHz)			Modula -tion	RB Size/ Offset	Max. Tune-up	Channel/Frequency(MHz)		
			23035/ 701.5	23095/ 707.5	23155/ 713.5				23060/ 704	23095/ 707.5	23130/ 711
QPSK	1/0	22.5	22.0	22.1	22.1	QPSK	1/0	22.5	22.0	22.1	22.2
	6/0	22.5	21.0	21.1	21.2		6/0	22.5	21.1	21.2	21.2
16QAM	1/0	22.5	21.4	21.5	21.6	16QAM	1/0	22.5	21.5	21.6	21.7
	6/0	22.5	20.7	20.7	20.6		6/0	22.5	20.7	20.7	20.7

BLE Power Table

Band	Mode	Channel	Frequency(MHz)	Modulation	Max. Tune up	Average Power(dBm)
BT4.0	1M	0	2402	DPSK	10.00	8.53
		19	2440		10.00	8.47
		38	2480		10.00	8.51
	2M	0	2402	DPSK	10.00	8.48
		19	2440		10.00	8.57
		38	2480		10.00	8.64

8.2SAR TEST 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.
4) Per KDB865664 D02, SAR plot is only required for the highest measured SAR in each exposure configuration, wireless mode and frequency band combination; Plots are also required when the measured SAR is > 1.5 W/kg, or > 7.0 W/kg for occupational exposure. The published RF exposure KDB procedures may require additional plots; for example, to support SAR to peak location separation ratio test exclusion and/or volume scan post-processing.

8.2.1 SAR MEASUREMENT RESULT

Test No.	Band	Mode	Channel	RB	Offset	Test Position	Separation Distance (cm)	Maximum Tune-up (dBm)	Conducted Power (dBm)	SAR 1g (W/kg)	Reported 1g SAR (W/kg)
T01	Cat-M1 B2	QPSK20M	19100	1	0	Bottom	0.5	22.50	20.80	**0.279**	0.413
T02	Cat-M1 B2	QPSK20M	19100	1	0	Top	0.5	22.50	20.80	0.031	0.046
T03	Cat-M1 B2	QPSK20M	19100	1	0	Left	0.5	22.50	20.80	0.038	0.057
T04	Cat-M1 B2	QPSK20M	19100	1	0	Right	0.5	22.50	20.80	0.003	0.004
T05	Cat-M1 B2	QPSK20M	19100	1	0	Rear	0.5	22.50	20.80	0.014	0.020
T06	Cat-M1 B4	QPSK20M	20050	1	0	Bottom	0.5	22.50	21.40	**0.173**	0.223
T07	Cat-M1 B4	QPSK20M	20050	1	0	Top	0.5	22.50	21.40	0.059	0.075
T08	Cat-M1 B4	QPSK20M	20050	1	0	Left	0.5	22.50	21.40	0.075	0.096
T09	Cat-M1 B4	QPSK20M	20050	1	0	Right	0.5	22.50	21.40	0.029	0.037
T10	Cat-M1 B4	QPSK20M	20050	1	0	Rear	0.5	22.50	21.40	0.053	0.068
T11	Cat-M1 B12	QPSK10M	23130	1	0	Bottom	0.5	22.50	22.20	**0.260**	0.279
T12	Cat-M1 B12	QPSK10M	23130	1	0	Top	0.5	22.50	22.20	0.157	0.168
T13	Cat-M1 B12	QPSK10M	23130	1	0	Left	0.5	22.50	22.20	0.082	0.088
T14	Cat-M1 B12	QPSK10M	23130	1	0	Right	0.5	22.50	22.20	0.004	0.004
T15	Cat-M1 B12	QPSK10M	23130	1	0	Rear	0.5	22.50	22.20	0.006	0.007

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

SAR test results of 2.4G frequency modulation_separation distance=0.5cm

Test No.	Band/Mode	Channel	Test Position	Maximum Tune-up (dBm)	Conducted Power (dBm)	SAR 1g (W/kg)	Reported 1g SAR (W/kg)
T16	BLE/2M	19	Top	10.00	8.57	0.084	0.117

9 SIMULTANEOUS TRANSMISSION CONDITIONS

9.1 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	Body
1	WWAN Ant + Bluetooth Ant	YES

Note: BT antenna only supports the aux antenna.

10.3 ESTIMATED SAR FOR SIMULTANEOUS TRANSMISSION SAR ANALYSIS

Considerations for SAR estimation

1. When standalone SAR test exclusion applies, standalone SAR must also be estimated to determine simultaneous transmission SAR test exclusion.
2. Dedicated Host Approach criteria for SAR test exclusion is likewise applied to SAR estimation, with certain distinctions between test exclusion and SAR estimation:

- When the separation distance from the antenna to an adjacent edge is ≤ 5 mm, a distance of 5 mm is applied for SAR estimation; this is the same between test exclusion and SAR estimation calculations.
- When the separation distance from the antenna to an adjacent edge is > 5 mm but ≤ 50 mm, the actual antenna-to-edge separation distance is applied for SAR estimation.
- When the minimum test separation distance is > 50 mm, the estimated SAR value is 0.4 W/kg

10.3.1 ESTIMATED SAR FOR BLUETOOTH

According to section 9, the Bluetooth must be estimated according to following to determine simultaneous transmission SAR test exclusion:

- *(max. power of channel, including tune-up tolerance, mW) / (min. test separation distance, mm)]·[$\sqrt{f_{(GHz)}}/x$]* W/kg for test separation distances ≤ 50 mm; where x = 7.5 for 1-g SAR, and x = 18.75 for 10-g SAR.
- 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the test separation distances is > 50 mm.

Antenna	Band	Frequency (MHz)	Output Power		Separation Distances(mm)					Estimated 1-g SAR (W/Kg)				
			dBm	mW	Rear	Top	Right	Left	Bottom	Rear	Top	Right	Left	Bottom
Bluetooth	2.4GHz	2440	10.00	10.00	7.00	**3.00**	**38.00**	12.00	34.00	0.298	Test	0.001	0.035	0.003

10.2 SIMULTANEOUS TRANSMISSION CONDITIONS

Test Position / SAR10g(W/kg)	Rear	Top	Right	Left	Bottom
WWAN Ant	0.068	0.168	0.037	0.096	0.413
BT Ant	0.298	0.117	0.001	0.035	0.003
WWAN+BT MAX$\sum SAR_{1g}$	0.366	0.285	0.038	0.131	0.416

Note: MAX. $\sum SAR_{1g}$=0.416 W/Kg<1.6 W/Kg, so Simultaneous SAR are not required

APPENDIX

10. TEST LAYOUT

Specific Absorption Rate Test Layout

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

HSL(750MHz)   HSL (1750-3800MHz)

Appendix A. SAR Plots of System Verification

(Pls See BTL-FCC SAR-1-2007T023_Appendix A.)

Appendix B. SAR Plots of SAR Measurement

(Pls See BTL-FCC SAR-1-2007T023_Appendix B.)

Appendix C. Calibration Certificate

(Pls See BTL-FCC SAR-1-2007T023_Appendix C.)

Appendix D. Photographs of the Test Set-Up

(Pls See BTL-FCC SAR-1-2007T023_Appendix D.)

End of Test Report