FCC SAR Compliance Test Report

Product Name: HUAWEI MateBook

Model: MACH-W29,MACH-W19

Report No.: SYBH(Z-SAR) 20171214030005-2

FCC ID: QISMACH-WX9

	APPROVED (Lab Manager)	PREPARED (Test Engineer)
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DATE	2018-01-30	2018-01-30

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※ ※ Notice ※ ※

1. The laboratory has passed the accreditation by China National Accreditation Service for Conformity Assessment (CNAS). The accreditation number is L0310.

2. The laboratory has passed the accreditation by The American Association for Laboratory Accreditation (A2LA). The accreditation number is 2174.01 & 2174.02 & 2174.03

3. The laboratory (Reliability Lab of Huawei Technologies Co., Ltd) is also named “Global Compliance and Testing Center of Huawei Technologies Co., Ltd”, the both names have coexisted since 2009.

4. The test report is invalid if not marked with the signatures of the persons responsible for preparing and approving the test report.

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6. The test report is only valid for the test samples.

7. Content of the test report, in part or in full, cannot be used for publicity and/or promotional purposes without prior written approval from the laboratory.

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※ ※ **Modified History** ※ ※

REV.	DESCRIPTION	ISSUED DATE	REMARK
Rev.1.0	Initial Test Report Release	2018-01-30	Cao Ting

1 General Information

1.1 Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing are as below Table 1.

Band	1-g Max Reported SAR(W/kg)
	Body(0mm)
WiFi 2.4G	**0.95**
WiFi 5G	0.63
BT	0.20
The highest reported SAR for body and Simultaneous transmission exposure conditions are 0.95W/kg and 1.58W/kg per KDB690783 D01	

Table 1:Summary of test result

Note: * For body operation, this device has been tested at a minimum of 0mm from the body per FCC KDB616217.

The device is in compliance with Specific Absorption Rate（SAR）for general population/uncontraolled 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.

1.2 RF exposure limits

Human Exposure	Uncontrolled Environment General Population	Controlled Environment Occupational
Spatial Peak SAR* (Brain/Body/Arms/Legs)	**1.60 W/kg**	8.00 W/kg
Spatial Average SAR** (Whole Body)	0.08 W/kg	0.40 W/kg
Spatial Peak SAR*** (Hands/Feet/Ankle/Wrist)	4.00 W/kg	20.00 W/kg

Table 2: RF exposure limits

The limit applied in this test report is shown in **bold** letters

Notes:

* The Spatial Peak value of the SAR averaged over any 1 gram of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

** The Spatial Average value of the SAR averaged over the whole body.

*** The Spatial Peak value of the SAR averaged over any 10 grams of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.

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.

1.3 EUT Description

<table>
<tr><td colspan="4">Device Information：</td></tr>
<tr><td>Product Name:</td><td colspan="3">HUAWEI MateBook</td></tr>
<tr><td>Model:</td><td colspan="3">MACH-W29; MACH-W19</td></tr>
<tr><td>FCC ID :</td><td colspan="3">QISMACH-WX9</td></tr>
<tr><td>SN:</td><td colspan="3">1#: VTFBB17C11000040
2#: EHUBB17C11000048
3#: EHUBB17C11000075
4#: 5JEBB17C07000005</td></tr>
<tr><td>Device Type :</td><td colspan="3">Portable device</td></tr>
<tr><td>Device Phase:</td><td colspan="3">Identical Prototype</td></tr>
<tr><td>Exposure Category:</td><td colspan="3">Uncontrolled environment / general population</td></tr>
<tr><td>Hardware Version :</td><td colspan="3">SP1MACHW19M</td></tr>
<tr><td>Software Version :</td><td colspan="3">1.3.0.15</td></tr>
<tr><td>Antenna Type :</td><td colspan="3">Internal antenna</td></tr>
<tr><td>Others Accessories</td><td colspan="3">NA</td></tr>
<tr><td colspan="4">Device Operating Configurations:</td></tr>
<tr><td>Supporting Mode(s)</td><td colspan="3">WiFi 2.4G/5G;BT</td></tr>
<tr><td>Test Modulation</td><td colspan="3">WiFi(DSSS/OFDM),BT(GFSK)</td></tr>
<tr><td rowspan="4">Operating Frequency Range(s)</td><td>Band</td><td>Tx (MHz)</td><td>Rx (MHz)</td></tr>
<tr><td>BT</td><td colspan="2">2402-2480</td></tr>
<tr><td>WiFi 2.4G</td><td colspan="2">2412-2462</td></tr>
<tr><td>WiFi 5G</td><td colspan="2">5150-5350
5470-5850</td></tr>
<tr><td rowspan="3">Test Channels (low-mid-high):</td><td colspan="3">802.11b/g/n 20M:1-6-11
802.11n 40M:3-6-9(WiFi 2.4G)</td></tr>
<tr><td colspan="3">802.11a/n/ac 20M: 36-40-44-48-52-56-60-64-100-104-108-112-116-120-124-128-132-136-140-149-153-157-161-165
802.11 n/ac 40M: 38-46-54-62-102-110-118-126-134-151-159
802.11ac 80M: 42-58-106-122-138-155(WiFi 5G)</td></tr>
<tr><td colspan="3">BT: 0-19-39-78</td></tr>
</table>

Table 3:Device information and operating configuration

1.3.1 General Description

MACH-W29/MACH-W19 is a notebook computer,Which supports 2.4G Wi-Fi, 5G Wi-Fi, and Bluetooth wireless frequency bands. It provides power and fingerprint key switch, one USB type A,two USB type C, and a earphone interfaces.

Name	Manufacture	Description
Li-ion	Dynapack Electronic Technology(SuZhou) Co., Ltd.	Model : HB4593R1ECW Rated capacity: 7410mAh Rated Voltage: 7.6V Limited Charge Voltage: 8.7V
Li-ion	Sunwoda Electronic Co., Ltd	Model : HB4593R1ECW Rated capacity: 7410mAh Rated Voltage: 7.6V Limited Charge Voltage: 8.7V

Difference description:

The difference between MACH-W29 and MACH-W19 is show in the following table:

Model	MACH-W29 (with GPU version)	MACH-W19 (with GPU version)	MACH-W19 (without GPU version)
PCB layout	The same	The same	The same
Main board	The same	The same	Delete GPU chip and related components
Frequency bands	The same, support Wi-Fi 2.4G&5G support BT 2.4G	The same, support Wi-Fi 2.4G&5G support BT 2.4G	The same, support Wi-Fi 2.4G&5G support BT 2.4G
BT/Wi-Fi antenna	The same	The same	The same
Appearance	The same	The same	The same
Dimension	The same	The same	The same
CPU	Intel core i7, Support max 4.0Hz	Intel core i5, Support max 3.4GHz	Intel core i5, Support max 3.4GHz
GPU	Support	Support	Not support
Memory	16/8G	8G	8G
SSD	512G/256G	256G	256G
Rear camera	Not support	Not support	Not support
Front camera	The same	The same	The same
Adapter	The same	The same	The same
Battery	The same	The same	The same
Accessories	The same, Docking Station	The same, Docking Station	The same, Docking Station

Note:According to the difference description above,

1) Fulll SAR test is performed on MACH-W29.
2) MACH-W19 (with GPU version) is tested at the SAR worst case of MACH-W29 for each same frequency band.
3) MACH-W19 (without GPU version) shares the same test data of MACH-W19 (with GPU version) for each same frequency band.

1.4 Test specification(s)

ANSI C95.1:1992 /IEEE C95.1:1991	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
KDB616217 D04	SAR for laptop and tablets v01r02
KDB248227 D01	SAR Guidance for IEEE 802 11 Wi-Fi SAR v02r02
KDB865664 D01	SAR measurement 100 MHz to 6 GHz v01r04
KDB865664 D02	RF Exposure Reporting v01r02
KDB690783 D01	SAR Listings on Grants v01r03

1.5 Testing laboratory

Test Site	The Reliability Laboratory of Huawei Technologies Co., Ltd.
Test Location	NO.2 New City Avenue Songshan Lake Sci. & Tech. Industry Park, Dongguan, Guangdong, P.R.C
Telephone	+86 755 28780808
Fax	+86 755 89652518
State of accreditation	The Test laboratory (area of testing) is accredited according to ISO/IEC 17025. CNAS Registration number: L0310 A2LA TESTING CERT #2174.01 & 2174.02 & 2174.03

1.6 Applicant and Manufacturer

Company Name	HUAWEI TECHNOLOGIES CO., LTD
Address	Administration Building, Headquarters of Huawei Technologies Co., Ltd., Bantian, Longgang District, Shenzhen, 518129, P.R.C

1.7 Application details

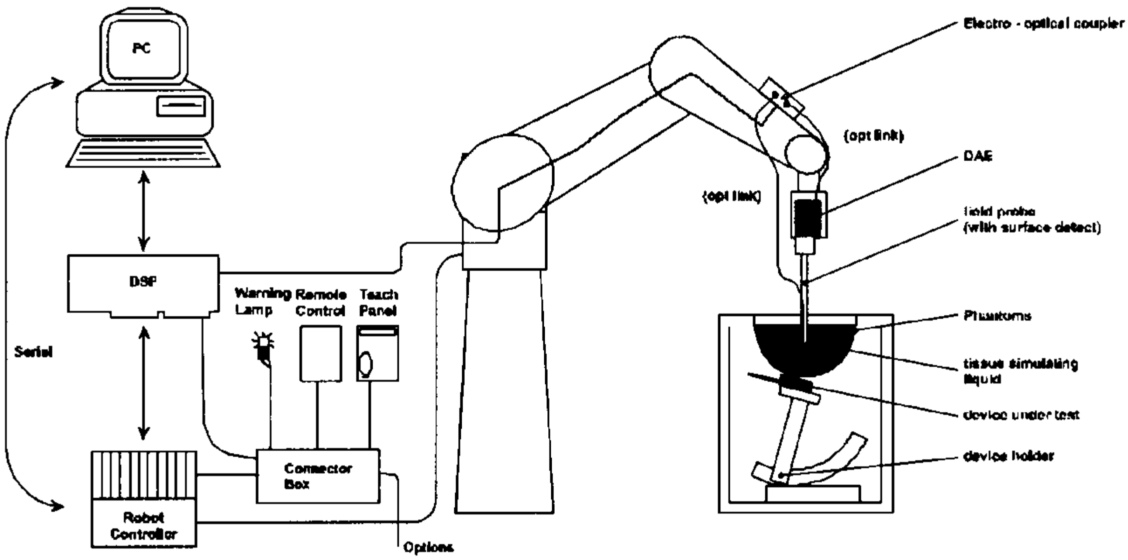
Start Date of test	2018-01-04
End Date of test	2018-01-05

1.8 Ambient Condition

Ambient temperature	20°C – 24°C
Relative Humidity	30% – 70%

2 SAR Measurement System

2.1 SAR Measurement Set-up



The DASY5/6 system for performing compliance tests consists of the following items:

- A standard high precision 6-axis robot (Stäubli RX family) with controller and software. An arm extension for accommodating the data acquisition electronics (DAE).

- 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.

- 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.
- A unit to operate the optical surface detector which is connected to the EOC.
- 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 DASY5/6 measurement server.
- The DASY5/6 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.
- DASY5/6 software and SEMCAD data evaluation software.
- Remote control with teach panel and additional circuitry for robot safety such as warning lamps, etc.
- The generic twin phantom enabling the testing of left-hand and right-hand usage.
- The device holder for handheld mobile phones.
- Tissue simulating liquid mixed according to the given recipes.
- System check dipoles allowing to validate the proper functioning of the system.

2.2 Test environment

The DASY5/6 measurement system is placed at the head end of a room with dimensions: 5 x 2.5 x 3 m³, the SAM phantom is placed in a distance of 75 cm from the side walls and 1.1m from the rear wall. Above the test system a 1.5 x 1.5 m² array of pyramid absorbers is installed to reduce reflections from the ceiling.

Picture 1 of the photo documentation shows a complete view of the test environment.

The system allows the measurement of SAR values larger than 0.005 mW/g.

2.3 Data Acquisition Electronics description

The data acquisition electronics (DAE) consist of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converte and a command decoder with a 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 mechanical probe mounting device includes two different sensor systems for frontal and sideways probe contacts. They are used for mechanical surface detection and probe collision detection.

DAE4

Input Impedance	200MOhm
The Inputs	symmetrical and floating
Common mode rejection	above 80 dB

2.4 Probe description

These probes are specially designed and calibrated for use in liquids with high permittivities. They should not be used in air, since the spherical isotropy in air is poor (±2 dB). The dosimetric probes have special calibrations in various liquids at different frequencies.

Isotropic E-Field Probe ES3DV3 for Dosimetric Measurements

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 4 GHz; Linearity: ± 0.2 dB (30 MHz to 4 GHz)	
Directivity	± 0.2 dB in HSL (rotation around probe axis) ± 0.3 dB in tissue material (rotation normal to probe axis)	
Dynamic range	5 μW/g to > 100 mW/g; Linearity: ± 0.2 dB	
Dimensions	Overall length: 337 mm (Tip: 20 mm) Tip diameter: 3.9 mm (Body: 12 mm) Distance from probe tip to dipole centers: 2.0 mm	
Application	General dosimetry up to 4 GHz Dosimetry in strong gradient fields Compliance tests of mobile phones	

Isotropic E-Field Probe EX3DV4 for Dosimetric Measurements

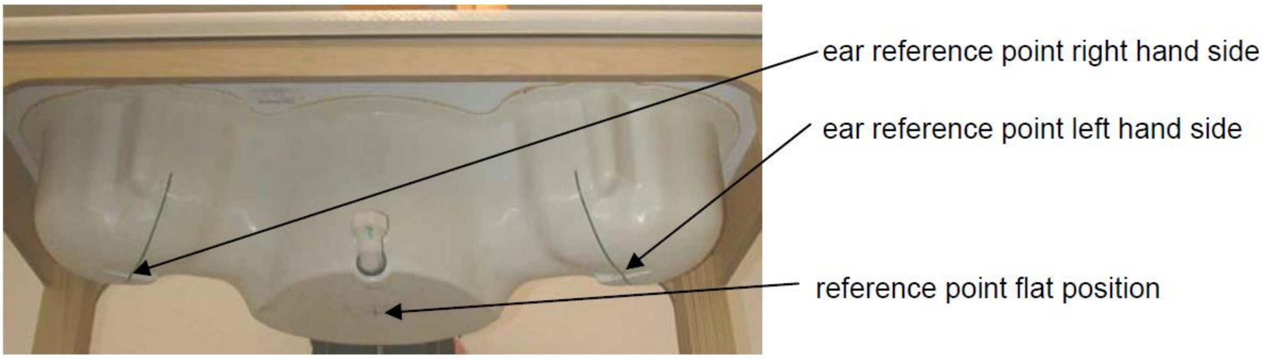
Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	 
Calibration	ISO/IEC 17025 calibration service available.	
Frequency	10 MHz to >6 GHz; Linearity: ± 0.2 dB (30 MHz to 6 GHz)	
Directivity	± 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: ± 0.2 dB(noise:typically<1μW/g)	
Dimensions	Overall length: 337 mm (Tip:20 mm) Tip diameter:2.5 mm (Body:12 mm) Typical distance from probe tip to dipole centers: 1mm	
Application	High precision dosimetric measurements in any exposure scenario(e.g.,very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%	

2.5 Phantom description

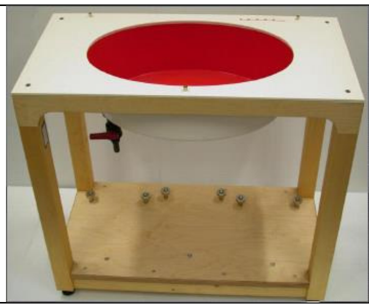
SAM Twin Phantom

Shell Thickness	2mm±0.2mm;The ear region:6.0±0.2mm	
Filling Volume	Approximately 25 liters	
Dimensions	Length:1000mm; Width:500mm; Height: adjustable feet	
Measurement Areas	Left hand Right hand Flat phantom	
The bottom plate contains three pairs 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 cover the phantom during off-periods to prevent water evaporation and changes in the liquid parameters. Free space scans of devices on top of this phantom cover are possible. Three reference marks are provided on the phantom counter. These reference marks are used to teach the absolute phantom position relative to the robot.		

The following figure shows the definition of reference point:



ELI4 Phantom

Shell Thickness	2mm±0.2mm	
Filling Volume	Approximately 30 liters	
Dimensions	Major axis:600mm; Minor axis:400mm;	
Measurement Areas	Flat phantom	
The ELI4 phantom is intended for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30MHz to 6GHz. ELI4 is fully compatible with the latest draft of the standard IEC 62209-2 and all known tissue simulating liquids.		

The phantom shell material is resistant to all ingredients used in the tissue-equivalent liquid recipes. The shell of the phantom including ear spacers is constructed from low permittivity and low loss material, with a relative permittivity $2 \leq \varepsilon r \leq 5$ at ≤3 GHz,$3 \leq \varepsilon r \leq 4$ at >3 GHz and and a loss tangent ≤0.05.

2.6 Device holder description

The DASY5/6 device holder has two scales for device rotation (with respect to the body axis) and the device inclination (with respect to the line between the ear openings). The plane between the ear openings and the mouth tip has a rotation angle of 65°. 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. This device holder is used for standard mobile phones or PDA's only. If necessary an additional support of polystyrene material is used.

The DASY device holder is constructed of low-loss POM material having the following dielectric parameters: relative permittivity ε =3 and loss tangent σ =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.
The device holder permits the device to be positioned with a tolerance of ±1° in the tilt angle.

Larger DUT's (e.g. notebooks) cannot be tested using this device holder. Instead a support of bigger polystyrene cubes and thin polystyrene plates is used to position the DUT in all relevant positions to find and measure spots with maximum SAR values.
Therefore those devices are normally only tested at the flat part of the SAM.

2.7 Test Equipment List

This table gives a complete overview of the SAR measurement equipment.
Devices used during the test described are marked ☒

	Manufacturer	Device	Type	Serial number	Date of last calibration*)	Valid period
☒	SPEAG	Dosimetric E-Field Probe	EX3DV4	3743	2017-11-23	One year
☒	SPEAG	Data acquisition electronics	DAE4	1235	2017-11-16	One year
☒	SPEAG	2450 MHz Dipole	D2450V2	978	2016-02-08	Three years
☒	SPEAG	5GHz Dipole	D5GHzV2	1155	2017-04-26	Three years
☒	SPEAG	Software	DASY5	N/A	NCR	NCR
☐	SPEAG	Twin Phantom	SAM7	TP-1594	NCR	NCR
☒	SPEAG	Flat Phantom	ELI 4.0	TP-1110	NCR	NCR
☒	R & S	WideBand Radio Communication Tester	CMW 500	126855	2017-05-15	One year
☒	Agilent	Network Analyser	E5071C	MY46213349	2017-12-31	One year
☒	Agilent	Dielectric Probe Kit	85070E	2484	NCR	NCR
☒	Agilent	Signal Analyzer	N9030A	MY49431698	2017-07-31	One year
☒	Agilent	Signal Generator	E8257D	MY49281095	2017-02-15	One year
☒	MINI-CIRCUITS	Amplifier	ZHL-42W	QA1402001	NCR	NCR
☒	AR	Directional Coupler	DC7144AM1	0423264	2017-04-12	One year
☒	MINI-CIRCUITS	Amplifier	ZVE-8G+	N523101139	NCR	One year
☒	Agilent	Dual Directional Coupler	772D	MY52180295	2017-05-25	One year
☒	Agilent	Power Meter	E4417A	MY54100027	2017-04-10	One year
☒	Agilent	Power Meter Sensor	E9321A	MY54130007	2017-04-10	One year
☒	Agilent	Power Meter Sensor	E9321A	MY54130001	2017-04-10	One year

Note:
1) Per KDB865664D01 requirements for dipole calibration, the test laboratory has adopted three-year extended calibration interval. Each measured dipole is expected to evaluate with the following criteria at least on annual interval in Appendix C.

a) There is no physical damage on the dipole;
b) System check with specific dipole is within 10% of calibrated value;
c) The most recent return-loss result, measured at least annually, deviates by no more than 20% from the previous measurement.
d) The most recent measurement of the real or imaginary parts of the impedance, measured at least annually is within 5Ω from the previous measurement.

2) Network analyzer probe calibration against air, distilled water and a shorting block performed before measuring liquid parameters.

3 SAR Measurement Procedure

3.1 Scanning procedure

The DASY5/6 installation includes predefined files with recommended procedures for measurements and system check. 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 DASY5/6 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°.)

- 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.
  Results of this coarse scan are shown in Appendix B.

- 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. A z-axis scan of the measurement with maximum SAR value is shown in Appendix B.

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*$\Delta z_{Zoom}(n-1)$	≥30mm
2-3GHz	≤12mm	≤5mm	≤5mm	≤4mm	≤1.5*$\Delta z_{Zoom}(n-1)$	≥30mm
3-4GHz	≤12mm	≤5mm	≤4mm	≤3mm	≤1.5*$\Delta z_{Zoom}(n-1)$	≥28mm
4-5GHz	≤10mm	≤4mm	≤3mm	≤2.5mm	≤1.5*$\Delta z_{Zoom}(n-1)$	≥25mm
5-6GHz	≤10mm	≤4mm	≤2mm	≤2mm	≤1.5*$\Delta z_{Zoom}(n-1)$	≥22mm

3.2 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, Computermathematik, 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, Computermathematik, 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

DASY5/6 uses the advanced extrapolation option which is able to compansate boundary effects on E-field probes.

3.3 Data Storage and Evaluation

Data Storage

The DASY5/6 software stores the acquired data from the data acquisition electronics as raw data (in microvolt readings from the probe sensors), together with all necessary software parameters for the data evaluation (probe calibration data, liquid parameters and device frequency and modulation data) in measurement files with the extension "DAE4". The software evaluates the desired unit and format for output each time the data is visualized or exported. This allows verification of the complete software setup even after the measurement and allows correction of incorrect parameter settings. For example, if a measurement has been performed with a wrong crest factor parameter in the device setup, the parameter can be corrected afterwards and the data can be re-evaluated.

The measured data can be visualized or exported in different units or formats, depending on the selected probe type ([V/m], [A/m], [°C], [mW/g], [mW/cm²], [dBrel], etc.). Some of these units are not available in certain situations or show meaningless results, e.g., a SAR output in a lossless media will always be zero. Raw data can also be exported to perform the evaluation with other software packages.

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	$Norm_i$, a_{i0}, a_{i1}, a_{i2}
	- Conversion factor	$ConvF_i$
	- Diode compression point	Dcpi
Device parameters:	- Frequency	f
	- Crest factor	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 DASY5/6 components. In the direct measuring mode of the multimeter option, the parameters of the actual system setup are used. In the scan visualization and export modes, the parameters stored in the corresponding document files are used.

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

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

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

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

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

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

a_{ij} = sensor sensitivity factors for H-field probes

f = carrier frequency [GHz]

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

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

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

$$E_{tot} = (E_x^2 + E_Y^2 + E_z^2)^{1/2}$$

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

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

ρ = 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.

$P_{pwe} = E_{tot}^2 / 3770$ 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 electric field strength in V/m

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

4 System Verification Procedure

4.1 Tissue Verification

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

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

Ingredients (% of weight)	**Head Tissue**					
Frequency Band (MHz)	750	835	1750	1900	2450	2600
Water	39.2	41.45	52.64	55.242	62.7	55.242
Salt (NaCl)	2.7	1.45	0.36	0.306	0.5	0.306
Sugar	57.0	56.0	0.0	0.0	0.0	0.0
HEC	0.0	1.0	0.0	0.0	0.0	0.0
Bactericide	0.0	0.1	0.0	0.0	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0
DGBE	0.0	0.0	47.0	44.542	36.8	44.452
Ingredients (% of weight)	**Body Tissue**					
Frequency Band (MHz)	750	835	1750	1900	2450	2600
Water	50.3	52.4	69.91	69.91	73.2	64.493
Salt (NaCl)	1.60	1.40	0.13	0.13	0.04	0.024
Sugar	47.0	45.0	0.0	0.0	0.0	0.0
HEC	0.0	1.0	0.0	0.0	0.0	0.0
Bactericide	0.0	0.1	0.0	0.0	0.0	0.0
Triton X-100	0.0	0.0	0.0	0.0	0.0	0.0
DGBE	0.0	0.0	29.96	29.96	26.7	32.252

Table 4: Tissue Dielectric Properties

Salt: 99+% Pure Sodium Chloride; Sugar: 98+% Pure Sucrose; Water: De-ionized, 16MΩ+ 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

☒**Simulating Body Liquid (MBBL600-6000MHz),Manufactured by SPEAG:**

Ingredients	(% by weight)
Water	60-80%
Esters,Emulsifiers,Inhibitors	20-40%
Sodium salt	0-1.5%

Tissue Type	Measured Frequency	Target Tissue		Measured Tissue		Deviation (Within +/-5%)		Liquid Temp.	Test Date
		Permit-tivity	Conduc-tivity [S/m]	Permit-tivity	Conduc-tivity [S/m]	$\Delta\varepsilon_r$	$\Delta\sigma$		
2450MHz Body	2410	52.80	1.91	51.09	1.990	-3.24%	4.19%	22.2°C	2018/1/4
	2435	52.70	1.94	51.06	2.016	-3.11%	3.92%		
	2450	52.70	1.95	51.05	2.028	-3.13%	4.00%		
	2460	52.70	1.96	51.05	2.035	-3.13%	3.83%		
5GHz Body	5250	48.90	5.36	49.43	5.411	1.08%	0.95%	22.3°C	2018/1/5
	5600	48.50	5.77	48.75	5.920	0.52%	2.60%		
	5750	48.30	5.94	48.46	6.147	0.33%	3.48%		

Table 5:Measured Tissue Parameter

Note: 1）The dielectric parameters of the tissue-equivalent liquid should be measured under similar ambient conditions and within 2 °C of the conditions expected during the SAR evaluation to satisfy protocol requirements.

2）KDB 865664 was ensured to be applied for probe calibration frequencies greater than or equal to 50MHz of the EUT frequencies.

3）The above measured tissue parameters were used in the DASY software to perform interpolation via the DASY software to determine actual dielectric parameters at the test frequencies. The SAR test plots may slightly differ from the table above since the DASY rounds to three significant digits.

4.2 System Check

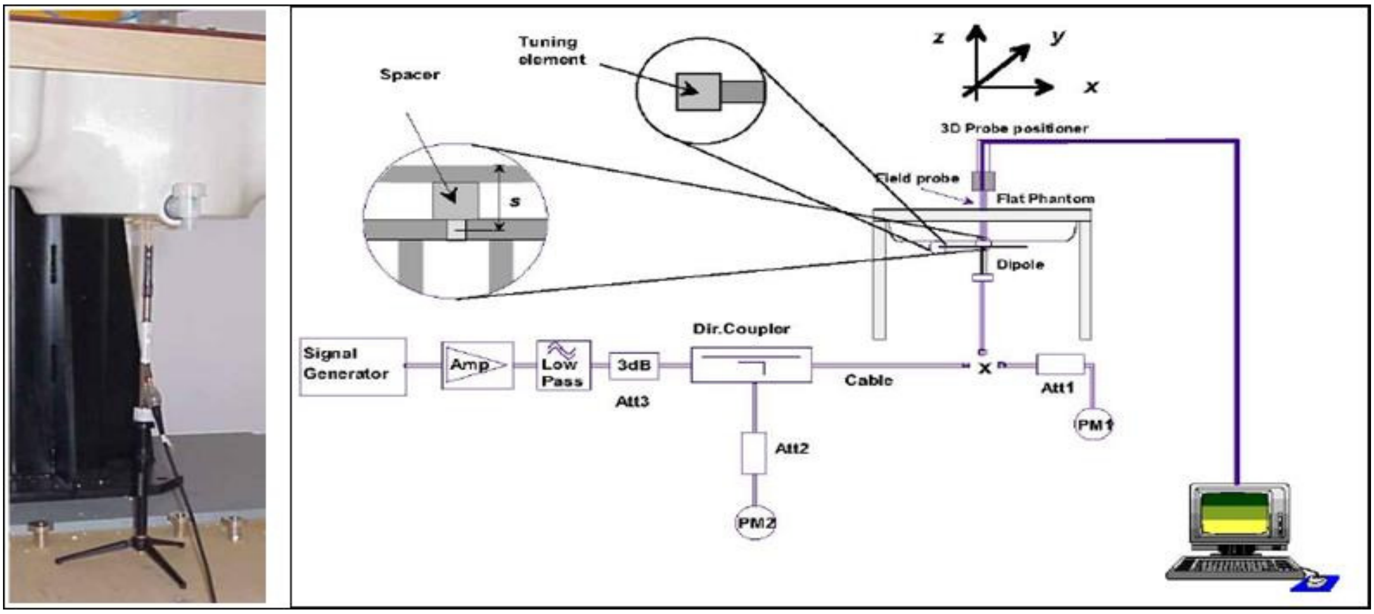
The system check is performed for verifying the accuracy of the complete measurement system and performance of the software. The system check is performed with tissue equivalent material according to IEEE 1528 (described above). The following table shows system check results for all frequency bands and tissue liquids used during the tests(Graphic Plot(s) see Appendix A).

System Check	Target SAR (1W) (+/-10%)		Measured SAR (Normalized to 1W)		Deviation (Within +/-10%)		Liquid Temp.	Test Date
	1-g (mW/g)	10-g (mW/g)	1-g (mW/g)	10-g (mW/g)	Δ1-g	Δ10-g		
2450MHz Body	52.10	24.70	52.80	24.36	1.34%	-1.38%	22.2°C	2018/1/4
5250MHz Body	74.80	20.90	77.20	21.80	3.21%	4.31%	22.3°C	2018/1/5
5600MHz Body	78.70	22.10	84.90	23.70	7.88%	7.24%	22.3°C	2018/1/5
5750MHz Body	75.90	21.20	78.80	22.20	3.82%	4.72%	22.3°C	2018/1/5

Table 6:System Check Results

4.3 System check Procedure

The system check is performed by using a system check dipole which is positioned parallel to the planar part of the SAM phantom at the reference point. The distance of the dipole to the SAM phantom is determined by a plexiglass spacer. The dipole is connected to the signal source consisting of signal generator and amplifier via a directional coupler, N-connector cable and adaption to SMA. It is fed with a power of 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 (result on plot).
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.



5 SAR measurement variability and uncertainty

5.1 SAR measurement variability

Per KDB865664 D01 SAR measurement 100 MHz to 6 GHz, SAR measurement variability must be assessed for each frequency band, which is determined by the SAR probe calibration point and tissue-equivalent medium used for the device measurements. The additional measurements are repeated after the completion of all measurements requiring the same head or body tissue-equivalent medium in a frequency band. The test device should be returned to ambient conditions (normal room temperature) with the battery fully charged before it is re-mounted on the device holder for the repeated measurement(s) to minimize any unexpected variations in the repeated results.

1) Repeated measurement is not required when the original highest measured SAR is < 0.80 W/kg; steps 2) through 4) do not apply.
2) When the original highest measured SAR is ⩾ 0.80 W/kg, repeat that measurement once.
3) Perform a second repeated measurement only if the ratio of largest to smallest SAR for the original and first repeated measurements is > 1.20 or when the original or repeated measurement is ⩾ 1.45 W/kg (~ 10% from the 1-g SAR limit).
4) Perform a third repeated measurement only if the original, first or second repeated measurement is ⩾ 1.5 W/kg and the ratio of largest to smallest SAR for the original, first and second repeated measurements is > 1.20.

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

The detailed repeated measurement results are shown in Section 7.2.

5.2 SAR measurement uncertainty

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.

6 SAR Test Configuration

6.1 Test Positions Configuration

Per FCC KDB616217D04, The required minimum test separation distance for incorporating transmitters and antennas into laptop, notebook and netbook computer displays is determined with the display screen opened at an angle of 90° to the keyboard compartment. If a computer has other operating configurations that require a different or more conservative display to keyboard angle for normal use, a KDB inquiry should be submitted to determine the test requirements. When antennas are incorporated in the keyboard section of a laptop computer, SAR is required for the bottom surface of the keyboard. Provided tablet use conditions are not supported by the laptop computer, SAR tests for bystander exposure from the edges of the keyboard and display screen of laptop computers are generally not required. However, when edge testing is necessary, the similar concerns for simultaneous transmission on adjacent or multiple edges described for laptop also apply.

For this device, the transmit antennas are located at the keyboard section. Body operating configurations are tested with the device bottom side positioned against a flat phantom with test separation distance of 0mm in a normal use configuration.

6.2 WiFi Test Configuration

For WiFi SAR testing, a communication link is set up with the testing software for WiFi mode test. During the test,at the each test frequency channel, the EUT is operated at the RF continuous emission mode. Per KDB 248227D01, a minimum transmission duty factor of 85% is required to avoid certain hardware and device implementation issues related to wide range SAR scaling. The *reported* SAR must be scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit.

6.2.1 Initial Test Position Procedure

For exposure condition with multiple test position, such as handsets operating next to the ear, devices with hotspot mode or UMPC mini-tablet , procedures for initial test position can be applied. Using the transmission mode determined by the DSSS procedure or initial test configuration, area scans are measured for all position in an exposure condition. The test position with the highest extrapolated(peak) SAR is used as the initial test position. When reported SAR for the initial test position is ≤ 0.4W/kg, no additional testing for the remaining test position is required. Otherwise, SAR is evaluated at the subsequent highest peak SAR position until the reported SAR result is ≤ 0.8W/kg or all test position are measured. For all positions/configurations tested using the initial test position and subsequent test positions, when the *reported* SAR is > 0.8 W/kg, SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel(s) until the *reported* SAR is ≤ 1.2 W/kg or all required channels are tested.

6.2.2 Initial Test Configuration Procedure

An initial test configuration is determined for OFDM transmission modes according to the channel bandwidth, modulation and data rate combination(s) with the highest maximum output power specified for production units in each standalone and aggregated frequency band. SAR is measured using the highest measured maximum output power channel. For configurations with the same specified or measured maximum output power, additional transmission mode and test channel selection procedures are required (see section 5.3.2 of KDB 248227D01). SAR test reduction of subsequent highest output test channels is based on the *reported* SAR of the initial test configuration.

For next to the ear, hotspot mode and UMC mini-tablet exposure configurations where multiple test positions are required, the initial test position procedure is applied to minimize the number of test positions required for SAR measurement using the initial test configuration transmission mode. For fixed exposure conditions that do not have multiple SAR test positions, SAR is measured in the transmission mode determined by the initial test configuration.

When the *reported* SAR of the initial test configuration is > 0.8 W/kg, SAR measurement is required for the subsequent next highest measured output power channel(s) in the initial test configuration until the *reported* SAR is ≤ 1.2 W/kg or all required channels are tested.

6.2.3 Sub Test Configuration Procedure

SAR measurement requirements for the remaining 802.11 transmission mode configurations that have not been tested in the initial test configuration are determined separately for each standalone and aggregated frequency band, in each exposure condition, according to the maximum output power specified for production units.

When the highest reported SAR for the initial test configuration, according to the initial test position or fixed exposure position requirements, is adjusted by the ratio of the subsequent test configuration to initial test configuration specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR is not required for that subsequent test configuration.

6.2.4 WiFi 2.4G SAR Test Procedures

Separate SAR procedures are applied to DSSS and OFDM configurations in the 2.4 GHz band to simplify DSSS test requirements. For 802.11b DSSS SAR measurements, DSSS SAR procedure applies to fixed exposure test position and initial test position procedure applies to multiple exposure test positions.

A) 802.11b DSSS SAR Test Requirements

SAR is measured for 2.4 GHz 802.11b DSSS using either a fixed test position or, when applicable, the initial test position procedure. SAR test reduction is determined according to the following:

1) When the *reported* SAR of the highest measured maximum output power channel (section 3.1 of of KDB 248227D01) for the exposure configuration is ≤ 0.8 W/kg, no further SAR testing is required for 802.11b DSSS in that exposure configuration.

2) When the *reported* SAR is > 0.8 W/kg, SAR is required for that exposure configuration using the next highest measured output power channel. When any *reported* SAR is > 1.2 W/kg, SAR is required for the third channel; i.e., all channels require testing.

B) 2.4GHz 802.11g/n OFDM SAR Test Exclusion Requirements

When SAR measurement is required for 2.4 GHz 802.11g/n OFDM configurations, the measurement and test reduction procedures for OFDM are applied (section 5.3 of of KDB 248227D01). SAR is not required for the following 2.4 GHz OFDM conditions.

1) When KDB Publication 447498 SAR test exclusion applies to the OFDM configuration.

2) When the highest *reported* SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg.

C) SAR Test Requirements for OFDM configurations

When SAR measurement is required for 802.11 a/g/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 applies. 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.

6.2.5 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. 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.

6.2.6 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, the channels at 5.60 – 5.65 GHz in U-NII-2C band must be disabled with acceptable mechanisms and documented in the equipment certification to avoid SAR requirements.10 TDWR restriction does not apply under the new rules; 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 SAR measurement accuracy and to facilitate test reduction, the channels in U-NII-2C band above 5.65 GHz may be grouped with the 5.8 GHz channels in U-NII-3 or §15.247 band to enable two SAR probe calibration frequency points to cover the bands, including the band gap channels.11 When band gap channels are supported and the bands are not aggregated for SAR testing, band gap channels must be considered independently in each band according to the normally required OFDM SAR measurement and probe calibration frequency points requirements.

6.2.7 OFDM Transmission Mode SAR Test Channel Selection Requirements

For 2.4 GHz and 5 GHz bands, When the same maximum output power was specified for multiple OFDM transmission mode configurations in a frequency band or aggregated band, SAR is measured using the configuration with the largest channel bandwidth,lowest order modulation and lowest data rate. When the maximum output power of a channel is the same for equivalent OFDM configurations(for example 802.11a, 802.11n and 802.11ac, or 802.11g and 802.11n, with the same channel bandwidth, modulation, and data rate, etc), the lower order 802.11 mode (i.e., 802.11a is chosen over 802.11n then 802.11ac, or 802.11g is chosen over 802.11n) is used for SAR measurement. When the maximum output power are the same for multiple test channel, either according to the default or additional power measurement requirement, SAR is measured using the channel closest to the middle of the frequency band or aggregted band. When there are multiple channels with the same maximum output power, SAR is measured using the higher number channel.

6.2.8 MIMO SAR Considerations

Per KDB 248227D01, simultaneous transmission provisions in KDB Publication 447498 should be used to determine simultaneous transmission SAR test exclusion for WiFi MIMO. If the sum of 1-g SAR single transmission SAR measurement is <1.6W/kg, no additional SAR measurements for MIMO are required. Alternatively,SAR for MIMO can be measured with all antennas transmitting simultaneously at the specified maximum output power of MIMO operation.

7 SAR Measurement Results

7.1 Conducted power measurements

7.1.1 Conducted power measurements of WiFi 2.4G

The output power of WiFi antenna is as following:

Mode	Ant	Channel	Frequency (MHz)	Data Rate (Mbps)	Tune-up	Average Power (dBm)	SAR Test (Yes/No)
802.11b SISO	Ant1	1	2412	1Mbps	18.5	17.60	No
		6	2437		18.5	**17.71**	Yes
		11	2462		18.5	17.58	No
	Ant2	1	2412	1Mbps	18.5	**17.49**	Yes
		6	2437		18.5	**17.46**	Yes
		11	2462		18.5	**17.25**	Yes
802.11g SISO	Ant1	1	2412	6Mbps	18.5	17.87	No
		6	2437		18.5	17.82	No
		11	2462		18.5	17.73	No
	Ant2	1	2412	6Mbps	18.5	17.79	No
		6	2437		18.5	17.66	No
		11	2462		18.5	17.65	No
802.11n SISO 20M	Ant1	1	2412	MCS0	18.5	17.77	No
		6	2437		18.5	17.80	No
		11	2462		18.5	17.70	No
	Ant2	1	2412	MCS0	18.5	17.53	No
		6	2437		18.5	17.38	No
		11	2462		18.5	17.53	No
802.11n SISO 40M	Ant1	3	2422	MCS0	16.5	15.83	No
		6	2437		16.5	15.75	No
		9	2452		16.5	15.80	No
	Ant2	3	2422	MCS0	16.5	15.74	No
		6	2437		16.5	15.69	No
		9	2452		16.5	15.77	No

Mode	Ant	Channel	Frequency (MHz)	Data Rate (Mbps)	Tune-up	Average Power (dBm)	SAR Test (Yes/No)
802.11n MIMO 20M	Ant1	1	2412	MCS8	/	15.26	No
		6	2437		/	15.39	No
		11	2462		/	15.28	No
	Ant2	1	2412	MCS8	/	14.96	No
		6	2437		/	14.94	No
		11	2462		/	14.92	No
	Sum	1	2412	MCS8	18.5	18.12	No
		6	2437		18.5	**18.18**	Yes
		11	2462		18.5	18.11	No
802.11n MIMO 40M	Ant1	3	2422	MCS8	/	12.75	No
		6	2437		/	12.69	No
		9	2452		/	12.78	No
	Ant2	3	2422	MCS8	/	12.61	No
		6	2437		/	12.53	No
		9	2452		/	12.62	No
	Sum	3	2422	MCS8	16.5	15.69	No
		6	2437		16.5	15.62	No
		9	2452		16.5	15.71	No

Table 7: Conducted power measurement results of WiFi 2.4G.

Note: 1) The Average conducted power of WiFi is measured with RMS detector.

7.1.2 Conducted power measurements of WiFi 5G

The output power of WiFi antenna is as following:

Mode	Antenna	Channel	Frequency (MHz)	Data Rate (Mbps)	Tune-up	Average Power (dBm)	SAR Test (Yes/No)
802.11a SISO	Ant1	CH 36	5180	6M	11.0	9.70	No
		CH 40	5200		11.0	9.56	No
		CH 44	5220		11.0	9.68	No
		CH 48	5240		11.0	9.80	No
		CH 52	5260		11.0	10.02	No
		CH 56	5280		11.0	9.82	No
		CH 60	5300		11.0	10.11	No
		CH 64	5320		11.0	10.22	No
		CH 100	5500		11.0	10.01	No
		CH 104	5520		11.0	9.88	No
		CH 108	5540		11.0	9.94	No
		CH 112	5560		11.0	9.83	No
		CH 116	5580		11.0	9.89	No
		CH 120	5600		11.0	9.79	No
		CH 124	5620		11.0	9.69	No
		CH 128	5640		11.0	9.98	No
		CH 132	5660		11.0	9.86	No
		CH 136	5680		11.0	9.82	No
		CH 140	5700		11.0	10.04	No
		CH 144	5720		11.0	10.12	No
		CH 149	5745		11.0	10.40	No
		CH 153	5765		11.0	10.39	No
		CH 157	5785		11.0	10.59	No
		CH 161	5805		11.0	10.31	No
		CH 165	5825		11.0	10.64	No
	Ant2	CH 36	5180	6M	10.5	8.79	No
		CH 40	5200		10.5	8.57	No
		CH 44	5220		10.5	8.71	No
		CH 48	5240		10.5	8.98	No
		CH 52	5260		10.5	9.26	No
		CH 56	5280		10.5	9.45	No
		CH 60	5300		10.5	9.60	No
		CH 64	5320		10.5	9.92	No
		CH 100	5500		10.5	9.20	No
		CH 104	5520		10.5	8.88	No
		CH 108	5540		10.5	9.04	No
		CH 112	5560		10.5	9.30	No
		CH 116	5580		10.5	9.26	No
		CH 120	5600		10.5	9.29	No
		CH 124	5620		10.5	9.39	No
		CH 128	5640		10.5	9.39	No
		CH 132	5660		10.5	9.33	No
		CH 136	5680		10.5	9.35	No
		CH 140	5700		10.5	9.26	No
		CH 144	5720		10.5	9.25	No
		CH 149	5745		10.5	9.20	No
		CH 153	5765		10.5	9.10	No
		CH 157	5785		10.5	9.56	No
		CH 161	5805		10.5	9.78	No
		CH 165	5825		10.5	10.19	No

Mode	Antenna	Channel	Frequency (MHz)	Data Rate (Mbps)	Tune-up	Average Power (dBm)	SAR Test (Yes/No)
802.11n SISO 20M (5GHz)	Ant1	CH 36	5180	MCS0	11.0	9.22	No
		CH 40	5200		11.0	9.05	No
		CH 44	5220		11.0	9.21	No
		CH 48	5240		11.0	9.24	No
		CH 52	5260		11.0	9.53	No
		CH 56	5280		11.0	9.55	No
		CH 60	5300		11.0	9.76	No
		CH 64	5320		11.0	9.80	No
		CH 100	5500		11.0	9.45	No
		CH 104	5520		11.0	9.31	No
		CH 108	5540		11.0	9.42	No
		CH 112	5560		11.0	9.51	No
		CH 116	5580		11.0	9.40	No
		CH 120	5600		11.0	9.37	No
		CH 124	5620		11.0	9.36	No
		CH 128	5640		11.0	9.55	No
		CH 132	5660		11.0	9.40	No
		CH 136	5680		11.0	9.42	No
		CH 140	5700		11.0	9.71	No
		CH 144	5720		11.0	9.81	No
		CH 149	5745		11.0	9.92	No
		CH 153	5765		11.0	9.87	No
		CH 157	5785		11.0	10.11	No
		CH 161	5805		11.0	10.10	No
		CH 165	5825		11.0	10.28	No
	Ant2	CH 36	5180	MCS0	10.5	8.71	No
		CH 40	5200		10.5	8.61	No
		CH 44	5220		10.5	8.71	No
		CH 48	5240		10.5	8.86	No
		CH 52	5260		10.5	9.12	No
		CH 56	5280		10.5	9.27	No
		CH 60	5300		10.5	9.52	No
		CH 64	5320		10.5	9.83	No
		CH 100	5500		10.5	9.13	No
		CH 104	5520		10.5	8.81	No
		CH 108	5540		10.5	8.96	No
		CH 112	5560		10.5	9.23	No
		CH 116	5580		10.5	9.15	No
		CH 120	5600		10.5	9.23	No
		CH 124	5620		10.5	9.29	No
		CH 128	5640		10.5	9.32	No
		CH 132	5660		10.5	9.26	No
		CH 136	5680		10.5	9.25	No
		CH 140	5700		10.5	9.16	No
		CH 144	5720		10.5	9.16	No
		CH 149	5745		10.5	9.10	No
		CH 153	5765		10.5	8.99	No
		CH 157	5785		10.5	9.44	No
		CH 161	5805		10.5	9.65	No
		CH 165	5825		10.5	10.09	No

Mode	Antenna	Channel	Frequency (MHz)	Data Rate (Mbps)	Tune-up	Average Power (dBm)	SAR Test (Yes/No)
802.11n SISO 40M (5GHz)	Ant1	CH 38	5190	MCS0	11.0	9.26	No
		CH 46	5230		11.0	9.31	No
		CH 54	5270		11.0	9.61	No
		CH 62	5310		11.0	9.84	No
		CH 102	5510		11.0	9.49	No
		CH 110	5550		11.0	9.56	No
		CH 118	5590		11.0	9.46	No
		CH 126	5630		11.0	9.38	No
		CH 134	5670		11.0	9.52	No
		CH 142	5710		11.0	9.85	No
		CH 151	5755		11.0	9.96	No
		CH 159	5795		11.0	10.17	No
	Ant2	CH 38	5190		10.5	8.85	No
		CH 46	5230		10.5	8.82	No
		CH 54	5270		10.5	9.33	No
		CH 62	5310		10.5	9.69	No
		CH 102	5510		10.5	9.16	No
		CH 110	5550		10.5	9.01	No
		CH 118	5590		10.5	9.23	No
		CH 126	5630		10.5	9.35	No
		CH 134	5670		10.5	9.38	No
		CH 142	5710		10.5	9.35	No
		CH 151	5755		10.5	9.23	No
		CH 159	5795		10.5	9.56	No

Mode	Antenna	Channel	Frequency (MHz)	Data Rate (Mbps)	Tune-up	Average Power (dBm)	SAR Test (Yes/No)
802.11ac SISO 20M (5GHz)	Ant1	CH 36	5180	MCS0	11.0	9.30	No
		CH 40	5200		11.0	9.13	No
		CH 44	5220		11.0	9.22	No
		CH 48	5240		11.0	9.30	No
		CH 52	5260		11.0	9.55	No
		CH 56	5280		11.0	9.59	No
		CH 60	5300		11.0	9.80	No
		CH 64	5320		11.0	9.81	No
		CH 100	5500		11.0	9.47	No
		CH 104	5520		11.0	9.34	No
		CH 108	5540		11.0	9.46	No
		CH 112	5560		11.0	9.50	No
		CH 116	5580		11.0	9.41	No
		CH 120	5600		11.0	9.40	No
		CH 124	5620		11.0	9.34	No
		CH 128	5640		11.0	9.55	No
		CH 132	5660		11.0	9.42	No
		CH 136	5680		11.0	9.45	No
		CH 140	5700		11.0	9.71	No
		CH 144	5720		11.0	9.79	No
		CH 149	5745		11.0	9.90	No
		CH 153	5765		11.0	9.87	No
		CH 157	5785		11.0	10.12	No
		CH 161	5805		11.0	10.12	No
		CH 165	5825		11.0	10.29	No
	Ant2	CH 36	5180		10.5	8.72	No
		CH 40	5200		10.5	8.59	No
		CH 44	5220		10.5	8.65	No
		CH 48	5240		10.5	8.90	No
		CH 52	5260		10.5	9.13	No
		CH 56	5280		10.5	9.32	No
		CH 60	5300		10.5	9.50	No
		CH 64	5320		10.5	9.79	No
		CH 100	5500		10.5	9.14	No
		CH 104	5520		10.5	9.77	No
		CH 108	5540		10.5	8.92	No
		CH 112	5560		10.5	9.21	No
		CH 116	5580		10.5	9.12	No
		CH 120	5600		10.5	9.17	No
		CH 124	5620		10.5	9.26	No
		CH 128	5640		10.5	9.30	No
		CH 132	5660		10.5	9.22	No
		CH 136	5680		10.5	9.25	No
		CH 140	5700		10.5	9.13	No
		CH 144	5720		10.5	9.16	No
		CH 149	5745		10.5	9.08	No
		CH 153	5765		10.5	9.00	No
		CH 157	5785		10.5	9.44	No
		CH 161	5805		10.5	9.65	No
		CH 165	5825		10.5	10.06	No

Mode	Antenna	Channel	Frequency (MHz)	Data Rate (Mbps)	Tune-up	Average Power (dBm)	SAR Test (Yes/No)
802.11ac SISO 40M (5GHz)	Ant1	CH 38	5190	MCS0	11.0	9.33	No
		CH 46	5230		11.0	9.35	No
		CH 54	5270		11.0	9.64	No
		CH 62	5310		11.0	9.87	No
		CH 102	5510		11.0	9.47	No
		CH 110	5550		11.0	9.52	No
		CH 118	5590		11.0	9.45	No
		CH 126	5630		11.0	9.37	No
		CH 134	5670		11.0	9.47	No
		CH 142	5710		11.0	9.82	No
		CH 151	5755		11.0	9.94	No
		CH 159	5795		11.0	10.15	No
	Ant2	CH 38	5190		10.5	8.76	No
		CH 46	5230		10.5	8.79	No
		CH 54	5270		10.5	9.29	No
		CH 62	5310		10.5	9.68	No
		CH 102	5510		10.5	9.16	No
		CH 110	5550		10.5	9.06	No
		CH 118	5590		10.5	9.26	No
		CH 126	5630		10.5	9.35	No
		CH 134	5670		10.5	9.36	No
		CH 142	5710		10.5	9.31	No
		CH 151	5755		10.5	9.20	No
		CH 159	5795		10.5	9.53	No

Mode	Antenna	Channel	Frequency (MHz)	Data Rate (Mbps)	Tune-up	Average Power (dBm)	SAR Test (Yes/No)
802.11ac SISO 80M (5GHz)	Ant1	CH 42	5210	MCS0	11.0	9.01	No
		CH 58	5290		11.0	**9.40**	Yes
		CH 106	5530		11.0	9.18	No
		CH 122	5610		11.0	9.14	No
		CH 138	5690		11.0	**9.31**	Yes
		CH 155	5775		11.0	**9.73**	Yes
	Ant2	CH 42	5210		10.5	**8.52**	Yes
		CH 58	5290		10.5	**9.10**	Yes
		CH 106	5530		10.5	**8.69**	Yes
		CH 122	5610		10.5	**9.22**	Yes
		CH 138	5690		10.5	**9.30**	Yes
		CH 155	5775		10.5	**8.70**	Yes

Mode	Antenna	Channel	Frequency (MHz)	Data Rate (Mbps)	Tune-up	Average Power (dBm)	SAR Test (Yes/No)
802.11n MIMO 20M (5GHz)	Ant1	CH 36	5180	MCS8	/	6.35	No
		CH 40	5200		/	6.21	No
		CH 44	5220		/	6.34	No
		CH 48	5240		/	6.43	No
		CH 52	5260		/	6.69	No
		CH 56	5280		/	6.67	No
		CH 60	5300		/	6.90	No
		CH 64	5320		/	6.91	No
		CH 100	5500		/	6.60	No
		CH 104	5520		/	6.51	No
		CH 108	5540		/	6.65	No
		CH 112	5560		/	6.70	No
		CH 116	5580		/	6.56	No
		CH 120	5600		/	6.59	No
		CH 124	5620		/	6.47	No
		CH 128	5640		/	6.71	No
		CH 132	5660		/	6.57	No
		CH 136	5680		/	6.67	No
		CH 140	5700		/	6.95	No
		CH 144	5720		/	7.07	No
		CH 149	5745		/	7.10	No
		CH 153	5765		/	7.09	No
		CH 157	5785		/	7.41	No
		CH 161	5805		/	7.37	No
		CH 165	5825		/	7.55	No
	Ant2	CH 36	5180		/	6.55	No
		CH 40	5200		/	6.30	No
		CH 44	5220		/	6.47	No
		CH 48	5240		/	6.71	No
		CH 52	5260		/	7.02	No
		CH 56	5280		/	7.17	No
		CH 60	5300		/	7.41	No
		CH 64	5320		/	7.68	No
		CH 100	5500		/	7.04	No
		CH 104	5520		/	6.78	No
		CH 108	5540		/	6.88	No
		CH 112	5560		/	7.14	No
		CH 116	5580		/	7.08	No
		CH 120	5600		/	7.17	No
		CH 124	5620		/	7.24	No
		CH 128	5640		/	7.28	No
		CH 132	5660		/	7.23	No
		CH 136	5680		/	7.23	No
		CH 140	5700		/	7.12	No
		CH 144	5720		/	7.12	No
		CH 149	5745		/	7.10	No
		CH 153	5765		/	6.96	No
		CH 157	5785		/	7.23	No
		CH 161	5805		/	7.42	No
		CH 165	5825		/	7.81	No
	Sum	CH 36	5180		11.0	9.46	No
		CH 40	5200		11.0	9.27	No
		CH 44	5220		11.0	9.42	No
		CH 48	5240		11.0	9.58	No
		CH 52	5260		11.0	9.87	No
		CH 56	5280		11.0	9.94	No
		CH 60	5300		11.0	10.17	No
		CH 64	5320		11.0	10.32	No
		CH 100	5500		11.0	9.84	No

		CH 104	5520		11.0	9.66	No
		CH 108	5540		11.0	9.78	No
		CH 112	5560		11.0	9.94	No
		CH 116	5580		11.0	9.84	No
		CH 120	5600		11.0	9.90	No
		CH 124	5620		11.0	9.88	No
		CH 128	5640		11.0	10.01	No
		CH 132	5660		11.0	9.92	No
		CH 136	5680		11.0	9.97	No
		CH 140	5700		11.0	10.05	No
		CH 144	5720		11.0	10.11	No
		CH 149	5745		11.0	10.11	No
		CH 153	5765		11.0	10.04	No
		CH 157	5785		11.0	10.33	No
		CH 161	5805		11.0	10.41	No
		CH 165	5825		11.0	10.69	No

Mode	Antenna	Channel	Frequency (MHz)	Data Rate (Mbps)	Tune-up	Average Power (dBm)	SAR Test (Yes/No)
802.11n MIMO 40M (5GHz)	Ant1	CH 38	5190	MCS8	/	5.91	No
		CH 46	5230		/	5.86	No
		CH 54	5270		/	6.06	No
		CH 62	5310		/	6.30	No
		CH 102	5510		/	6.09	No
		CH 110	5550		/	6.01	No
		CH 118	5590		/	6.20	No
		CH 126	5630		/	6.16	No
		CH 134	5670		/	6.20	No
		CH 142	5710		/	6.26	No
		CH 151	5755		/	6.62	No
		CH 159	5795		/	6.92	No
	Ant2	CH 38	5190		/	6.29	No
		CH 46	5230		/	6.20	No
		CH 54	5270		/	6.65	No
		CH 62	5310		/	6.51	No
		CH 102	5510		/	6.16	No
		CH 110	5550		/	6.19	No
		CH 118	5590		/	6.30	No
		CH 126	5630		/	5.94	No
		CH 134	5670		/	6.50	No
		CH 142	5710		/	6.46	No
		CH 151	5755		/	6.33	No
		CH 159	5795		/	6.66	No
	Sum	CH 38	5190		11.0	9.11	No
		CH 46	5230		11.0	9.04	No
		CH 54	5270		11.0	9.38	No
		CH 62	5310		11.0	9.42	No
		CH 102	5510		11.0	9.14	No
		CH 110	5550		11.0	9.11	No
		CH 118	5590		11.0	9.26	No
		CH 126	5630		11.0	9.06	No
		CH 134	5670		11.0	9.36	No
		CH 142	5710		11.0	9.37	No
		CH 151	5755		11.0	9.49	No
		CH 159	5795		11.0	9.80	No

Mode	Antenna	Channel	Frequency (MHz)	Data Rate (Mbps)	Tune-up	Average Power (dBm)	SAR Test (Yes/No)
802.11ac MIMO 20M (5GHz)	Ant1	CH 36	5180	MCS0	/	6.19	No
		CH 40	5200		/	6.47	No
		CH 44	5220		/	6.42	No
		CH 48	5240		/	6.51	No
		CH 52	5260		/	6.72	No
		CH 56	5280		/	6.77	No
		CH 60	5300		/	6.92	No
		CH 64	5320		/	7.02	No
		CH 100	5500		/	6.77	No
		CH 104	5520		/	6.65	No
		CH 108	5540		/	6.78	No
		CH 112	5560		/	6.82	No
		CH 116	5580		/	6.69	No
		CH 120	5600		/	6.67	No
		CH 124	5620		/	6.63	No
		CH 128	5640		/	6.88	No
		CH 132	5660		/	6.74	No
		CH 136	5680		/	6.75	No
		CH 140	5700		/	7.06	No
		CH 144	5720		/	7.16	No
		CH 149	5745		/	7.28	No
		CH 153	5765		/	7.25	No
		CH 157	5785		/	7.40	No
		CH 161	5805		/	7.49	No
		CH 165	5825		/	7.61	No
	Ant2	CH 36	5180		/	6.23	No
		CH 40	5200		/	6.15	No
		CH 44	5220		/	6.04	No
		CH 48	5240		/	6.36	No
		CH 52	5260		/	6.69	No
		CH 56	5280		/	6.87	No
		CH 60	5300		/	7.01	No
		CH 64	5320		/	7.32	No
		CH 100	5500		/	6.78	No
		CH 104	5520		/	6.42	No
		CH 108	5540		/	6.65	No
		CH 112	5560		/	6.89	No
		CH 116	5580		/	6.81	No
		CH 120	5600		/	6.88	No
		CH 124	5620		/	7.01	No
		CH 128	5640		/	7.08	No
		CH 132	5660		/	7.01	No
		CH 136	5680		/	6.98	No
		CH 140	5700		/	6.90	No
		CH 144	5720		/	6.86	No

		CH 149	5745		/	6.82	No
		CH 153	5765		/	6.61	No
		CH 157	5785		/	7.10	No
		CH 161	5805		/	7.30	No
		CH 165	5825		/	7.35	No
	Sum	CH 36	5180		11.0	9.22	No
		CH 40	5200		11.0	9.32	No
		CH 44	5220		11.0	9.24	No
		CH 48	5240		11.0	9.45	No
		CH 52	5260		11.0	9.72	No
		CH 56	5280		11.0	9.83	No
		CH 60	5300		11.0	9.98	No
		CH 64	5320		11.0	10.18	No
		CH 100	5500		11.0	9.79	No
		CH 104	5520		11.0	9.55	No
		CH 108	5540		11.0	9.73	No
		CH 112	5560		11.0	9.87	No
		CH 116	5580		11.0	9.76	No
		CH 120	5600		11.0	9.79	No
		CH 124	5620		11.0	9.83	No
		CH 128	5640		11.0	9.99	No
		CH 132	5660		11.0	9.89	No
		CH 136	5680		11.0	9.88	No
		CH 140	5700		11.0	9.99	No
		CH 144	5720		11.0	10.02	No
		CH 149	5745		11.0	10.07	No
		CH 153	5765		11.0	9.95	No
		CH 157	5785		11.0	10.26	No
		CH 161	5805		11.0	10.41	No
		CH 165	5825		11.0	10.49	No

Mode	Antenna	Channel	Frequency(MHz)	Data Rate (Mbps)	Tune-up	Average Power (dBm)	SAR Test(Yes/No)
802.11ac MIMO 40M (5GHz)	Ant1	CH 38	5190	MCS0	/	5.86	No
		CH 46	5230		/	5.85	No
		CH 54	5270		/	6.17	No
		CH 62	5310		/	6.47	No
		CH 102	5510		/	6.11	No
		CH 110	5550		/	6.23	No
		CH 118	5590		/	6.09	No
		CH 126	5630		/	6.18	No
		CH 134	5670		/	6.19	No
		CH 142	5710		/	6.51	No
		CH 151	5755		/	6.66	No
		CH 159	5795		/	6.85	No
	Ant2	CH 38	5190		/	6.30	No
		CH 46	5230		/	6.24	No
		CH 54	5270		/	6.77	No
		CH 62	5310		/	6.50	No
		CH 102	5510		/	6.26	No
		CH 110	5550		/	6.09	No
		CH 118	5590		/	6.37	No
		CH 126	5630		/	6.61	No
		CH 134	5670		/	6.55	No
		CH 142	5710		/	6.41	No
		CH 151	5755		/	6.25	No
		CH 159	5795		/	6.60	No
	Sum	CH 38	5190		11.0	9.10	No
		CH 46	5230		11.0	9.06	No
		CH 54	5270		11.0	9.49	No
		CH 62	5310		11.0	9.50	No
		CH 102	5510		11.0	9.20	No
		CH 110	5550		11.0	9.17	No
		CH 118	5590		11.0	9.24	No
		CH 126	5630		11.0	9.41	No
		CH 134	5670		11.0	9.38	No
		CH 142	5710		11.0	9.47	No
		CH 151	5755		11.0	9.47	No
		CH 159	5795		11.0	9.74	No

Mode	Antenna	Channel	Frequency (MHz)	Data Rate (Mbps)	Tune-up	Average Power (dBm)	SAR Test (Yes/No)
802.11ac MIMO 80M (5GHz)	Ant1	CH 42	5210	MCS0	/	5.76	No
		CH 58	5290		/	5.88	No
		CH 106	5530		/	5.67	No
		CH 122	5610		/	5.62	No
		CH 138	5690		/	5.82	No
		CH 155	5775		/	6.24	No
	Ant2	CH 42	5210		/	6.2	No
		CH 58	5290		/	6.29	No
		CH 106	5530		/	5.92	No
		CH 122	5610		/	6.16	No
		CH 138	5690		/	6.32	No
		CH 155	5775		/	5.91	No
	Sum	CH 42	5210		11.0	9.00	No
		CH 58	5290		11.0	9.10	No
		CH 106	5530		11.0	9.01	No
		CH 122	5610		11.0	9.02	No
		CH 138	5690		11.0	9.09	No
		CH 155	5775		11.0	9.09	No

Table 8: Conducted power measurement results of WiFi 5G.

Note: 1) The Average conducted power of WiFi is measured with RMS detector.

7.1.3 Conducted power measurements of BT

The output power of BT antenna is as following:

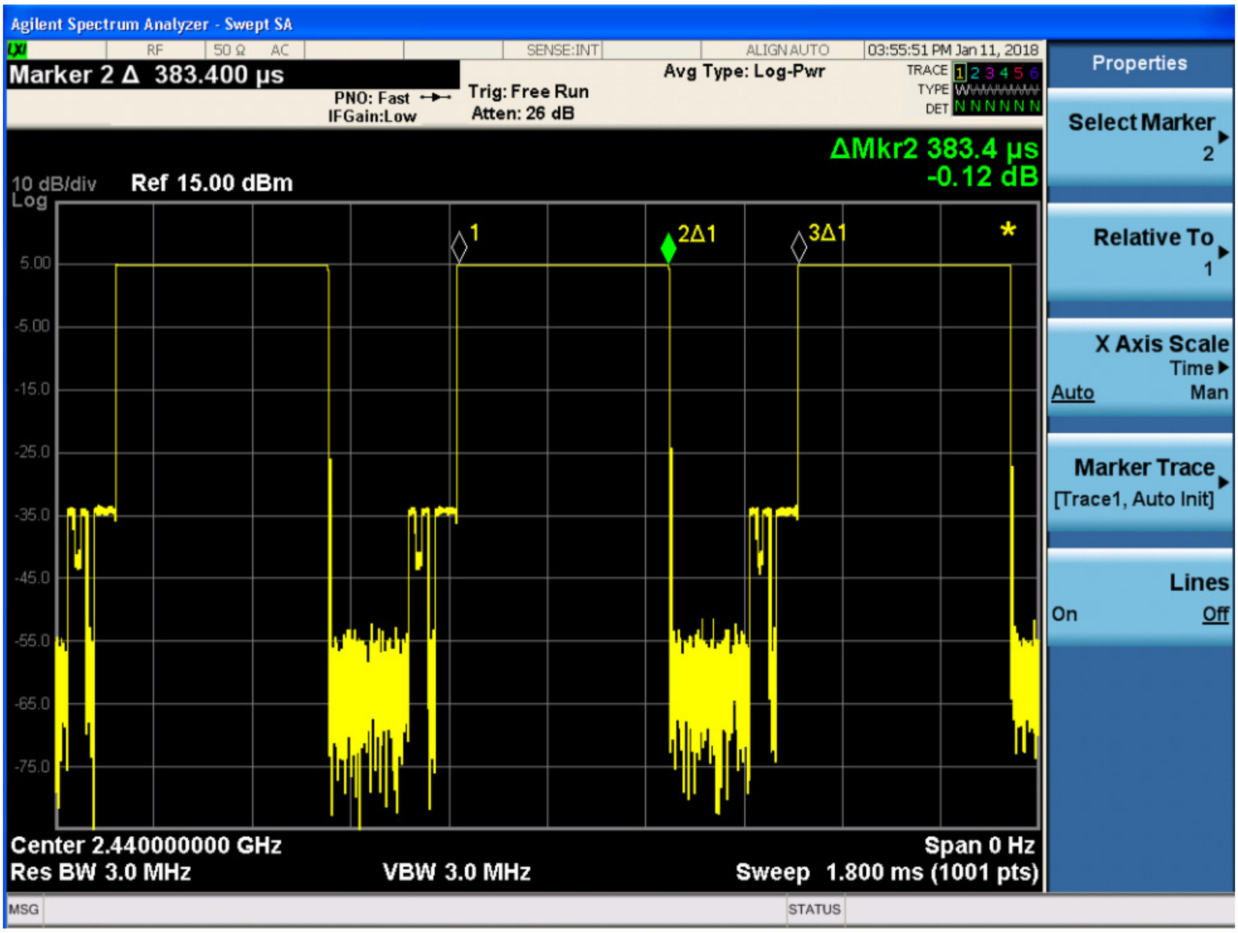
BT 2450	Tune-up	Average Conducted Power (dBm)		
		0CH	39CH	78CH
DH5	**11.5**	**10.02**	**10.36**	**10.19**
2DH5	8.0	7.59	7.95	7.73
3DH5	7.0	6.62	6.98	6.83

BT 2450	Tune-up	Average Conducted Power (dBm)		
		0CH	19CH	39CH
BLE	7.0	3.72	3.99	3.92

Table 9: Conducted power measurement results of BT.

Note:

1) The conducted power of BT is measured with RMS detector.
2) The bolded mode was selected for SAR testing.



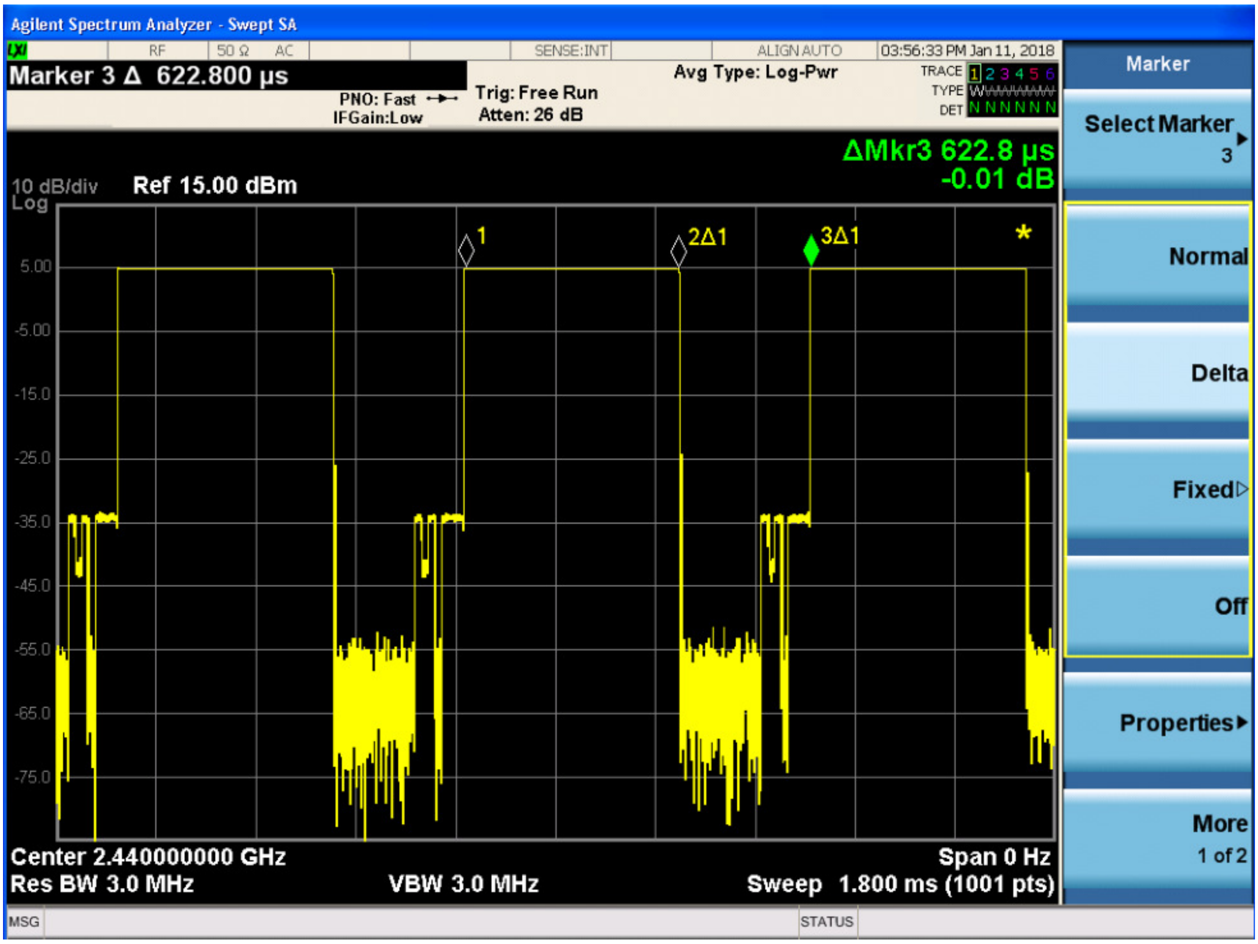


Figure: Bluetooth Transmission Plot

So the bluetooth duty cycle is calculated as below:

$$\text{Duty Cycle} = \frac{Pulse\ Width}{Period} * 100\% = \frac{383.4}{622.8} * 100\% = 61.6\%$$

7.2 SAR measurement Results

General Notes:

1) Per KDB447498 D01, all SAR measurement results are scaled to the maximum tune-up tolerance limit to demonstrate SAR compliance.

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:

- ≤ 0.8W/kg for 1-g or 2.0W/kg for 10-g respectively, when the transmission band is ≤ 100MHz.
- ≤ 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.
- ≤ 0.4 W/kg or 1.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≥ 200 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,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 KDB648474 D04, SAR is evaluated without a headset connected to the device. When the standalone reported body-worn SAR is ≤1.2 W/kg, no additional SAR evaluations using a headset are required.

5) Per KDB616217 D04, When SAR is tested in representative host devices and the highest reported standalone SAR for certain specific operating configurations and exposure conditions are ≤ 1.2 W/kg, the additional tests of a transmitter module in one or more representative host configurations may be performed to allow the transmitter to be incorporated in similar or less conservative host configurations and exposure conditions supported by the same test requirements for that host platform.

6) 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(Refer to appendix B for details).

WiFi Notes:

Per KDB248227D01:

1) When reported SAR for the initial test position is ≤ 0.4W/kg, no additional testing for the remaining test position is required. Otherwise, SAR is evaluated at the subsequent highest peak SAR position until the reported SAR result is ≤ 0.8W/kg or all test position are measured. For all positions/configurations tested using the initial test position and subsequent test positions, when the *reported* SAR is > 0.8 W/kg, SAR is measured for these test positions/configurations on the subsequent next highest measured output power channel(s) until the *reported* SAR is ≤ 1.2 W/kg or all required channels are tested..

2) When the DSSS *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.

3) When the highest *reported* SAR for DSSS is adjusted by the ratio of OFDM to DSSS specified maximum output power and the adjusted SAR is ≤ 1.2 W/kg, SAR measurement is required for 2.4 GHz 802.11g/n OFDM configurations

4) The highest SAR measured for the initial test position or initial test configuration should be used to determine SAR test exclusion according to the sum of 1-g SAR and SAR peak to location ratio provisions in KDB 447498. In addition, a test lab may also choose to perform standalone SAR measurements for test positions and 802.11 configurations that are not required by the initial test position or initial test configuration procedures and apply the results to determine simultaneous transmission SAR test exclusion, according to sum of 1-g and SAR peak to location ratio requirements to reduce the number of simultaneous transmission SAR measurements.

5) For WIFI 2.4G MIMO, SAR is measured with all antennas transmitting simultaneously at the specified maximum output power of MIMO operation.

6) For WiFi 5G MIMO, the conservative “max + max” multi-Tx method is used to the determine SAR compliance. As the sum of 1-g SAR single transmission SAR measurement is <1.6W/kg, no additional SAR measurements for MIMO are required in this report per KDB248227 and KDB447498.

BT Notes:

1) The reported SAR for BT is scaled to 100% transmission duty factor to determine compliance at the maximum tune-up tolerance limit.

7.2.1 SAR measurement Result of WiFi 2.4G

Test Position of Body	Dist.	Test Channel /Freq.(MHz)	Test Mode	Area Scan 1-g SAR （W/kg）	Measured SAR(W/kg)		Power Drift (dB)	Actual duty factor	Scaled 1-g SAR (W/kg)	Conducted Power (dBm)	Tune-up Power (dBm)	Reported 1-g SAR (W/kg)	Accessory Information	SAR Plot.
					1-g	10-g								
Test data of MACH-W29														
ANT1														
Bottom Side	0mm	6/2437	802.11 b	0.524	0.581	0.215	-0.15	99%	0.587	17.71	18.50	0.704	Battery 1#	/
Bottom Side	0mm	6/2437	802.11 b	0.505	0.594	0.219	0.01	99%	0.600	17.71	18.50	0.720	Battery 2#	/
ANT2														
Bottom Side	0mm	1/2412	802.11 b	0.451	0.499	0.181	0.00	99%	0.504	17.49	18.50	0.636	Battery 1#	/
Bottom Side	0mm	1/2412	802.11 b	0.534	0.713	0.263	0.15	99%	0.720	17.49	18.50	0.909	Battery 2#	/
Bottom Side	0mm	6/2437	802.11 b	0.584	**0.742**	0.273	0.00	99%	0.749	17.46	18.50	**0.952**	Battery 2#	Yes
Bottom Side	0mm	11/2462	802.11 b	0.572	0.640	0.241	0.00	99%	0.646	17.25	18.50	0.862	Battery 2#	/
MIMO														
Bottom Side	0mm	6/2437	802.11n (20M)	0.332	0.393	0.141	0.03	98%	0.401	18.18	18.50	0.432	Battery 1#	/
Bottom Side	0mm	6/2437	802.11n (20M)	0.333	0.394	0.142	0.04	98%	0.402	18.18	18.50	0.433	Battery 2#	/
MACH-W19 tested at the SAR worse case of MACH-W29														
Bottom Side	0mm	6/2437	802.11 b	0.529	0.617	0.230	0.16	99%	0.623	17.41	18.50	0.801	/	/

Table 10: Body SAR test results of WiFi 2.4G

Note:

1) Per KDB248227D01, for Body SAR test of WiFi 2.4G SISO(ANT1 or ANT2), SAR is measured for 2.4 GHz 802.11b DSSS using the initial test position procedure.The highest reported SAR for DSSS is adjusted by the ratio of OFDM 802.11g/n to DSSS specified maximum output power and the adjusted SAR is < 1.2 W/kg, so SAR for 802.11g/n is not required.

2) Per KDB248227D01, for Body SAR test of WiFi 2.4G MIMO, SAR is measured for 2.4 GHz 802.11n 20M using the initial test position procedure.The highest reported SAR for 802.11n 20M is adjusted by the ratio of 802.11n 40M to 802.11n 20M specified maximum output power and the adjusted SAR is < 1.2 W/kg, so SAR for 802.11n 40M is not required.

7.2.2 SAR measurement Result of WiFi 5G

Test Position of Body	Dist.	Test Channel /Freq.(MHz)	Test Mode	Area Scan 1-g SAR (W/kg)	Measured SAR(W/kg) 1-g	Measured SAR(W/kg) 10-g	Power Drift (dB)	Actual duty factor	Scaled 1-g SAR (W/kg)	Conducted Power (dBm)	Tune-up Power (dBm)	Reported 1-g SAR (W/kg)	Accessory Information	SAR Plot.
Test data of MACH-W29														
Test data of U-NII-1&U-NII-2A band														
ANT1														
Bottom Side	0mm	58/5290	802.11ac(80M)	0.218	0.215	0.076	0.03	96%	0.224	9.40	11.00	0.324	Battery 1#	/
Bottom Side	0mm	58/5290	802.11ac(80M)	0.247	0.234	0.081	0.00	96%	0.244	9.40	11.00	0.352	Battery 2#	/
ANT2														
Bottom Side	0mm	58/5290	802.11ac(80M)	0.279	0.283	0.096	0.00	96%	0.295	9.10	10.50	0.407	Battery 1#	/
Bottom Side	0mm	58/5290	802.11ac(80M)	0.251	0.242	0.082	0.00	96%	0.252	9.10	10.50	0.348	Battery 2#	/
Bottom Side	0mm	42/5210	802.11ac(80M)	0.269	0.270	0.092	0.00	96%	0.281	8.52	10.50	0.444	Battery 1#	/
Test data of U-NII-2C band														
ANT1														
Bottom Side	0mm	138/5690	802.11ac(80M)	0.242	0.253	0.090	0.03	96%	0.264	9.31	11.00	0.389	Battery 1#	/
Bottom Side	0mm	138/5690	802.11ac(80M)	0.274	0.274	0.095	0.00	96%	0.285	9.31	11.00	0.421	Battery 2#	/
ANT2														
Bottom Side	0mm	138/5690	802.11ac(80M)	0.443	**0.460**	0.155	0.00	96%	0.479	9.30	10.50	**0.632**	Battery 1#	Yes
Bottom Side	0mm	138/5690	802.11ac(80M)	0.365	0.384	0.129	0.00	96%	0.400	9.30	10.50	0.527	Battery 2#	/
Bottom Side	0mm	106/5530	802.11ac(80M)	0.366	0.378	0.129	0.00	96%	0.394	8.69	10.50	0.597	Battery 1#	/
Bottom Side	0mm	122/5610	802.11ac(80M)	0.419	0.444	0.152	0.00	96%	0.463	9.22	10.50	0.621	Battery 1#	/
Test data of U-NII-3 band														
ANT1														
Bottom Side	0mm	155/5775	802.11ac(80M)	0.251	0.266	0.094	0.03	96%	0.277	9.73	11.00	0.371	Battery 1#	/
Bottom Side	0mm	155/5775	802.11ac(80M)	0.291	0.294	0.100	0.00	96%	0.306	9.73	11.00	0.410	Battery 2#	/
ANT2														
Bottom Side	0mm	155/5775	802.11ac(80M)	0.321	0.329	0.111	0.00	96%	0.343	8.70	10.50	0.519	Battery 1#	/
Bottom Side	0mm	155/5775	802.11ac(80M)	0.322	0.349	0.119	0.00	96%	0.364	8.70	10.50	0.550	Battery 2#	/
MACH-W19 tested at the SAR worse case of MACH-W29														
Bottom Side	0mm	138/5690	802.11ac(80M)	0.355	0.375	0.128	0.00	96%	0.391	9.30	10.50	0.515	/	/

Table 11: Body-supported SAR test results of WiFi 5G

Test Position	**WiFi SISO Max$_{SAR}$(W/kg)**		**WiFi SISO Max$_{SAR}$(W/kg)**
	WiFi 5G Ant 1	**WiFi 5G Ant 1**	**“max + max” sum of 1-g SAR**
Bottom Side 0mm	0.421	0.632	1.053

Table 12: Body SAR calculated results of WiFi 5G MIMO

Note:

1) Per KDB248227D01, for Body SAR test of WiFi 5G SISO, SAR is measured for 5GHz 802.11ac 80M using the initial test position procedure.The highest reported SAR is adjusted by the ratio of 802.11ac to other WiFi 5G mode specified maximum output power and the adjusted SAR is < 1.2 W/kg, so SAR for other WiFi 5G mode is not required.
2) For WiFi 5G MIMO, the conservative “max + max” multi-Tx method is used to the determine SAR compliance. As the sum of 1-g SAR single transmission SAR measurement is <1.6W/kg, no additional SAR measurements for MIMO are required in this report per KDB248227 and KDB447498.
3) 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. As 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).

7.2.3 SAR measurement Result of BT

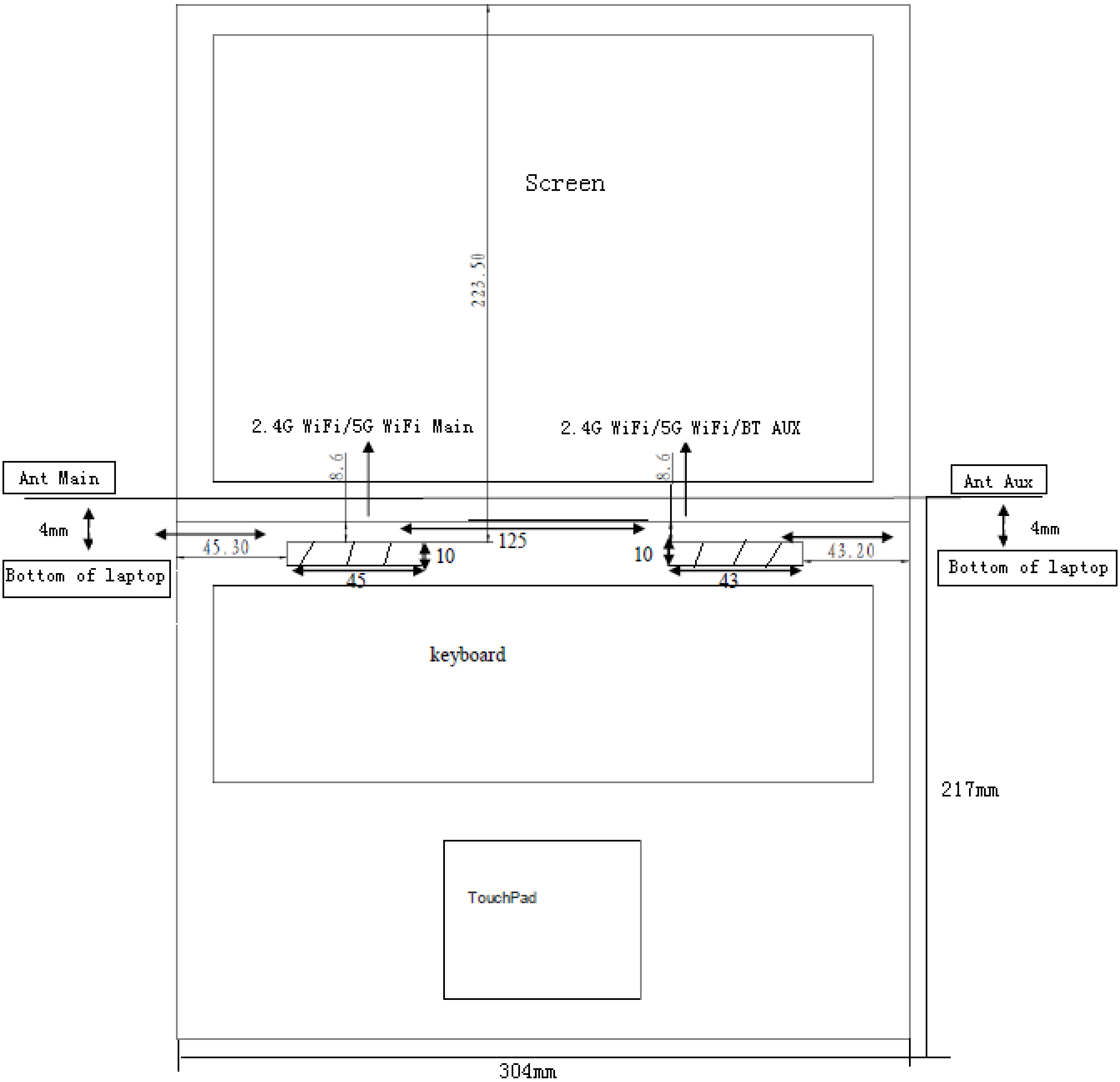
Test Position of Body	Dist.	Test Channel /Freq.(MHz)	Test Mode	Measured SAR(W/kg)		Power Drift (dB)	Actual duty factor	Scaled 1-g SAR (W/kg)	Conducted Power (dBm)	Tune-up Power (dBm)	Reported 1-g SAR (W/kg)	Accessory Information	SAR Plot.
				1-g	10-g								
Test data of Mach-W29													
Bottom Side	0mm	39/2441	DH5	0.078	0.028	0.00	62%	0.126	10.36	11.50	0.164	Battery 1#	/
Bottom Side	0mm	39/2441	DH5	0.065	0.024	0.00	62%	0.105	10.36	11.50	0.137	Battery 1#	/
Bottom Side	0mm	0/2402	DH5	0.081	0.028	0.00	62%	0.131	10.02	11.50	0.185	Battery 2#	/
Bottom Side	0mm	78/2480	DH5	**0.090**	0.032	0.00	62%	0.145	10.19	11.50	**0.196**	Battery 3#	Yes
Mach-W19 test data at the SAR worst case of Mach-W29													
Bottom Side	0mm	78/2480	DH5	0.068	0.024	0.00	62%	0.110	10.36	11.50	0.142	/	/

Table 13: Body-supported SAR test results of BT

7.3 Multiple Transmitter Evaluation

The following tables list information which is relevant for the decision if a simultaneous transmit evaluation is necessary according to FCC KDB 447498D01 General RF Exposure Guidance.

The location of the antennas inside the device is shown as below picture:



<Front View>

Note:

1) For feet in laptop , the antenna location can be positioned against the user during normal use and the additional separation introduced by such protrusions between the outer housing and a flat phantom is < 5 mm

2) The device has two Tx antennas (WiFi Main Antenna and WiFi Aux Antenna). It can transmit from either Main Antenna or Aux Antenna, they also can transmit simultaneously.

3) Main Ant = Ant1, Aux Antenna = Ant 2;

7.3.1 Simultaneous Transmission Possibilities

The Simultaneous Transmission Possibilities of this device are as below:

No.	Simultaneous Tx Combination	Body
1	WiFi 5G Main Ant + BT	Yes
2	WiFi 5G Aux Ant + BT	Yes
3	WiFi 5G MIMO + BT	Yes
4	WiFi 2.4G Main Ant + BT	Yes
5	WiFi 5G Main Ant + WiFi 2.4G Main Ant	Yes
6	WiFi 5G Main Ant + WiFi 2.4G Aux Ant	Yes
7	WiFi 5G Aux Ant + WiFi 2.4G Main Ant	Yes
8	WiFi 5G Aux Ant + WiFi 2.4G Aux Ant	Yes
9	WiFi 5G Main Ant + WiFi 2.4G Main Ant + BT	Yes
10	WiFi 5G Aux Ant + WiFi 2.4G Main Ant + BT	Yes

Table 14: Simultaneous Transmission Possibilities

Note:

1) WiFi 2.4G Aux and Bluetooth can't transmit simultaneously, because they share the same antenna.
2) Wi-Fi 2.4G has two TX antennas. Wi-Fi 2.4G 802.11n support 2*2 MIMO function.
3) Wi-Fi 5G has two TX antennas. Wi-Fi 5G 802.11 n/ac support 2*2 MIMO function.
4) Main Ant = Ant1, Aux Antenna = Ant 2;

7.3.2 SAR Summation Scenario

Test Position	WiFi Max_{SAR}(W/kg)				BT Max_{SAR} (W/kg)	Σ1-g SAR (W/kg)						
	WiFi 5G Main ANT	WiFi 5G Aux ANT	WiFi 2.4G Main ANT	WiFi 2.4G Aux ANT								
	1	2	3	4	5	1+3	1+4	2+3	2+4	1+3+5	2+3+5	1+2+5
Body 0mm (Bottom Side)	0.421	0.632	0.720	0.952	0.196	1.141	1.373	1.352	**1.584**	1.337	1.548	1.249

Table 15: SAR Simultaneous Tx Combination.

The above numeral summed SAR results is sufficient to determine that simultaneous transmission cases will not exceed the SAR limit and therefore simultaneous transmission SAR with Volume Scans is not required per KDB 447498 D01.

Appendix A. System Check Plots

(Pls See Appendix No.: SYBH(Z-SAR)20171214030005-2A, total: 8 pages)

Appendix B. SAR Measurement Plots

(Pls See Appendix No.: SYBH(Z-SAR)20171214030005-2B, total: 4 pages)

Appendix C. Calibration Certificate

(Pls See Appendix No.: SYBH(Z-SAR)20171214030005-2C, total: 40 pages)

Appendix D. Photo documentation

(Pls See Appendix No.: SYBH(Z-SAR)20171214030005-2D, total: 4 pages)

End