TEST REPORT

APPLICANT	:	OnePlus Technology (Shenzhen) Co., Ltd.
PRODUCT NAME	:	OnePlus Pad
MODEL NAME	:	OPD2203
BRAND NAME	:	ONEPLUS
FCC ID	:	2ABZ2-OPD2203
STANDARD(S)	:	FCC 47 CFR Part 2(2.1093) IEEE 1528-2013
RECEIPT DATE	:	2023-02-23
TEST DATE	:	2023-03-14 to 2023-03-20
ISSUE DATE	:	2023-04-20

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Change History		
Version	**Date**	**Reason for Change**
1.0	2023-04-20	First edition

1 SAR Results Summary

The maximum results of Specific Absorption Rate (SAR) found during test as bellows:

Frequency Band		Highest SAR Summary Body (Separation 0mm) 1g SAR (W/kg)
WLAN	2.4GHz WLAN	0.817
	5GHz WLAN	1.134
2.4GHz Band	Bluetooth	0.607

Highest Simultaneous Transmission 1g SAR (W/kg)	1.572 W/kg	Limit(W/kg): 1.6 W/kg

Note:

1. This device is compliance with Specific Absorption Rate (SAR) for general population or uncontrolled exposure limits (1.6 W/kg) specified in FCC 47 CFR part 1 (1.1310) and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013.
2. When the test result is a critical value, we will use the measurement uncertainty give the judgment result based on the 95% confidence intervals.

2 Technical Information

Note: Provide by applicant.

2.1 Applicant and Manufacturer Information

Applicant:	OnePlus Technology (Shenzhen) Co., Ltd.
Applicant Address:	18C02, 18C03, 18C04, and 18C05, Shum Yip Terra Building, Binhe Avenue North, Futian District, Shenzhen, Guangdong, P.R. China
Manufacturer:	OnePlus Technology (Shenzhen) Co., Ltd.
Manufacturer Address:	18C02, 18C03, 18C04, and 18C05, Shum Yip Terra Building, Binhe Avenue North, Futian District, Shenzhen, Guangdong, P.R. China

2.2 Equipment under Test (EUT) Description

Product Name:	OnePlus Pad
EUT No.:	3#
Hardware Version:	98110_1_11
Software Version:	OPD2203_13.1
Operation Frequency:	WLAN 2.4GHz: 2412 MHz ~ 2462 MHz WLAN 5.2GHz: 5180 MHz ~ 5240 MHz WLAN 5.2GHz: 5260 MHz ~ 5320 MHz WLAN 5.2GHz: 5500 MHz ~ 5720 MHz WLAN 5.8GHz: 5745 MHz ~ 5825 MHz Bluetooth: 2402 MHz ~ 2480 MHz
Modulation technology:	802.11b: DSSS 802.11a/g/n-HT20/HT40/ac-VHT20/40/80/160: OFDM 802.11ax-HEW20/40/80/160: OFDMA Bluetooth BR+EDR: GFSK, π/4-DQPSK, 8-DPSK Bluetooth LE: GFSK
Operation Class:	Class B
Antenna Type:	WLAN: Fixed Internal Antenna Bluetooth: Fixed Internal Antenna

2.3 Environment of Test Site

Temperature:	18°C ~25°C
Humidity:	35%~75% RH
Atmospheric Pressure:	1010 mbar

Test Frequency:	WLAN 2.4GHz WLAN 5GHz Bluetooth
Power Level:	WLAN 2.4GHz/WLAN 5GHz/Bluetooth refers to Annex E in this Report
Operation Mode:	Call established

During SAR test, EUT is in Traffic Mode (Channel Allocated) at Normal Voltage Condition. A communication link is set up with a System Simulator (SS) by air link, and a call is established.

The EUT shall use its internal transmitter. The antenna(s), battery and accessories shall be those specified by the Factory. The EUT battery must be fully charged and checked periodically during the test to ascertain uniform power output. If a wireless link is used, the antenna connected to the output of the base station simulator shall be placed at least 50 cm away from the handset.
The signal transmitted by the simulator to the antenna feeding point shall be lower than the output power level of the handset by at least 35 dB.

3 Specific Absorption Rate (SAR)

3.1 Introduction

SAR is related to the rate at which energy is absorbed per unit mass in an object exposed to a radio field. The SAR distribution in a biological body is complicated and is usually carried out by experimental techniques or numerical modeling. The standard recommends limits for two tiers of groups, occupational or controlled and general population or uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational or controlled exposure limits are higher than the limits for general population or uncontrolled.

3.2 SAR Definition

The SAR definition is the time derivative (rate) of the incremental energy (dW) absorbed by (dissipated in) an incremental mass (dm) contained in a volume element (dv) of a given density (ρ). The equation description is as below:

$$SAR = \frac{d}{dt}\left(\frac{dU}{dm}\right) = \frac{d}{dt}\left(\frac{dU}{\rho dv}\right)$$

SAR is expressed in units of Watts per kilogram (W/kg)

SAR measurement can be either related to the temperature elevation in tissue by

$$SAR = C\left(\frac{\delta T}{\delta t}\right)$$

Where: C is the specific heat capacity, δT is the temperature rise and δt is the exposure duration, or related to the electrical field in the tissue by

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

Where: σ is the conductivity of the tissue, ρ is the mass density of the tissue and E is the RMS electrical field strength. However for evaluating SAR of low power transmitter, electrical field measurement is typically applied.

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4 RF Exposure Limits

4.1 Uncontrolled Environment

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be made fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

4.2 Controlled Environment

Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e. as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

Limits for General Population/Uncontrolled Exposure (W/kg)

Type Exposure	Uncontrolled Environment Limit
Spatial Peak SAR (1g cube tissue for head and trunk)	1.6 W/kg
Spatial Peak SAR (10g cube tissue for limbs)	4.0 W/kg
Spatial Peak SAR (1g cube tissue for whole body)	0.08 W/kg

Note:

1. Occupational/Uncontrolled Environments are defined as locations where there is exposure that may be incurred by people who are aware of the potential for exposure (i.e. as a result of employment or occupation).
2. Whole-Body SAR is averaged over the entire body, partial-body SAR is averaged over any 1gram of tissue defined as a tissue volume in the shape of a cube. SAR for hands, wrists, feet and ankles is averaged over any 10 grams of tissue defined as a tissue volume in the shape of a cube.

5 Applied Reference Documents

Leading reference documents for testing:

Identity	Document Title	Method Determination /Remark
FCC 47CFR Part 2(2.1093)	Radio Frequency Radiation Exposure valuation: Portable Devices	No deviation
IEEE 1528-2013	IEEE Recommended Practice for Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques	No deviation
KDB 447498 D01v06	General RF Exposure Guidance	No deviation
KDB 248227 D01v02r02	SAR Measurement Procedures for 802.11 Transmitters	No deviation
KDB 616217 D04 v01r01	SAR Evaluation Considerations for Laptop, Notebook, Notebook and Tablet Computers	No deviation
KDB 865664 D01v01r04	SAR Measurement 100 MHz to 6 GHz	No deviation
KDB 865664 D02v01r02	RF Exposure Reporting	No deviation
KDB 941225 D06v02r01	SAR Evaluation Procedures For Portable Devices With Wireless Router Capabilities	No deviation
Note 1: Additions to, deviation, or exclusions from the method shall be judged in the "method determination" column of add, deviate or exclude from the specific method shall be explained in the "Remark" of the above table.		

6 SAR Measurement System

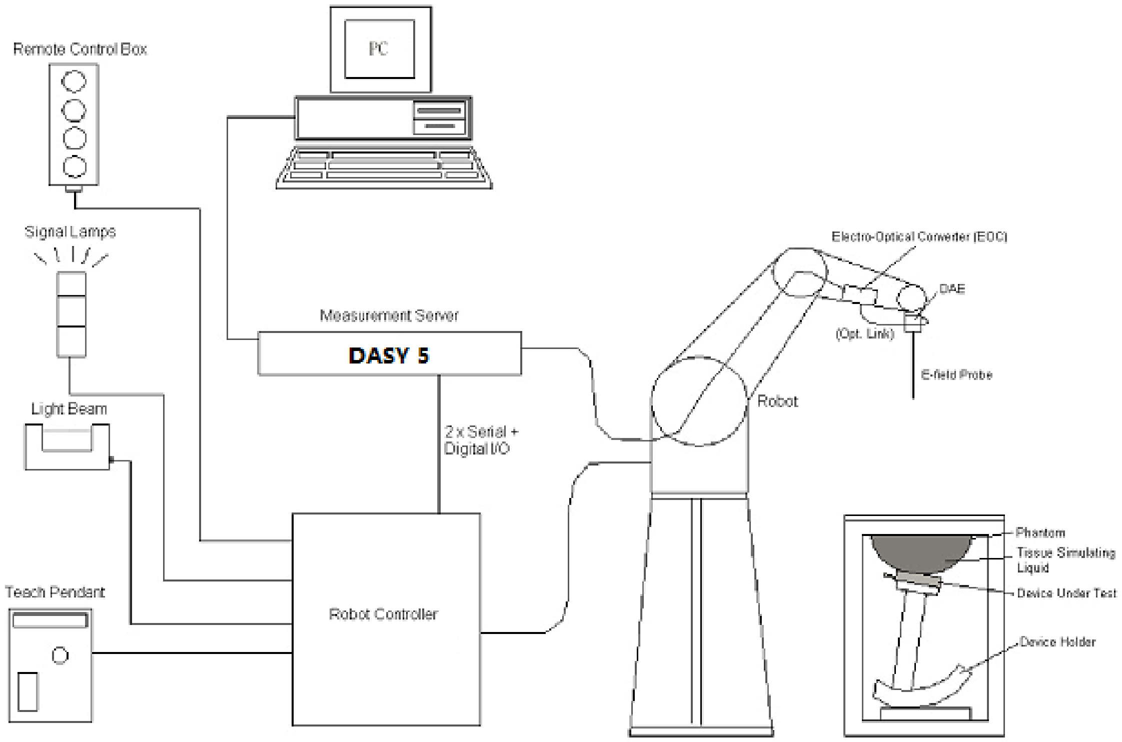

Fig.6.1 SPEAG DASY System Configurations

The DASY system for performance compliance tests is illustrated above graphically. This system consists of the following items:

- A standard high precision 6-axis robot with controller, a teach pendant and software.
- A data acquisition electronic (DAE) attached to the robot arm extension.
- A dosimetric probe equipped with an optical surface detector system.
- The electro-optical converter (EOC) performs the conversion between optical and electrical signals.
- A measurement server performs the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- A probe alignment unit which improves the accuracy of the probe positioning.
- A computer operating Windows XP.
- DASY software.
- Remove control with teach pendant and additional circuitry for robot safety such as warming lamps, etc.
- The SAM twin phantom.
- A device holder.
- Tissue simulating liquid.

➢ Dipole for evaluating the proper functioning of the system.

Component details are described in the following sub-sections.

6.1 E-Field Probe

The SAR measurement is conducted with the dosimetric probe (manufactured by SPEAG). The probe is specially designed and calibrated for use in liquid with high permittivity. The dosimetric probe has special calibration in liquid at different frequency. This probe has a built in optical surface detection system to prevent from collision with phantom.

➢ **E-Field Probe Specification**

<EX3DV4 Probe>

Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Frequency	10 MHz to 6 GHz; Linearity: ± 0.2 dB
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)
Dynamic Range	10 µW/g to 100 mW/g; Linearity: ± 0.2 dB
Dimensions	Overall length: 330 mm (Tip: 20 mm) Tip diameter: 2.5 mm (Body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm

Fig 6.2 Photo of EX3DV4

➢ **E-Field Probe Calibration**

Each probe needs to be calibrated according to a dosimetric assessment procedure with accuracy better than ±10%. The spherical isotropy shall be evaluated and within ±0.25 dB. The sensitivity parameters (Norm X, Norm Y and Norm Z), the diode compression parameter (DCP) and the conversion factor (ConvF) of the probe are tested. The calibration data can be referred to Annex E of this report.

6.2 Data Acquisition Electronics (DAE)

The Data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock. The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.

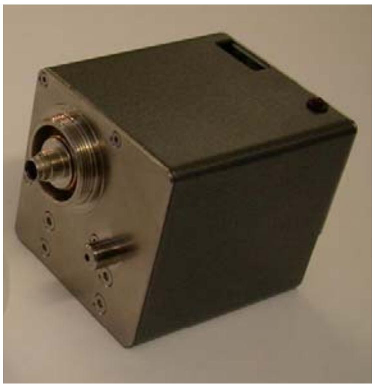

Fig 6.2 Photo of DAE

6.3 Robot

The SPEAG DASY system uses the high precision robots (DASY5: TX60XL) type from Stäubli SA (France). For the 6-axis controller system, the robot controller version (DASY5: CS8c) from Stäubliis used. The Stäublirobot series have many features that are important for our application:

- High precision (repeatability 0.02 mm)
- High reliability (industrial design)
- Low maintenance costs (virtually maintenance free due to direct drive gears; nobelt drives)
- Jerk-free straight movements
- Low ELF interference (motor control fields shielded via the closed metallic construction shields)

Fig. 6.3 Photo of Robot

6.4 Measurement Server

The measurement server is based on a PC/104 CPU board with CPU (DASY 5: 400MHz, Intel Celeron), chip-disk (DASY5: 128 MB), RAM (DASY5: 128 MB). The necessary circuits for communication with the DAE electronic box, as well as the 16 bit AD converter system for optical detection and digital I/O interface are contained on the DASY I/O board, which is directly connected to the PC/104 bus of the CPU board.
The measurement server performs all the real-time data evaluation for field measurements and surface detection, controls robot movements and handles safety operations.

Fig. 6.4 Photo of Server for DASY5

6.5 Light Beam Unit

The light beam switch allows automatic "tooling" of the probe. During the process, the actual position of the probe tip with respect to the robot arm is measured, as well as the probe length and the horizontal probe offset. The software then corrects all movements, such that the robot coordinates are valid for the probe tip.
The repeatability of this process is better than 0.1 mm. If a position has been taught with an aligned probe, the same position will be reached with another aligned probe within 0.1 mm, even if the other probe has different dimensions. During probe rotations, the probe tip will keep its actual position.

Fig. 6.5 Photo of Light Beam

6.6 Phantom

<SAM Twin Phantom>

Shell Thickness	2 ± 0.2 mm (sagging: <1%) Center ear point: 6 ± 0.2 mm	 **Fig. 6.6 Photo of SAM Phantom**
Filling Volume Dimensions	Approx. 25 liters Length: 1000 mm; Width: 500 mm; Height: adjustable feet	
Measurement Areas	Left Head, Right Head, Flat phantom	

The bottom plate contains three pair of bolts for locking the device holder. The device holder positions are adjusted to the standard measurement positions in the three sections. A white cover is provided to tap the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. On the phantom top, three reference markers are provided to identify the phantom position with respect to the robot.

6.7 Device Holder

<Device Holder for SAM Twin Phantom>

The SAR in the phantom is approximately inversely proportional to the square of the distance between the source and the liquid surface. For a source at 5 mm distance, a positioning uncertainty of ±0.5 mm would produce a SAR uncertainty of ± 20 %. Accurate device positioning is therefore crucial for accurate and repeatable measurements. The positions in which the devices must be measured are defined by the standards.

The DASY device holder is designed to cope with different positions given in the standard. It has two scales for the device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear reference points). The rotation center for both scales is the ear reference point (ERP).

Thus the device needs no repositioning when changing the angles.

The DASY device holder is constructed of low-low POM material having the following dielectric parameters: relative permittivity ε = 3 and loss tangent δ = 0.02. The amount of dielectric material has been reduced in the closest vicinity of the device, since measurements have suggested that the influence of the clamp on the test results could thus be lowered.

<Laptop Extension Kit>

The extension is lightweight and made of POM, acrylic glass and foam. It fits easily on the upper part of the mounting device in place of the phone positioned. The extension is fully compatible with the SAM Twin and ELI phantoms.

Fig 6.7 Device Holder

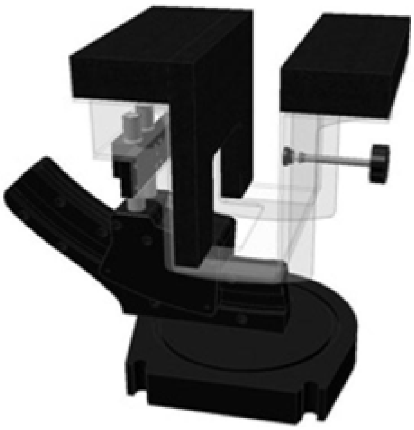

Fig 6.8 Laptop Extension Kit

6.8 Data storage and Evaluation

- **Data Storage**

The DASY software stores the assessed data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all the necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files. The post-processing software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verifications of the complete software setup even after the measurement and allows correction of erroneous parameter settings. For example, if a measurement has been performed with an incorrect crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be reevaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type (e.g., [V/m], [mW/g]). Some of these units are not available in certain situations or give meaningless results, e.g., a SAR-output in a non-lose media, will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

- **Data Evaluation**

The DASY post-processing software (SEMCAD) automatically executes the following procedures to calculate the field units from the microvolt readings at the probe connector. The parameters used in the evaluation are stored in the configuration modules of the software:

Probe Parameters:	- Sensitivity	$Norm_i$, a_{i0}, a_{i1}, a_{i2}
	- Conversion	$ConvF_i$
	- Diode compression point	dcp_i
Device Parameters:	- Frequency	f
	- Crest	cf
Media Parameters:	- Conductivity	σ
	- Density	ρ

These parameters must be set correctly in the software. They can be found in the component documents or they can be imported into the software from the configuration files issued for the DASY 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:

$$V_i = U_i + U_i^2 \cdot \frac{cf}{dcp_i}$$

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: $E_i = \sqrt{\frac{v_i}{Norm_i \cdot ConvF}}$

H-Field Probes: $H_i = \sqrt{V_i} \cdot \frac{a_{i0} + a_{i1} f + a_{i2} f^2}{f}$

With V_i = compensated signal of channel i, (i = x, y, z)
$Norm_i$= senor sensitivity of channel i, (i = x, y, z), μV/ (V/m)^2
ConvF = sensitivity enhancement in solution
a_{ij} = sensor sensitivity factors for H-field probes
f = carrier frequency (GHz)
E_i = electric field strength of channel i in V/m
Hi = magnetic field strength of channel i in A/m
The RSS value of the field components gives the total field strength (Hermitian magnitude):

$$E_{tot} = \sqrt{E_x^2 + E_y^2 + E_z^2}$$

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

$$SAR = E_{tot}^2 \cdot \frac{\sigma}{\rho \cdot 1000}$$

With SAR = local specific absorption rate in mW/g
Etot= total field strength in V/m
σ = conductivity in (mho/m) or (Siemens/m)
ρ= equipment tissue density in g/cm3
Note that the density is set to 1, to account for actual head tissue density rather than the density of the tissue simulating liquid.

6.9 Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial No./ SW Version	Calibration	
				Last Cal.	Due Date
SPEAG	2450MHz System Validation Kit	D2450V2	805	2021.12.17	2024.12.16
SPEAG	5000MHz System Validation Kit	D5GHzV2	1176	2021.12.19	2024.12.18
SPEAG	DOSIMETRIC ASSESSMENT SYSTEM	DASY52	52.10.4.1527	NCR	NCR
SPEAG	Dosimetric E-Field Probe	EX3DV4	7624	2022.03.31	2023.03.30
SPEAG	Data Acquisition Electronics	DAE3	373	2022.12.28	2023.12.27
SPEAG	ELI Phantom	QD OVA004Ax	N/A	NCR	NCR
SPEAG	Phone Positioner	N/A	N/A	NCR	NCR
Agilent	Network Analyzer	E5071B	MY42404762	2023.02.09	2024.02.08
Speag	Dielectric Assessment KIT	DAK-3.5	1279	2022.09.17	2023.09.16
mini-circuits	Amplifier	ZHL-42W+	608501717	NCR	NCR
mini-circuits	Amplifier	ZVE-8G+	754401735	NCR	NCR
Agilent	Signal Generator	N5182B	MY53050509	2022.11.30	2023.11.29
R&S	Power Senor	NRP8S	103215	2023.02.09	2024.02.08
Agilent	Power Meter	E4416A	MY45102093	2022.10.11	2023.10.10
R&S	Power Sensor	NRP8S	103240	2023.02.09	2024.02.08
Anritsu	Power Meter	E4418B	GB43318055	2022.08.30	2023.08.29
Agilent	Dual Directional Coupler	778D	50422	NA	NA
MCL	Attenuation	351-218-010	N/A	NA	NA
R&S	Spectrum Analyzer	N9030A	MY54170556	2022.10.10	2023.10.09
KTJ	Thermo meter	TA298	N/A	2022.12.08	2023.12.07
N/A	Tissue Simulating Liquids	HBBL600-10000V6		24H	

Note:

1. The calibration certificate of DASY can be referred to Annex F of this report.
2. Referring to KDB 865664 D01v01r04, the dipole calibration interval can be extended to 3 years with justification. The dipoles are also not physically damaged, or repaired during the interval.
3. The Insertion Loss calibration of Dual Directional Coupler and Attenuator were characterized via the network analyzer and compensated during system check.
4. The dielectric probe kit was calibrated via the network analyzer, with the specified procedure (calibrated in pure water) and calibration kit (standard) short circuit, before the dielectric measurement. The specific procedure and calibration kit are provided by Speag.
5. In system check we need to monitor the level on the power meter, and adjust the power amplifier level to have precise power level to the dipole; the measured SAR will be normalized

to 1W input power according to the ratio of1W to the input power to the dipole. For system check, the calibration of the power amplifier is deemed not critically required for correct measurement; the power meter is critical and we do have calibration for it

6. Attenuator insertion loss is calibrated by the network Analyzer, which the calibration is valid, before system check.
7. N.C.R means No Calibration Requirement.

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7 Tissue Simulating Liquids

For the measurement of the field distribution inside the SAM phantom with DASY, the phantom must be filled with around 25 liters of homogeneous body tissue simulating liquid. For head SAR testing, the liquid height from the ear reference point (ERP) of the phantom to the liquid top surface is larger than 15 cm, which is shown in Fig. 7.1, for body SAR testing, the liquid height from the centre of the flat phantom to liquid top surface is larger than 15 cm, which is shown in Fig. 7.2.

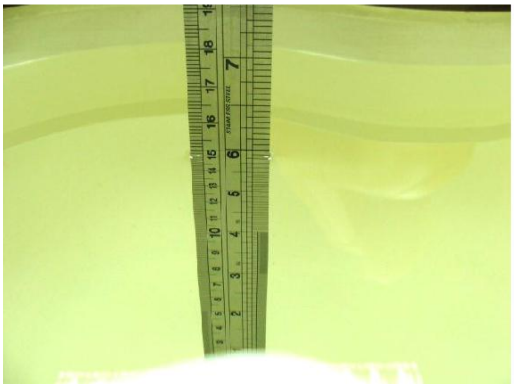

Fig 7.1 Photo of Liquid Height for Head SAR

Fig 7.2 Photo of Liquid Height for Body SAR

The following table gives the recipes for tissue simulating liquids

Frequency (MHz)	Water (%)	Sugar (%)	Cellulose (%)	Salt (%)	Preventol (%)	DGBE (%)	Conductivity (σ)	Permittivity (εr)
Head								
750	41.1	57.0	0.2	1.4	0.2	0	0.89	41.9
835	40.3	57.9	0.2	1.4	0.2	0	0.90	41.5
1800,1900,2000	55.2	0	0	0.3	0	44.5	1.40	40.0
2450	55.0	0	0	0	0	45.0	1.80	39.2
2600	54.8	0	0	0.1	0	45.1	1.96	39.0

Simulating Liquid for 5GHz, Manufactured by SPEAG

Ingredients	(% by weight)
Water	64~78%
Mineral oil	11~18%
Emulsifiers	9~15%
Additives and Salt	2~3%

The relative permittivity and conductivity of the tissue material should be within ±5% of the values given in the table below recommended by the FCC OET 65supplement C and RSS 102 Issue 5.

Target Frequency	Head		Body	
(MHz)	ε r	σ (S/m)	ε r	σ (S/m)
150	52.3	0.76	61.9	0.80
300	45.3	0.87	58.2	0.92
450	43.5	0.87	56.7	0.94
835	41.5	0.90	55.2	0.97
900	41.5	0.97	55.0	1.05
915	41.5	0.98	55.0	1.06
1450	40.5	1.20	54.0	1.30
1610	40.3	1.29	53.8	1.40
1800-2000	40.0	1.40	53.3	1.52
2450	39.2	1.80	52.7	1.95
3000	38.5	2.40	52.0	2.73
5800	35.3	5.27	48.2	6.00

(ε r = relative permittivity, σ = conductivity and ρ = 1000 kg/m^3)

The dielectric parameters of liquids were verified prior to the SAR evaluation using a Speag Dielectric Probe Kit and an Agilent Network Analyzer.

The following table shows the measuring results for simulating liquid.

Table 1: Dielectric Performance of Tissue Simulating Liquid

Frequency (MHz)	Tissue Type	Liquid Temp.(℃)	Conductivity (σ)	Conductivity Target (σ)	Delta (σ) (%)	Limit (%)	Date
2450	HSL	22.2	1.810	1.80	0.56	±5	2023.03.14
5250	HSL	22.1	4.710	4.71	1.70	±5	2023.03.15
5600	HSL	22.2	5.220	5.07	2.96	±5	2023.03.17
5750	HSL	22.3	5.215	5.22	-0.19	±5	2023.03.20

Frequency (MHz)	Tissue Type	Liquid Temp.(℃)	Permittivity (εr)	Permittivity Target (εr)	Delta (εr) (%)	Limit (%)	Date
2450	HSL	22.2	39.259	39.20	0.15	±5	2023.03.14
5250	HSL	22.1	35.950	35.95	-0.07	±5	2023.03.15
5600	HSL	22.2	35.713	35.50	0.60	±5	2023.03.17
5750	HSL	22.3	35.247	35.35	-0.29	±5	2023.03.20

Note:

According to April 2019 TCB Workshop that FCC has permitted the use of single head-tissue simulating liquid specified in IEC 62209-1 for all SAR tests.

8 SAR System Verification

Each DASY system is equipped with one or more system validation kits. These units, together with the predefined measurement procedures within the DASY software, enable the user to conduct the system performance check and system validation. System validation kit includes a dipole, tripod holder to fix it underneath the flat phantom and a corresponding distance holder.

- **System Validation**

According to FCC KDB 865664 D02, SAR system verification is required to confirm measurement accuracy. The SAR systems (including SAR probes, system components and software versions) used for this device were validated against its performance specifications prior to the SAR measurements. Reference dipoles are used with the required tissue-equivalent media for system validation, according to the procedures outlined in FCC KDB 865664 D01 and IEEE 1528-2013. Since SAR probe calibrations are frequency dependent, each probe calibration point must be validated at a frequency within the valid frequency range of the probe calibration point, using the system that normally operates with the probe for routine SAR measurements and according to the required tissue-equivalent media. A tabulated summary of the system validation status, measurement frequencies, SAR probes, calibrated signal type(s) and tissue dielectric parameters has been included.

- **Purpose of System Performance check**

The system performance check verifies that the system operates within its specifications. System and operator errors can be detected and corrected. It is recommended that the system performance check be performed prior to any usage of the system in order to guarantee reproducible results. The system performance check uses normal SAR measurements in a simplified setup with a well characterized source. This setup was selected to give a high sensitivity to all parameters that might fail or vary over time. The system check does not intend to replace the calibration of the components, but indicates situations where the system uncertainty is exceeded due to drift or failure.

- **System Setup**

In the simplified setup for system evaluation, the EUT is replaced by a calibrated dipole and the power source is replaced by a continuous wave that comes from a signal generator. The calibrated dipole must be placed beneath the flat phantom section of the SAM twin phantom with the correct distance holder. The distance holder should touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The equipment setup is shown below:

Fig 8.1 Photo of Dipole Setup

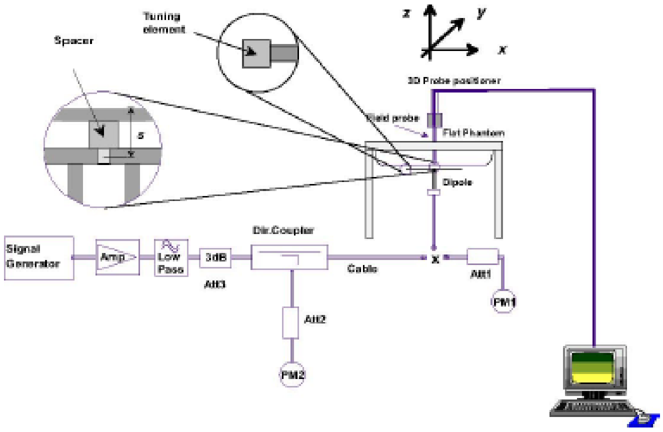

Fig 8.2 System Setup for System Evaluation

➢ **System Verification Results**

Comparing to the original SAR value provided by SPEAG, the verification data should be within its specification of 10%. Below table shows the target SAR and measured SAR after normalized to 1W input power. The table as below indicates the system performance check can meet the variation criterion and the plots can be referred to Annex C of this report.

Dipole S/N	Probe S/N	DAE S/N
D2450V2-805	7624	373
D5GHzV2-1176-5250	7624	373
D5GHzV2-1176-5600	7624	373
D5GHzV2-1176-5750	7624	373

Frequency (MHz)	Tissue Type	Conductivity (σ)	Permittivity (εr)	CW Signal Validation		
				Sensitivity	Probe Linearity	Probe Isotropy
750	HSL	0.851	42.43	PASS	PASS	PASS
835	HSL	0.898	41.88	PASS	PASS	PASS
1750	HSL	1.386	39.91	PASS	PASS	PASS
1800	HSL	1.449	41.26	PASS	PASS	PASS
1900	HSL	1.435	39.65	PASS	PASS	PASS
2000	HSL	1.451	39.42	PASS	PASS	PASS
2300	HSL	1.764	38.99	PASS	PASS	PASS
2450	HSL	1.863	38.85	PASS	PASS	PASS
2600	HSL	1.973	38.58	PASS	PASS	PASS
5250	HSL	4.528	35.32	PASS	PASS	PASS

5600	HSL	4.905	34.89	PASS	PASS	PASS
5750	HSL	5.077	34.28	PASS	PASS	PASS

Frequency (MHz)	**Tissue Type**	**Conductivity (σ)**	**Permittivity (εr)**	**Modulation Signal Validation**		
				Mod. Type	**Duty Factor**	**PAR**
750	HSL	0.851	42.43	N/A	N/A	N/A
835	HSL	0.898	41.88	GMSK	PASS	N/A
1750	HSL	1.386	39.91	N/A	N/A	N/A
1800	HSL	1.449	41.26	N/A	N/A	N/A
1900	HSL	1.435	39.65	GMSK	PASS	N/A
2000	HSL	1.451	39.42	GMSK	PASS	N/A
2300	HSL	1.764	38.99	OFDM	PASS	PASS
2450	HSL	1.863	38.85	OFDM	PASS	PASS
2600	HSL	1.973	38.58	TDD	PASS	N/A
5250	HSL	4.528	35.32	OFDM	N/A	PASS
5600	HSL	4.905	34.89	OFDM	N/A	PASS
5750	HSL	5.077	34.28	OFDM	N/A	PASS

<Validation Results>

Date	Freq. (MHz)	Tissue Type	Input Power (mW)	Measured 1g SAR (W/kg)	Targeted 1g SAR (W/kg)	Normalized 1g SAR (W/kg)	Deviation (%)
2023.03.14	2450	HSL	250	12.88	52.30	51.52	-1.49
2023.03.15	5250	HSL	100	7.51	76.70	75.1	-2.09
2023.03.17	5600	HSL	100	7.86	80.80	78.6	-2.72
2023.03.20	5750	HSL	100	7.76	78.70	77.6	-1.40

Date	Freq. (MHz)	Tissue Type	Input Power (mW)	Measured 1g SAR (W/kg)	Targeted 1g SAR (W/kg)	Normalized 1g SAR (W/kg)	Deviation (%)
2023.03.14	2450	HSL	250	5.98	23.90	23.92	0.08
2023.03.15	5250	HSL	100	2.14	22.10	21.4	-3.17
2023.03.17	5600	HSL	100	2.29	23.30	22.9	-1.72
2023.03.20	5750	HSL	100	2.29	22.50	22.9	1.78

Note: System checks the specific test data please see Annex C.

9 EUT Testing Position

This EUT was tested in five different positions. They are Bottom Face/Edge 1/Edge 2/ Edge 3/ Edge 4 for the EUT with phantom 0 mm gap, as illustrated below, please refer to Annex B for the test setup photos.

9.1 Body-Supported Device Configurations

According to KDB 616217 section 4.3, SAR should be separately assessed with each surface and separation distance positioned against the flat phantom that correspond to the intended use as specified by the manufacturer. The antennas in tablets are typically located near the back (bottom) surface and/or along the edges of the devices; therefore, SAR evaluation is required for these configurations. Exposures from antennas through the front (top) surface of the display section of a full-size tablet, away from the edges, are generally limited to the user's hands. Exposures to hands for typical consumer transmitters used in tablets are not expected to exceed the extremity SAR limit; therefore, SAR evaluation for the front surface of tablet display screens are generally not necessary, except for tablets that are designed to require continuous operations with the hand(s) next to the antenna(s).

- To position the device parallel to the phantom surface with either keypad up or down.
- To adjust the device parallel to the flat phantom.
- To adjust the distance between the device surface and the flat phantom to 0 mm.
- When each surface is measurement, the SAR Test Exclusion Threshold in KDB 447498 should be applied.

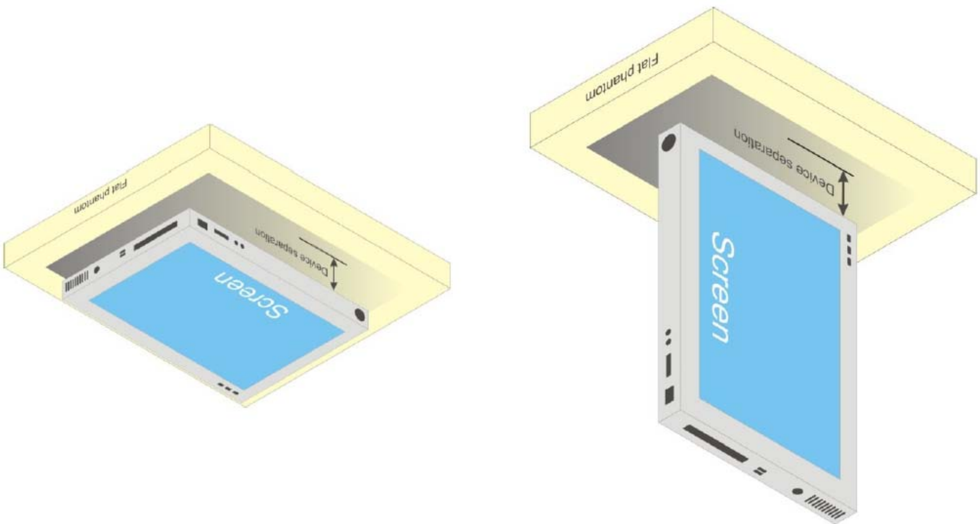

Fig.9.1 Illustration for Body Position

9.2 Wireless Router (Hotspot) Configurations

Some battery-operated handsets have the capability to transmit and receive internet connectivity through simultaneous transmission of WIFI in conjunction with a separate licensed transmitter. The FCC has provided guidance in KDB Publication 941225 D06 where SAR test considerations for handsets (L x W ≥9 cm x 5 cm) are based on a composite test separation distance of 10 mm from the front, back and edges of the device with antennas 2.5 cm or closer to the edge of the device, determined from general mixed use conditions for this type of devices. Since the hotspot SAR results may overlap with the body-worn accessory SAR requirements, the more conservative configurations can be considered, thus excluding some body-worn accessory SAR tests.

When the user enables the personal wireless router functions for the handset, actual operations include simultaneous transmission of both the WIFI transmitter and another licensed transmitter. Both transmitters often do not transmit at the same transmitting frequency and thus cannot be evaluated for SAR under actual use conditions. Therefore, SAR must be evaluated for each frequency transmission and mode separately and summed with the WIFI transmitter according to KDB 648474 publication procedures. The “Portable Hotspot” feature on the handset was NOT activated, to ensure the SAR measurements were evaluated for a single transmission frequency RF signal.

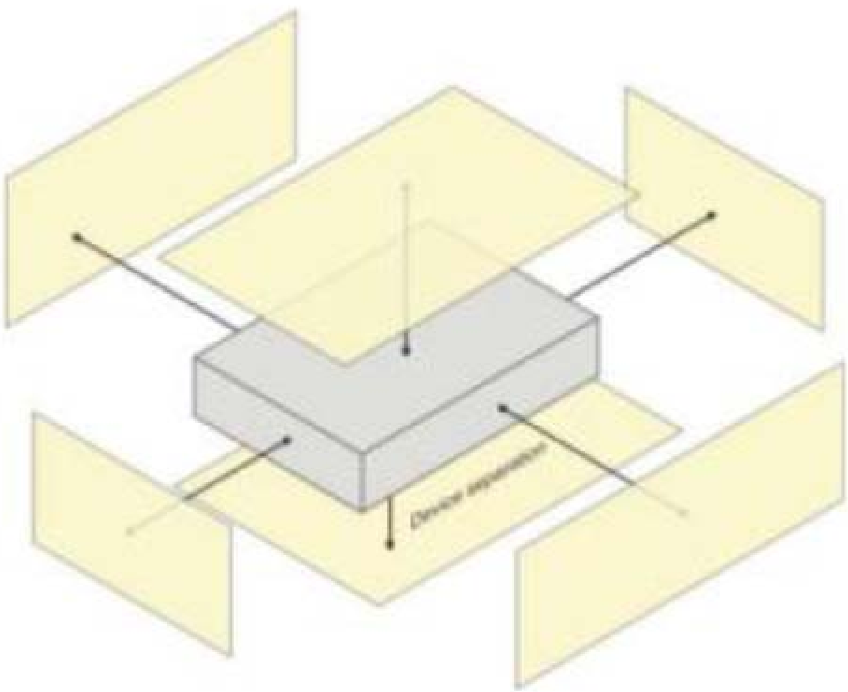

Fig.9.2 Illustration for Hotspot Position

10 Measurement Procedures

The measurement procedures are as bellows:

<Conducted power measurement>

- For WWAN power measurement, use base station simulator to configure EUT WWAN transition in conducted connection with RF cable, at maximum power in each supported wireless interface and frequency band.
- Read the WWAN RF power level from the base station simulator.
- For WLAN/BT power measurement, use engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power in each supported wireless interface and frequency band.
- Connect EUT RF port through RF cable to the power meter or spectrum analyzer, and measure WLAN/BT output power.

<Conducted power measurement>

- Use base station simulator to configure EUT WWAN transmission in radiated connection, and engineering software to configure EUT WLAN/BT continuously transmission, at maximum RF power, in the highest power channel.
- Place the EUT in positions as Annex B demonstrates.
- Set scan area, grid size and other setting on the DASY software.
- Measure SAR results for the highest power channel on each testing position.
- Find out the largest SAR result on these testing positions of each band.
- Measure SAR results for other channels in worst SAR testing position if the Reported SAR or highest power channel is larger than 0.8 W/kg.

According to the test standard, the recommended procedure for assessing the peak spatial-average SAR value consists of the following steps:

- Power reference measurement.
- Area scan.
- Zoom scan.
- Power drift measurement.

10.1 Spatial Peak SAR Evaluation

The procedure for spatial peak SAR evaluation has been implemented according to the test standard. It can be conducted for 1g and 10g, as well as for user-specific masses. The DASY software includes all numerical procedures necessary to evaluate the spatial peak SAR value.

The base for the evaluation is a “cube” measurement. The measured volume must include the 1g and 10 g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan.

The entire evaluation of the spatial peak values is performed within the post-processing engine (SEMCAD). The system always gives the maximum values for 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

- Extraction of the measured data (grid and values) from the Zoom Scan.
- Calculation of the SAR value at every measurement point based on all stored data (A/D values and measurement parameters).
- Generation of a high-resolution mesh within the measured volume.
- Interpolation of all measured values form the measurement grid to the high-resolution grid
- Extrapolation of the entire 3-D field distribution to the phantom surface over the distance from sensor to surface
- Calculation of the averaged SAR within masses of 1g and 10g.

10.2 Power Reference Measurement

The Power Reference Measurement and Power Drift Measurement are for monitoring the power drift of the device under test in the batch process. The minimum distance of probe sensors to surface determines the closest measurement point to phantom surface. This distance cannot be smaller than the distance of sensor calibration points to probe tip as defined in the probe properties.

10.3 Area Scan Procedures

Area scans are defined prior to the measurement process being executed with a user defined variable spacing between each measurement point (integral) allowing low uncertainty measurements to be conducted. Scans defined for FCC applications utilize a10mm^2 step integral, with 1mm interpolation used to locate the peak SAR area used for zoom scan assessments.

When an Area Scan has measured all reachable points, it computes the field maxima found in the scanned area, within a range of the global maximum. The range (in dB) is specified in the standards for compliance testing.

10.4 Zoom Scan Procedures

Zoom Scans are used to assess the peak spatial SAR values within a cubic averaging volume containing 1 g and 10 g of simulated tissue. A density of 1000 kg/m^3 is used to represent the head and body tissue density and not the phantom liquid density, in order to be consistent with the definition of the liquid dielectric properties, i.e. the side length of the 1g cube is 10mm, with the side length of the 10 g cube 21,5mm.The zoom scan integer steps can be user defined so as to reduce uncertainty, but normal practice for typical test applications utilize a physical step of 5x5x7 (8mmx8mmx5mm) providing a volume of 32mm in the X & Y axis, and 30mm in the Z axis.

10.5 SAR Averaged Methods

In DASY, the interpolation and extrapolation are both based on the modified Quadratic Sheppard's method. The interpolation scheme combines a least-square fitted function method and a weighted average method which are the two basic types of computational interpolation and approximation.

Extrapolation routines are used to obtain SAR values between the lowest measurement points and the inner phantom surface. The extrapolation distance is determined by the surface detection distance and the probe sensor offset. The uncertainty increases with the extrapolation distance. To keep the uncertainty within 1% for the 1g and 10g cubes, the extrapolation distance should not be larger than 5 mm.

10.6 Power Drift Monitoring

All SAR testing is under the EUT install full charged battery and transmit maximum output power. In DASY measurement software, the power reference measurement and power drift measurement procedures are used for monitoring the power drift of EUT during SAR test. Both these procedures measure the field at a specified reference position before and after the SAR testing. The software will calculate the field difference in dB. If the power drifts more than 5%, the SAR will be retested.

11 SAR Test Configuration

<WLAN 2.4GHz>

1. SAR is measured for 2.4 GHz 802.11b DSSS using either the fixed test position or, when applicable, the initial test position procedure. SAR test reduction is determined according to the following:
   a. 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.
   b. When the reported SAR is > 0.8 W/kg, SAR is required for that position 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. 2.4 GHz 802.11 g/n OFDM are additionally evaluated for SAR if the highest reported SAR for 802.11b, adjusted by the ratio of the OFDM to DSSS specified maximum output power, is > 1.2 W/kg. When SAR is required for OFDM modes in 2.4 GHz band, the Initial Test configuration Procedures should be followed.
3. For held-to-ear and hotspot operations, the initial test position procedures were applied. The test position with the highest extrapolated peak SAR will be used as the initial test position. When reported SAR for the initial test position is ≤ 0.4 W/kg, no additional testing for the remaining test positions was required. Otherwise, SAR is evaluated at the subsequent highest peak SAR positions until the reported SAR result is ≤ 0.8 W/kg or all test positions are measured.
4. Justification for test configurations for WLAN per KDB Publication 248227 D02DR02-41929 for 2.4 GHz WI-FI single transmission chain operations, the highest measured maximum output power channel for DSSS was selected for SAR measurement. SAR for OFDM modes (2.4 GHz802.11g/n) was not required due to the maximum allowed powers and the highest reported SAR.
5. A fixed level power reduction is applied for WiFi when handset operates "held to the body" condition or "held to the ear" condition, the power reduction triggered by audio receiver detection and call establish status.
6. Per KDB 248227 D01v02r02, In the 2.4 GHz band, separate SAR procedures are applied to DSSS and OFDM configurations to simplify DSSS test requirements.SAR is not required for the following 2.4 GHz OFDM conditions:
   a. When KDB Publication 447498 SAR test exclusion applies to the OFDM configuration.
   b. 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.

<WLAN 5GHz>

A) U-NII-1 and U-NII-2A Bands

For devices that operate in only one of the U-NII-1 and U-NII-2A bands, the normally required SAR procedures for OFDM configurations are applied. For devices that operate in both U-NII bands using the same transmitter and antenna(s), SAR test reduction is determined according to the following：

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 for that configuration (802.11 mode and exposure condition); otherwise, both bands are tested independently for SAR.
2. 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.
3. The two U-NII bands may be aggregated to support a 160 MHz channel on channel number 50.
4. Without additional testing, the maximum output power for this is limited to the lower of the maximum output power certified for the two bands. When SAR measurement is required for at least one of the bands and the highest reported SAR adjusted by the ratio of specified maximum output power of aggregated to standalone band is > 1.2 W/kg, SAR is required for the 160 MHz channel. This procedure does not apply to an aggregated band with maximum output higher than the standalone band(s); the aggregated band must be tested independently for SAR. SAR is not required when the 160 MHz channel is operating at a reduced maximum power and also qualifies for SAR test exclusion.

B) U-NII-2C and 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, all channels that operate at 5.60 – 5.65 GHz must be included to apply the SAR test reduction and measurement procedures. When the same transmitter and antenna(s) are used for U-NII-2C band and U-NII-3 band or 5.8 GHz band of §15.247, the bands may be aggregated to enable additional channels with 20, 40 or 80 MHz bandwidth to span across the band gap, as illustrated in Appendix B. The maximum output power for the additional band gap channels is limited to the lower of those certified for the bands. Unless band gap channels are permanently disabled, they must be considered for SAR testing. 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. To maintain

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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. 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.

C) OFDM Transmission Mode SAR Test Configuration and Channel Selection Requirements

The initial test configuration for 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 configurations in a frequency band have the same specified maximum output power, the initial test configuration is determined according to the following steps applied sequentially.

1. The largest channel bandwidth configuration is selected among the multiple configurations with the same specified maximum output power.
2. If multiple configurations have the same specified maximum output power and largest channel bandwidth, the lowest order modulation among the largest channel bandwidth configurations is selected.
3. If multiple configurations have the same specified maximum output power, largest channel band width and lowest order modulation, the lowest data rate configuration among these configurations is selected.
4. When multiple transmission modes (802.11a/g/n/ac) have the same specified maximum output power, largest channel bandwidth, lowest order modulation and lowest data rate, the lowest order 802.11 mode is selected; i.e., 802.11a is chosen over 802.11n then 802.11ac or 802.11g is chosen over 802.11n. After an initial test configuration is determined, if multiple test channels have the same measured maximum output power, the channel chosen for SAR measurement is determined according to the following. These channel selection procedures apply to both the initial test configuration and subsequent test configuration(s), with respect to the default power measurement procedures or additional power measurements required for further SAR test reduction. The same procedures also apply to subsequent highest output power channel(s) selection.
5. The channel closest to mid-band frequency is selected for SAR measurement.
6. For channels with equal separation from mid-band frequency; for example, high and low channels or two mid-band channels, the higher frequency (number) channel is selected for SAR measurement.

D) SAR Test Requirements for OFDM configurations

When SAR measurement is required for 802.11 a/n/ac OFDM configurations, each standalone and frequency aggregated band is considered separately for SAR test reduction. When the same transmitter and antenna(s) are used for U-NII-1 and U-NII-2A bands, additional SAR test reduction Vapplies. When band gap channels between U-NII-2C band and 5.8 GHz U-NII-3 or §15.247 band are supported, the highest maximum output power transmission mode configuration and maximum output power channel across the bands must be used to determine SAR test reduction, according to the initial test configuration and subsequent test configuration requirements. 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.

12 Conducted Output Power

Remark: The output power of WLAN/Bluetooth refers to the annex E of this report.

13 Exposure Positions Consideration

13.1 EUT Antenna Location

The location of antenna was recorded in annex B

13.2 Test Positions Consideration

Exposure Position	Wireless Interface	BT (Chain 0) (ANT 0)	BT (Chain 0) (ANT 3)	2.4GHz WLAN (Chain 0) (ANT 0)	2.4GHz WLAN (Chain 0) (ANT 3)	2.4GHz WLAN (Chain 1) (ANT 1)	2.4GHz WLAN (Chain 1) (ANT 2)	5GHz WLAN (Chain 0) (ANT 0)	5GHz WLAN (Chain 0) (ANT 3)	5GHz WLAN (Chain 1) (ANT 1)	5GHz WLAN (Chain 1) (ANT 2)
	Calculated Frequency	2480MHz	2480MHz	2462MHz	2462MHz	2462MHz	2462MHz	5825MHz	5825MHz	5825MHz	5825MHz
	Maximum power (dBm)	12	12	16.5	16.5	16	16	14	14	14.5	14.5
	Maximum rated power(mW)	16.0	16.0	45.0	45.0	40.0	40.0	25.0	25.0	28.0	28.0
Bottom Face	Separation distance(mm)	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0
	exclusion threshold	5.0	5.0	14.1	14.1	12.6	12.6	12.1	12.1	13.5	13.5
	Testing required?	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**	**Yes**
Edge 1	Separation distance(mm)	5.0	82.6	5.0	82.6	5.0	156.6	5.0	82.6	5.0	156.6
	exclusion threshold	5.0	421.0	14.1	421.0	12.6	1161.0	12.1	388.0	13.5	1128.0
	Testing required?	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**	**Yes**	**No**
Edge 2	Separation distance(mm)	24.4	5.0	24.4	5.0	240.3	222.5	24.4	5.0	240.3	222.5

	exclusion threshold	1.0	5.0	2.9	14.1	1999.0	1821.0	2.5	12.1	1966.0	1787.0
	Testing required?	**No**	**Yes**	**No**	**Yes**	**No**	**No**	**No**	**Yes**	**No**	**No**
Edge 3	Separation distance(mm)	181.6	72.5	181.6	72.5	153.7	5.0	181.6	72.5	153.7	5.0
	exclusion threshold	1412.0	320.0	1412.0	320.0	1133.0	12.6	1379.0	287.0	1100.0	13.5
	Testing required?	**No**	**No**	**No**	**No**	**No**	**Yes**	**No**	**No**	**No**	**Yes**
Edge 4	Separation distance(mm)	198.0	198.0	198.0	198.0	5.0	3.9	198.0	198.0	5.0	3.9
	exclusion threshold	1575.0	1575.0	1575.0	1575.0	12.6	12.6	1542.0	1542.0	13.5	13.5
	Testing required?	**No**	**No**	**No**	**No**	**Yes**	**Yes**	**No**	**No**	**Yes**	**Yes**

Note:

1. Per KDB 616217 D04v01r02, when the overall diagonal dimension of display is > 20 cm, the test distance is 0mm; the SAR Test Exclusion Threshold in KDB 447498 section 4.3.1 can be applied to determine SAR test exclusion for adjacent edge configurations.
2. Per KDB 616217 D04v01r02, SAR evaluation for the front surface of tablet display screens is generally not necessary.
3. Per KDB 616217 D04v01r02, additional testing for hotspot SAR is not required.

14 SAR Test Results Summary

14.1 Test Guidance

1. The reported SAR is the measured SAR value adjusted for maximum tune-up tolerance.
   a. Tune-up scaling Factor = tune-up limit power (mW) / EUT RF power (mW), where tune-up limit is the maximum rated power among all production units.
   b. For SAR testing of WLAN signal with non-100% duty cycle, the measured SAR is scaled-up by the duty cycle scaling factor which is equal to "1/(duty cycle)".
   c. For WLAN/Bluetooth: Reported SAR(W/kg)= Measured SAR(W/kg)* Duty Cycle scaling factor * Tune-up scaling factor.
2. Per KDB 447498 D01v06, for each exposure position, 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:
   a. ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
   b. ≤ 0.6 W/kg or 1.5 W/kg, for 1-g or 10-g respectively, when the transmission band is between 100 MHz and 200 MHz
   c. ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 MHz
3. Per KDB248227 D01v02r02, a Wi-Fi device must be configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools for SAR measurement. The test frequencies established using test mode must correspond to the actual channel frequencies required for operations in the U.S. When 802.11 frame gaps are accounted for in the transmission, a maximum transmission duty factor of 92 - 96% is typically achievable in most test mode configurations. A minimum transmission duty factor of 85% is required to avoid certain hardware and device implementation issues related to wide range SAR scaling. In addition, a periodic transmission duty factor is required for current generation SAR systems to measure SAR correctly. Unless it is permitted by specific KDB procedures or continuous transmission is specifically restricted by the device, the reported SAR must be scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit. When a device is not capable of sustaining continuous transmission or the output can become nonlinear, and it is limited by hardware design and unable to transmit at higher than 85% duty factor, a periodic duty factor within 15% of the maximum duty factor the device is capable of transmitting should be used. The reported SAR must be scaled to the maximum transmission duty factor to determine compliance. Descriptions of the procedures applied to establish the specific duty factor used for SAR testing are required in SAR reports to support the test results.

14.2 Body SAR Data

Plot No.	Band/Mode	Test Position	CH.	Ave. Power (dBm)	Tune-up Limit (dBm)	Tune-up Scaling Factor	Meas. SAR_{1g} (W/kg)	Reported SAR_{1g} (W/kg)
Chain 0 (ANT 0 & ANT 3)								
	WLAN 2.4GHz/802.11ax40	Bottom Face	6	14.85	16.5	1.462	0.486	0.711
	WLAN 2.4GHz/802.11ax40	Edge 1	6	14.85	16.5	1.462	0.089	0.130
	WLAN 2.4GHz/802.11ax40	Edge 2	6	14.85	16.5	1.462	0.132	0.193
1#	WLAN 2.4GHz/802.11ax40	Bottom Face	3	14.66	16.5	1.528	0.535	0.817
	WLAN 2.4GHz/802.11ax40	Bottom Face	9	14.62	16.5	1.542	0.492	0.759
Chain 1 (ANT 1 & ANT 2)								
	WLAN 2.4GHz/802.11ax40	Bottom Face	3	14.03	16	1.574	0.336	0.529
	WLAN 2.4GHz/802.11ax40	Edge 1	3	14.03	16	1.574	0.127	0.200
	WLAN 2.4GHz/802.11ax40	Edge 3	3	14.03	16	1.574	0.199	0.313
	WLAN 2.4GHz/802.11ax40	Edge 4	3	14.03	16	1.574	0.145	0.228
	WLAN 2.4GHz/802.11ax40	Bottom Face	6	14.01	16	1.581	0.327	0.517
	WLAN 2.4GHz/802.11ax40	Bottom Face	9	13.69	15.5	1.517	0.326	0.495
Chain 0 (ANT 0 & ANT 3)								
	WLAN 5.2GHz/802.11ax20	Bottom Face	48	11.66	13.5	1.528	0.465	0.710
	WLAN 5.2GHz/802.11ax20	Edge 1	48	11.66	13.5	1.528	0.213	0.325
	WLAN 5.2GHz/802.11ax20	Edge 2	48	11.66	13.5	1.528	0.235	0.359
2#	WLAN 5.2GHz/802.11ax20	Bottom Face	36	11.07	13	1.560	0.693	1.081
	WLAN 5.2GHz/802.11ax20	Bottom Face	44	11.57	13.5	1.560	0.495	0.772
Chain 1 (ANT 1 & ANT 2)								
	WLAN 5.2GHz/802.11ax160	Bottom Face	50	11.89	13.5	1.449	0.507	0.739
	WLAN 5.2GHz/802.11ax160	Edge 1	50	11.89	13.5	1.449	0.100	0.146
	WLAN 5.2GHz/802.11ax160	Edge 3	50	11.89	13.5	1.449	0.088	0.128
	WLAN 5.2GHz/802.11ax160	Edge 4	50	11.89	13.5	1.449	0.102	0.149
Chain 0 (ANT 0 & ANT 3)								
3#	WLAN 5.3GHz/802.11ax20	Bottom Face	64	12.43	14	1.435	0.790	1.134
	WLAN 5.3GHz/802.11ax20	Edge 1	64	12.43	14	1.435	0.274	0.393
	WLAN 5.3GHz/802.11ax20	Edge 2	64	12.43	14	1.435	0.315	0.452
	WLAN 5.3GHz/802.11ax20	Bottom Face	52	11.86	13.5	1.459	0.611	0.891
	WLAN 5.3GHz/802.11ax20	Bottom Face	60	12.41	14	1.442	0.641	0.924
Chain 1 (ANT 1 & ANT 2)								
	WLAN 5.3GHz/802.11ax20	Bottom Face	60	12.17	14	1.524	0.316	0.482
	WLAN 5.3GHz/802.11ax20	Edge 1	60	12.17	14	1.524	0.114	0.174
	WLAN 5.3GHz/802.11ax20	Edge 3	60	12.17	14	1.524	0.136	0.207
	WLAN 5.3GHz/802.11ax20	Edge 4	60	12.17	14	1.524	0.213	0.325
	WLAN 5.3GHz/802.11ax20	Bottom Face	52	11.44	13	1.432	0.527	0.755
	WLAN 5.3GHz/802.11ax20	Bottom Face	64	12.17	14	1.524	0.574	0.875
Chain 0 (ANT 0 & ANT 3)								
	WLAN 5.5GHz/802.11ax40	Bottom Face	102	9.67	11.5	1.524	0.596	0.908
	WLAN 5.5GHz/802.11ax40	Edge 1	102	9.67	11.5	1.524	0.242	0.369
	WLAN 5.5GHz/802.11ax40	Edge 2	102	9.67	11.5	1.524	0.305	0.465
4#	WLAN 5.5GHz/802.11ax40	Bottom Face	110	9.38	11	1.452	0.673	0.977
	WLAN 5.5GHz/802.11ax40	Bottom Face	142	8.7	10.5	1.514	0.647	0.979
Chain 1 (ANT 1 & ANT 2)								

	WLAN 5.5GHz/802.11ax20	Bottom Face	144	12.79	14.5	1.483	0.434	0.643
	WLAN 5.5GHz/802.11ax20	Edge 1	144	12.79	14.5	1.483	0.111	0.165
	WLAN 5.5GHz/802.11ax20	Edge 3	144	12.79	14.5	1.483	0.165	0.245
	WLAN 5.5GHz/802.11ax20	Edge 4	144	12.79	14.5	1.483	0.215	0.319
	WLAN 5.5GHz/802.11ax20	Bottom Face	100	11.94	13.5	1.432	0.620	0.888
	WLAN 5.5GHz/802.11ax20	Bottom Face	116	10.67	12.5	1.524	0.546	0.832
Chain 0 (ANT 0 & ANT 3)								
	WLAN 5.8GHz/802.11ax20	Bottom Face	165	11.01	13	1.581	0.498	0.788
	WLAN 5.8GHz/802.11ax20	Edge 1	165	11.01	13	1.581	0.202	0.369
	WLAN 5.8GHz/802.11ax20	Edge 2	165	11.01	13	1.581	0.271	0.465
	WLAN 5.8GHz/802.11ax20	Bottom Face	149	10.47	12	1.422	0.563	0.801
	WLAN 5.8GHz/802.11ax20	Bottom Face	157	10.58	12.5	1.556	0.502	0.781
Chain 1 (ANT 1 & ANT 2)								
	WLAN 5.8GHz/802.11ax20	Bottom Face	157	10.48	12	1.419	0.633	0.898
	WLAN 5.8GHz/802.11ax20	Edge 1	157	10.48	12	1.419	0.140	0.174
	WLAN 5.8GHz/802.11ax20	Edge 3	157	10.48	12	1.419	0.156	0.207
	WLAN 5.8GHz/802.11ax20	Edge 4	157	10.48	12	1.419	0.241	0.325
5#	WLAN 5.8GHz/802.11ax20	Bottom Face	149	9.21	11	1.510	0.639	0.965
	WLAN 5.8GHz/802.11ax20	Bottom Face	165	9.78	11.5	1.486	0.638	0.948
Chain 0 (ANT 0 & ANT 3)								
	Bluetooth/DH5	Bottom Face	39	11.10	12	1.231	0.433	0.577
	Bluetooth/DH5	Edge 1	39	11.10	12	1.231	0.134	0.179
	Bluetooth/DH5	Edge 2	39	11.10	12	1.231	0.164	0.219
6#	Bluetooth/DH5	Bottom Face	0	10.77	12	1.327	0.422	0.607
	Bluetooth/DH5	Bottom Face	78	10.51	12	1.410	0.390	0.596

Note:

1. Per KDB 447498 D01v06, for each exposure position, if the highest output channel Reported SAR ≤0.8W/kg, other channels SAR testing is not necessary.
2. Additional WLAN SAR testing was performed for simultaneous transmission analysis.
3. Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required when the measured SAR is ≥0.8W/kg.
4. Per KDB248227 D01v02r02, OFDM SAR is not required 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.
5. According to KDB 865664 D02v01r02, SAR plot is required for the highest measured SAR in each exposure configuration, wireless mode and frequency band combination.
6. For TDD-LTE, the reported SAR should be scaled with the duty cycle scaling factor 1.006.
7. The 2.4G WLAN reported 1g SAR (W/kg) should be scaled with the duty cycle scaling factor 1.000, 5G WLAN 802.11ax20 with 1.000, 5G WLAN 802.11ax40 with 1.000, 5G WLAN 802.11ax160 with 1.006 and Bluetooth with 1.084.

15 Simultaneous Transmission Analysis

15.1 Simultaneous Transmission Consideration

No.	Simultaneous Transmission Consideration	Body
1	WLAN 2.4GHz Chain 0 (Ant 0+Ant 3)/Chain 1(Ant 1+Ant 2)	Yes
2	WLAN 5GHz Chain 0(Ant 0+Ant 3)/Chain 1(Ant 1+Ant 2)	Yes
3	Bluetooth Chain 0(Ant 0+Ant 3)	Yes
4	Bluetooth Chain 0(Ant 0+Ant 3)+WLAN 2.4GHz Chain 1(Ant 1+Ant 2)	Yes
5	Bluetooth Chain 0(Ant 0+Ant 3)+WLAN 5GHz Chain 1(Ant 1+Ant 2)	Yes
6	WLAN 2.4GHz Chain 0 (Ant 0+Ant 3)+WLAN 2.4GHz Chain 1(Ant 1+Ant 2)	Yes
7	WLAN 5GHz Chain 0(Ant 0+Ant 3)+WLAN 5GHz Chain 1(Ant 1+Ant 2)	Yes
8	WLAN 2.4GHz Chain 0 (Ant 0+Ant 3)+WLAN 5GHz Chain 1(Ant 1+Ant 2)	Yes
9	WLAN 2.4GHz Chain 1(Ant 1+Ant 2)+WLAN 5GHz Chain 0(Ant 0+Ant 3)	Yes

Note:

1. Simultaneous Transmission SAR evaluation is not required for Bluetooth (Chain 0) and WLAN 2.4GHz (Chain 0), because the software mechanism have been incorporated to guarantee that the WLAN 2.4GHz (Chain 0) and Bluetooth (Chain 0) transmitters would not simultaneously operate.
2. Per KDB 447498D01v06, simultaneous transmission SAR evaluation procedures is as followed:

   Step 1: If sum of 1 g SAR <1.6 W/kg, Simultaneous SAR measurement is not required.

   Step 2: If sum of 1 g SAR >1.6 W/kg, ratio of SAR to peak separation distance for pair of transmitters calculated.

   Step 3: If the ratio of SAR to peak separation distance is ≤0.04, Simultaneous SAR measurement is not required.

   Step 4: If the ratio of SAR to peak separation distance is >0.04, Simultaneous SAR measurement is required and simultaneous transmission SAR value is calculated.

   (The ratio is determined by: $(SAR_1 + SAR_2)$ ^ 1.5/Ri ≤0.04,

   R_i is the separation distance between the peak SAR locations for the antenna pair in mm.
3. WLAN only support MIMO transmission.

15.2 Simultaneous Transmission Analysis

➢ **Body Simultaneous Transmission for WLAN 2.4GHz (Chain 1) MIMO+WLAN 2.4GHz (Chain 0) MIMO/Bluetooth (Chain 0) MIMO**

WWAN Band	Exposure Position	1 2.4GHz WLAN (Chain 0) 1g SAR (W/kg)	2 2.4GHz WLAN (Chain 1) 1g SAR (W/kg)	3 Bluetooth (Chain 0) 1g SAR (W/kg)	1+2 Summed 1g SAR (W/kg)	2+3 Summed 1g SAR (W/kg)
WLAN	Bottom face at 0mm	0.817	0.529	0.607	1.346	1.136
	Edge 1 at 0mm	0.130	0.200	0.179	0.330	0.379
	Edge 2 at 0mm	0.193		0.219	0.193	0.219
	Edge 3 at 0mm		0.313		0.313	0.313
	Edge 4 at 0mm		0.228		0.228	0.228

➢ **Body Simultaneous Transmission for WLAN 5GHz (Chain 1) MIMO+WLAN 5GHz (Chain 0) MIMO/Bluetooth (Chain 0) MIMO**

WWAN Band	Exposure Position	1 5GHz WLAN (Chain 0) 1g SAR (W/kg)	2 5GHz WLAN (Chain 1) 1g SAR (W/kg)	3 Bluetooth (Chain 0) 1g SAR (W/kg)	1+2 Summed 1g SAR (W/kg)	2+3 Summed 1g SAR (W/kg)
WLAN	Bottom face at 0mm	1.134	0.965	0.607	2.099	1.572
	Edge 1 at 0mm	0.393	0.174	0.179	0.567	0.353
	Edge 2 at 0mm	0.465		0.219	0.465	0.219
	Edge 3 at 0mm		0.245		0.245	0.245
	Edge 4 at 0mm		0.325		0.325	0.325

➢ **Body Simultaneous Transmission for WLAN 2.4GHz (Chain 0) MIMO+WLAN 5GHz (Chain 1) MIMO**

WWAN Band	Exposure Position	1 2.4GHz WLAN (Chain 0) 1g SAR (W/kg)	2 5GHz WLAN (Chain 1) 1g SAR (W/kg)	1+2 Summed 1g SAR (W/kg)
WLAN	Bottom face at 0mm	0.817	0.965	1.782
	Edge 1 at 0mm	0.130	0.174	0.304
	Edge 2 at 0mm	0.193		0.193
	Edge 3 at 0mm		0.245	0.245
	Edge 4 at 0mm		0.325	0.325

- **Body Simultaneous Transmission for WLAN 2.4GHz (Chain 1) MIMO+WLAN 5GHz (Chain 0) MIMO**

WWAN Band	Exposure Position	1	2	1+2 Summed 1g SAR (W/kg)
		2.4GHz WLAN (Chain 1)	5GHz WLAN (Chain 0)	
		1g SAR (W/kg)	1g SAR (W/kg)	
WLAN	Bottom face at 0mm	0.529	1.134	1.663
	Edge 1 at 0mm	0.200	0.393	0.593
	Edge 2 at 0mm		0.465	0.465
	Edge 3 at 0mm	0.313		0.313
	Edge 4 at 0mm	0.228		0.228

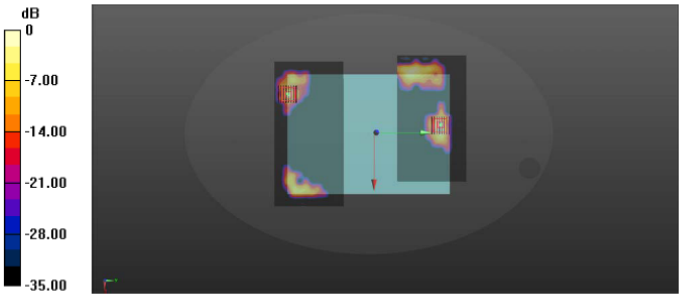
15.3 SPLSR Assessment and Analysis

- **General Guidance**

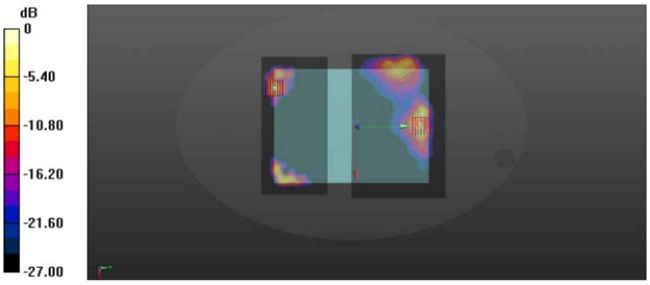
1. Per KDB 447498, When standalone SAR is measured, the peak location is determined by the x, y, z coordinates of the extrapolated and interpolated results reported by the zoom scan measurement, or area scan measurement when area scan based 1-g SAR estimation is applicable.
2. When standalone SAR is measured for both antennas in the pair, the peak location separation distance is computed by the square root of [(x1−x2)2 + (y1−y2)2 + (z1−z2)2], where (x1, y1, z1) and (x2, y2, z2) are the coordinates in the area scans or extrapolated peak SAR locations in the zoom scans, as appropriate.
3. The ratio is determined by (SAR1 + SAR2)1.5/Ri, rounded to two decimal digits, and must be ≤ 0.04 for all antenna pairs in the configuration to qualify for 1-g SAR test exclusion.

➢ Results of SPLSR Analysis

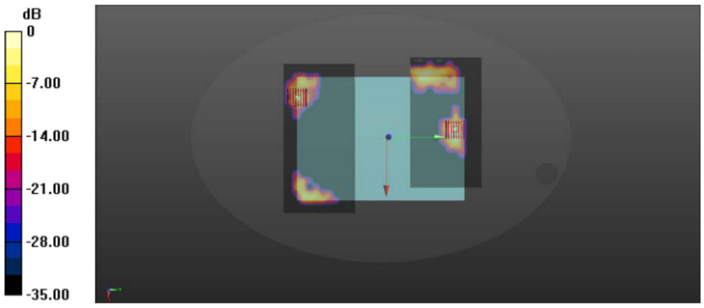
Band	Position	SAR (W/kg)	SAR peak location (cm)			3D distance (mm)	Summed SAR(W/kg)	SPLSR Results	Simultaneous SAR
			X	Y	Z				
WLAN 5GHz (Chain 0)	Bottom Face	1.141	0.003	0.126	-0.149	247.5	2.11	0.01	Not required
WLAN 5GHz (Chain 1)		0.965	-0.049	-0.116	-0.149				



Band	Position	SAR (W/kg)	SAR peak location (cm)			3D distance (mm)	Summed SAR(W/kg)	SPLSR Results	Simultaneous SAR
			X	Y	Z				
WLAN 2.4GHz (Chain 0)	Bottom Face	0.817	0.015	0.13	-0.147	254.2	1.78	0.01	Not required
WLAN 5GHz (Chain 1)		0.965	-0.049	-0.116	-0.149				



Band	Position	SAR (W/kg)	SAR peak location (cm)			3D distance (mm)	Summed SAR(W/kg)	SPLSR Results	Simultaneous SAR
			X	Y	Z				
WLAN 5GHz (Chain 0)	Bottom Face	1.141	0.003	0.126	-0.149	239.7	1.67	0.01	Not required
WLAN 2.4GHz (Chain 1)		0.529	-0.0678	-0.103	-0.148				



16 Uncertainty Assessment

According to KDB 865664 D01 SAR measurement 100 MHz to 6GHz, when the highest measured 1-g SAR is less than 1.5 W/kg and 10-g extremity SAR less than 3.75 W/kg, the expanded SAR measurement uncertainty must be less than 30% with a confidence interval of k=2. When these conditions are met, extensive SAR measurement uncertainty analysis described in IEEE 1528-2013 is not required in the SAR report and submitted for equipment approval. For this device, both the 1-g SAR is less than 1.5 W/kg. Therefore the measurement uncertainty table is not required in this report.

17 Measurement Conclusion

The SAR evaluation indicates that the EUT complies with the RF radiation exposure limits of FCC, with respect to all parameters subject to this test. These measurements were taken to simulate the RF effects of RF exposure under worst-case conditions. Precise laboratory measures were taken to assure repeatability of the tests. The results and statements relate only to the item(s) tested. Please note that the absorption and distribution of electromagnetic energy in the body are very complex phenomena that depend on the mass, shape, and size of the body, the orientation of the body with respect to the field vectors, and the electrical properties of both the body and the environment. Other variables that may play a substantial role in possible biological effects are those that characterize the environment (e.g. ambient temperature, air velocity, relative humidity, and body insulation) and those that characterize the individual (e.g. age, gender, activity level, debilitation, or disease). Because various factors may interact with one another to vary the specific biological outcome of an exposure to electromagnetic fields, any protection guide should consider maximal amplification of biological effects as a result of field-body interactions, environmental conditions, and physiological variables.

Annex A General Information

1. Identification of the Responsible Testing Laboratory

Laboratory Name:	Shenzhen Morlab Communications Technology Co., Ltd.
Laboratory Address:	FL.1-3, Building A, FeiYang Science Park, No.8 LongChang Road, Block 67, BaoAn District, ShenZhen, GuangDong Province, P. R. China
Telephone:	+86 755 36698555
Facsimile:	+86 755 36698525

2. Identification of the Responsible Testing Location

Name:	Shenzhen Morlab Communications Technology Co., Ltd.
Address:	FL.1-3, Building A, FeiYang Science Park, No.8 LongChang Road, Block 67, BaoAn District, ShenZhen, GuangDong Province, P. R. China

3. Facilities and Accreditations

The FCC designation number is CN1192, the test firm registration number is 226174.

Note：

The main report is end here and the other Annex (B,C,D,E,F) will be submitted separately.

****** END OF MAIN REPORT ******