FCC SAR TEST REPORT

FCC ID	:	**RF41469A**
Equipment	:	**Handheld terminal**
Brand Name	:	**KEYENCE**
Model Name	:	**BT-A700GA**
Applicant	:	**KEYENCE CORPORATION 1-3-14, Higashi-Nakajima, Higashi-Yodogawa-ku, Osaka, 533-8555, JAPAN**
Manufacturer	:	**KEYENCE CORPORATION 1-3-14, Higashi-Nakajima, Higashi-Yodogawa-ku, Osaka, 533-8555, JAPAN**
Standard	:	**FCC 47 CFR Part 2 (2.1093) ANSI/IEEE C95.1-1992 IEEE 1528-2013**

The product was received on Mar. 05, 2019 and testing was started from Mar. 06, 2019 and completed on Mar. 06, 2019 We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample has been evaluated in accordance with the test procedures and has been in compliance with the applicable technical standards.

The report must not be used by the client to claim product certification, approval, or endorsement by TAF or any agency of government.

The test results in this variant report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory, the test report shall not be reproduced except in full.

Cona Huang

Approved by: Cona Huang / Deputy Manager

SPORTON INTERNATIONAL INC. EMC & Wireless Communications Laboratory
No. 52, Huaya 1st Rd., Guishan Dist., Taoyuan City, Taiwan (R.O.C.)

Table of Contents

1. Statement of Compliance **4**
2. Guidance Applied **5**
3. Equipment Under Test (EUT) Information **5**
3.1 General Information 5
4. RF Exposure Limits **6**
4.1 Uncontrolled Environment 6
4.2 Controlled Environment 6
5. Specific Absorption Rate (SAR) **7**
5.1 Introduction 7
5.2 SAR Definition 7
6. System Description and Setup **8**
6.1 E-Field Probe 9
6.2 Data Acquisition Electronics (DAE) 9
6.3 Phantom 10
6.4 Device Holder 11
7. Measurement Procedures **12**
7.1 Spatial Peak SAR Evaluation 12
7.2 Power Reference Measurement 13
7.3 Area Scan 13
7.4 Zoom Scan 14
7.5 Volume Scan Procedures 14
7.6 Power Drift Monitoring 14
8. Test Equipment List **15**
9. System Verification **16**
9.1 Tissue Simulating Liquids 16
9.2 Tissue Verification 17
9.3 System Performance Check Results 18
10. Conducted RF Output Power (Unit: dBm) **19**
11. Bluetooth Exclusions Applied **28**
12. SAR Test Results **29**
12.1 Extremity SAR 30
13. Simultaneous Transmission Analysis **31**
13.1 Extremity Exposure Conditions 31
14. Uncertainty Assessment **32**
15. References **32**
Appendix A. Plots of System Performance Check
Appendix B. Plots of High SAR Measurement
Appendix C. DASY Calibration Certificate
Appendix D. Test Setup Photos

History of this test report

Report No.	Version	Description	Issued Date
FA911730-01	01	Initial issue of report	Apr. 24, 2019

1. Statement of Compliance

The maximum results of Specific Absorption Rate (SAR) found during testing for KEYENCE CORPORATION, Handheld terminal, BT-A700GA, are as follows.

Equipment Class	Frequency Band	Highest SAR Summary Extremity (Separation 0mm) 10g SAR (W/kg)	Highest Simultaneous Transmission 10g SAR (W/kg)
DTS	2.4GHz WLAN	0.15	0.27
NII	5GHz WLAN	0.07	0.14
Date of Testing:		2019/3/6	

Sporton Lab is accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 1190) and the FCC designation No. TW1190 under the FCC 2.948(e) by Mutual Recognition Agreement (MRA) in FCC test. This device is in compliance with Specific Absorption Rate (SAR) for general population/uncontrolled exposure limits (4.0 W/kg for extremity 10g SAR) specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992, and had been tested in accordance with the measurement methods and procedures specified in IEEE 1528-2013 and FCC KDB publications

Reviewed by: Jason Wang
Report Producer: Wan Liu

2. Guidance Applied

The Specific Absorption Rate (SAR) testing specification, method, and procedure for this device is in accordance with the following standards:

- FCC 47 CFR Part 2 (2.1093)
- ANSI/IEEE C95.1-1992
- IEEE 1528-2013
- FCC KDB 865664 D01 SAR Measurement 100 MHz to 6 GHz v01r04
- FCC KDB 865664 D02 SAR Reporting v01r02
- FCC KDB 447498 D01 General RF Exposure Guidance v06
- FCC KDB 248227 D01 802.11 Wi-Fi SAR v02r02

3. Equipment Under Test (EUT) Information

3.1 General Information

Product Feature & Specification	
Equipment Name	Handheld terminal
Brand Name	KEYENCE
Model Name	BT-A700GA
FCC ID	RF41469A
Wireless Technology and Frequency Range	WLAN 2.4GHz Band: 2412 MHz ~ 2462 MHz WLAN 5.2GHz Band: 5180 MHz ~ 5240 MHz WLAN 5.3GHz Band: 5260 MHz ~ 5320 MHz WLAN 5.5GHz Band: 5500 MHz ~ 5700 MHz WLAN 5.8GHz Band: 5745 MHz ~ 5825 MHz Bluetooth: 2402 MHz ~ 2480 MHz
Mode	WLAN 2.4GHz : 802.11b/g/n/ac HT20/HT40/VHT20/VHT40 WLAN 5GHz : 802.11a/n/ac HT20/HT40/VHT20/VHT40/VHT80 Bluetooth BR/EDR/LE
HW Version	EV1
EUT Stage	Engineering Sample
Remark: 1. WLAN operation in 5600 MHz ~ 5650 MHz is disabled	

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. The 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 Occupational/Controlled Exposure (W/kg)

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.4	8.0	20.0

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

Whole-Body	Partial-Body	Hands, Wrists, Feet and Ankles
0.08	1.6	4.0

1. 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. Specific Absorption Rate (SAR)

5.1 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/controlled and general population/uncontrolled, based on a person's awareness and ability to exercise control over his or her exposure. In general, occupational/controlled exposure limits are higher than the limits for general population/uncontrolled.

5.2 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:

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

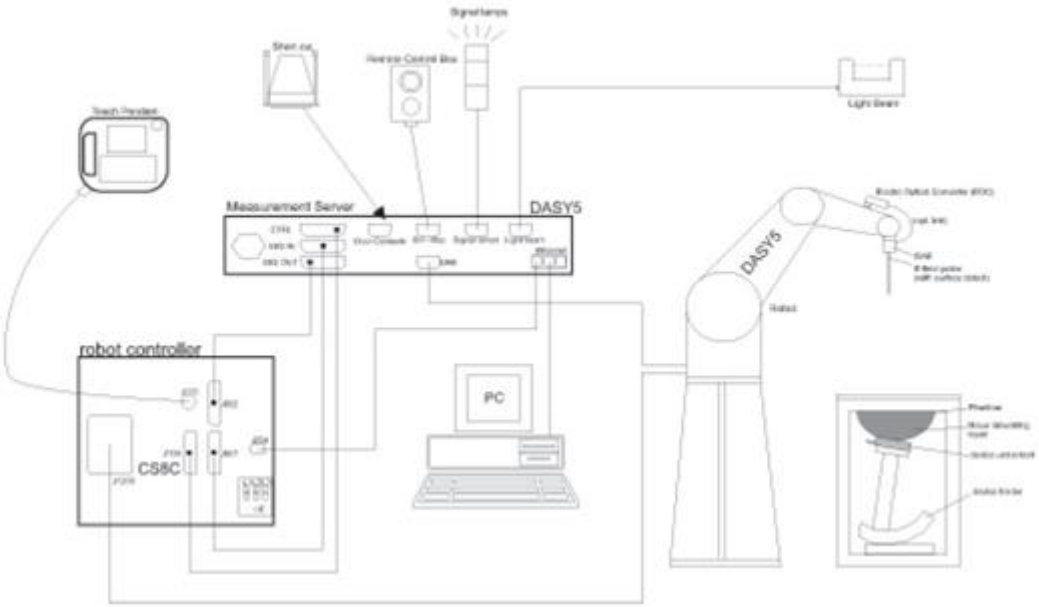
SAR is expressed in units of Watts per kilogram (W/kg)

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

Where: σ is the conductivity of the tissue, ρ is the mass density of the tissue and E is the RMS electrical field strength.

6. System Description and Setup

The DASY system used for performing compliance tests consists of the following items:



- A standard high precision 6-axis robot with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
- An isotropic Field probe optimized and calibrated for the targeted measurement.
- A data acquisition electronics (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.
- The Electro-optical converter (EOC) performs the conversion from optical to electrical signals for the digital communication to the DAE. To use optical surface detection, a special version of the EOC is required. The EOC signal is transmitted to the measurement server.
- The function of the measurement server is to perform the time critical tasks such as signal filtering, control of the robot operation and fast movement interrupts.
- The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
- A computer running WinXP or Win7 and the DASY5 software.
- Remote control and teach pendant as well as additional circuitry for robot safety such as warning lamps, etc.
- The phantom, the device holder and other accessories according to the targeted measurement.

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.

<ES3DV3 Probe>

Construction	Symmetric design with triangular core Interleaved sensors Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Frequency	10 MHz – 4 GHz; Linearity: ±0.2 dB (30 MHz – 4 GHz)	
Directivity	±0.2 dB in TSL (rotation around probe axis) ±0.3 dB in TSL (rotation normal to probe axis)	
Dynamic Range	5 µW/g – >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: 3.0 mm	

<EX3DV4 Probe>

Construction	Symmetric design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Frequency	10 MHz – >6 GHz Linearity: ±0.2 dB (30 MHz – 6 GHz)	
Directivity	±0.3 dB in TSL (rotation around probe axis) ±0.5 dB in TSL (rotation normal to probe axis)	
Dynamic Range	10 µW/g – >100 mW/g Linearity: ±0.2 dB (noise: typically <1 µW/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: 1 mm	

6.2 Data Acquisition Electronics (DAE)

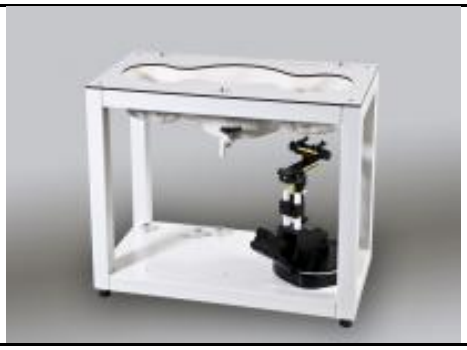
The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an 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 5.1 Photo of DAE

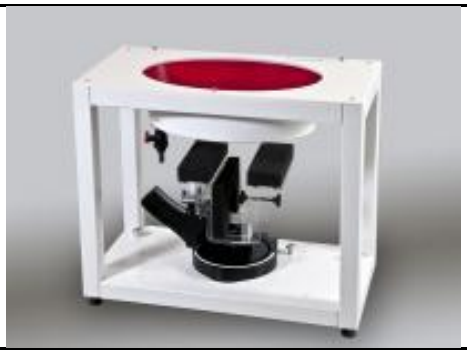
6.3 Phantom

<SAM Twin Phantom>

Shell Thickness	2 ± 0.2 mm; Center ear point: 6 ± 0.2 mm	
Filling Volume	Approx. 25 liters	
Dimensions	Length: 1000 mm; Width: 500 mm; Height: adjustable feet	
Measurement Areas	Left Hand, Right Hand, 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.

<ELI Phantom>

Shell Thickness	2 ± 0.2 mm (sagging: <1%)	
Filling Volume	Approx. 30 liters	
Dimensions	Major ellipse axis: 600 mm Minor axis: 400 mm	

The ELI phantom is intended for compliance testing of handheld and body-mounted wireless devices in the frequency range of 30 MHz to 6 GHz. ELI4 is fully compatible with standard and all known tissue simulating liquids.

6.4 Device Holder

<Mounting Device for Hand-Held Transmitter>

In combination with the Twin SAM V5.0/V5.0c or ELI phantoms, the Mounting Device for Hand-Held Transmitters enables rotation of the mounted transmitter device to specified spherical coordinates. At the heads, the rotation axis is at the ear opening. Transmitter devices can be easily and accurately positioned according to IEC 62209-1, IEEE 1528, FCC, or other specifications. The device holder can be locked for positioning at different phantom sections (left head, right head, flat). And upgrade kit to Mounting Device to enable easy mounting of wider devices like big smart-phones, e-books, small tablets, etc. It holds devices with width up to 140 mm.

Mounting Device for Hand-Held Transmitters

Mounting Device Adaptor for Wide-Phones

<Mounting Device for Laptops and other Body-Worn Transmitters>

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.

Mounting Device for Laptops

7. Measurement Procedures

The measurement procedures are as follows:

<Conducted power measurement>

(a) For WWAN power measurement, use base station simulator to configure EUT WWAN transmission in conducted connection with RF cable, at maximum power in each supported wireless interface and frequency band.
(b) Read the WWAN RF power level from the base station simulator.
(c) 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
(d) Connect EUT RF port through RF cable to the power meter, and measure WLAN/BT output power

<SAR measurement>

(a) 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.
(b) Place the EUT in the positions as Appendix D demonstrates.
(c) Set scan area, grid size and other setting on the DASY software.
(d) Measure SAR results for the highest power channel on each testing position.
(e) Find out the largest SAR result on these testing positions of each band
(f) Measure SAR results for other channels in worst SAR testing position if the reported SAR of 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:

(a) Power reference measurement
(b) Area scan
(c) Zoom scan
(d) Power drift measurement

7.1 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 10g 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 the 1g and 10g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

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

7.2 Power Reference Measurement

The Power Reference Measurement and Power Drift Measurements 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.

7.3 Area Scan

The area scan is used as a fast scan in two dimensions to find the area of high field values, before doing a fine measurement around the hot spot. The sophisticated interpolation routines implemented in DASY software can find the maximum found in the scanned area, within a range of the global maximum. The range (in dB0 is specified in the standards for compliance testing. For example, a 2 dB range is required in IEEE standard 1528 and IEC 62209 standards, whereby 3 dB is a requirement when compliance is assessed in accordance with the ARIB standard (Japan), if only one zoom scan follows the area scan, then only the absolute maximum will be taken as reference. For cases where multiple maximums are detected, the number of zoom scans has to be increased accordingly.

Area scan parameters extracted from FCC KDB 865664 D01v01r04 SAR measurement 100 MHz to 6 GHz.

	≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface	5 ± 1 mm	½·δ·ln(2) ± 0.5 mm
Maximum probe angle from probe axis to phantom surface normal at the measurement location	30° ± 1°	20° ± 1°
Maximum area scan spatial resolution: Δx_{Area}, Δy_{Area}	≤ 2 GHz: ≤ 15 mm 2 – 3 GHz: ≤ 12 mm	3 – 4 GHz: ≤ 12 mm 4 – 6 GHz: ≤ 10 mm
	When the x or y dimension of the test device, in the measurement plane orientation, is smaller than the above, the measurement resolution must be ≤ the corresponding x or y dimension of the test device with at least one measurement point on the test device.	

7.4 Zoom Scan

Zoom scans are used assess the peak spatial SAR values within a cubic averaging volume containing 1 gram and 10 gram of simulated tissue. The zoom scan measures points (refer to table below) within a cube shoes base faces are centered on the maxima found in a preceding area scan job within the same procedure. When the measurement is done, the zoom scan evaluates the averaged SAR for 1 gram and 10 gram and displays these values next to the job's label.

Zoom scan parameters extracted from FCC KDB 865664 D01v01r04 SAR measurement 100 MHz to 6 GHz.

			≤ 3 GHz	> 3 GHz
Maximum zoom scan spatial resolution: Δx_{Zoom}, Δy_{Zoom}			≤ 2 GHz: ≤ 8 mm 2 – 3 GHz: ≤ 5 mm*	3 – 4 GHz: ≤ 5 mm* 4 – 6 GHz: ≤ 4 mm*
Maximum zoom scan spatial resolution, normal to phantom surface	uniform grid: $\Delta z_{Zoom}(n)$		≤ 5 mm	3 – 4 GHz: ≤ 4 mm 4 – 5 GHz: ≤ 3 mm 5 – 6 GHz: ≤ 2 mm
	graded grid	$\Delta z_{Zoom}(1)$: between 1st two points closest to phantom surface	≤ 4 mm	3 – 4 GHz: ≤ 3 mm 4 – 5 GHz: ≤ 2.5 mm 5 – 6 GHz: ≤ 2 mm
		$\Delta z_{Zoom}(n>1)$: between subsequent points	$\leq 1.5 \cdot \Delta z_{Zoom}(n-1)$	
Minimum zoom scan volume	x, y, z		≥ 30 mm	3 – 4 GHz: ≥ 28 mm 4 – 5 GHz: ≥ 25 mm 5 – 6 GHz: ≥ 22 mm

Note: δ is the penetration depth of a plane-wave at normal incidence to the tissue medium; see draft standard IEEE P1528-2011 for details.

* When zoom scan is required and the *reported* SAR from the *area scan based 1-g SAR estimation* procedures of KDB 447498 is ≤ 1.4 W/kg, ≤ 8 mm, ≤ 7 mm and ≤ 5 mm zoom scan resolution may be applied, respectively, for 2 GHz to 3 GHz, 3 GHz to 4 GHz and 4 GHz to 6 GHz.

7.5 Volume Scan Procedures

The volume scan is used for assess overlapping SAR distributions for antennas transmitting in different frequency bands. It is equivalent to an oversized zoom scan used in standalone measurements. The measurement volume will be used to enclose all the simultaneous transmitting antennas. For antennas transmitting simultaneously in different frequency bands, the volume scan is measured separately in each frequency band. In order to sum correctly to compute the 1g aggregate SAR, the EUT remain in the same test position for all measurements and all volume scan use the same spatial resolution and grid spacing. When all volume scan were completed, the software, SEMCAD postprocessor can combine and subsequently superpose these measurement data to calculating the multiband SAR.

7.6 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.

8. Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	2450MHz System Validation Kit	D2450V2	736	Aug. 31, 2018	Aug. 30, 2019
SPEAG	5GHz System Validation Kit	D5GHzV2	1006	Sep. 27, 2018	Sep. 26, 2019
SPEAG	Data Acquisition Electronics	DAE4	1399	Nov. 16, 2018	Nov. 15, 2019
SPEAG	Dosimetric E-Field Probe	EX3DV4	3931	Sep. 27, 2018	Sep. 26, 2019
Gencom	Thermometer	TE1	TM225-1	Mar. 16, 2018	Mar. 15, 2019
SPEAG	Device Holder	N/A	N/A	N/A	N/A
Anritsu	Signal Generator	MG3710A	6201502524	Dec. 11, 2018	Dec. 10, 2019
Agilent	ENA Network Analyzer	E5071C	MY46104758	Sep. 19, 2018	Sep. 18, 2019
SPEAG	Dielectric Probe Kit	DAK-3.5	1126	Sep. 19, 2018	Sep. 18, 2019
LINE SEIKI	Digital Thermometer	DTM3000-spezial	3169	Sep. 11, 2018	Sep. 10, 2019
Anritsu	Power Meter	ML2495A	1419002	May. 18, 2018	May. 17, 2019
Anritsu	Power Sensor	MA2411B	1339124	May. 18, 2018	May. 17, 2019
Anritsu	Power Meter	ML2495A	1240001	Sep. 13, 2018	Sep. 12, 2019
Anritsu	Power Sensor	MA2411B	1207349	Sep. 13, 2018	Sep. 12, 2019
Agilent	Spectrum Analyzer	E4408B	MY44211028	Aug. 28, 2018	Aug. 27, 2019
Anritsu	Spectrum Analyzer	MS2830A	6201396378	Jun. 23, 2018	Jun. 22, 2019
Mini-Circuits	Power Amplifier	ZVE-8G+	6382	Aug. 09, 2018	Aug. 08, 2019
Mini-Circuits	Power Amplifier	ZHL-42W+	15542	Aug. 09, 2018	Aug. 08, 2019
ATM	Dual Directional Coupler	C122H-10	P610410z-02	Note 1	
Woken	Attenuator 1	WK0602-XX	N/A	Note 1	
PE	Attenuator 2	PE7005-10	N/A	Note 1	
PE	Attenuator 3	PE7005- 3	N/A	Note 1	

General Note:

1. Prior to system verification and validation, the path loss from the signal generator to the system check source and the power meter, which includes the amplifier, cable, attenuator and directional coupler, was measured by the network analyzer. The reading of the power meter was offset by the path loss difference between the path to the power meter and the path to the system check source to monitor the actual power level fed to the system check source.

9. System Verification

9.1 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. 10.1. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm, which is shown in Fig. 10.2.

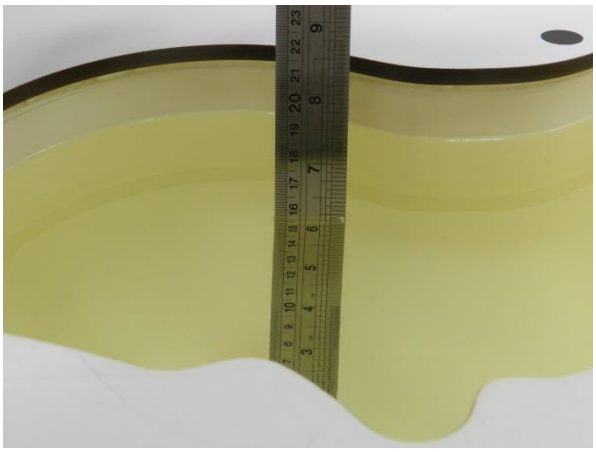


Fig 10.1Photo of Liquid Height for Head SAR

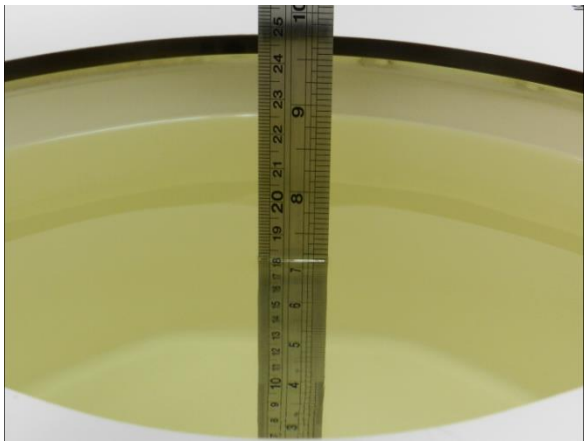


Fig 10.2 Photo of Liquid Height for Body SAR

9.2 Tissue Verification

The following tissue formulations are provided for reference only as some of the parameters have not been thoroughly verified. The composition of ingredients may be modified accordingly to achieve the desired target tissue parameters required for routine SAR evaluation.

Frequency (MHz)	Water (%)	Sugar (%)	Cellulose (%)	Salt (%)	Preventol (%)	DGBE (%)	Conductivity (σ)	Permittivity (εr)
For 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
900	40.3	57.9	0.2	1.4	0.2	0	0.97	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
For Body								
750	51.7	47.2	0	0.9	0.1	0	0.96	55.5
835	50.8	48.2	0	0.9	0.1	0	0.97	55.2
900	50.8	48.2	0	0.9	0.1	0	1.05	55.0
1800, 1900, 2000	70.2	0	0	0.4	0	29.4	1.52	53.3
2450	68.6	0	0	0	0	31.4	1.95	52.7
2600	68.1	0	0	0.1	0	31.8	2.16	52.5

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%

<Tissue Dielectric Parameter Check Results>

Frequency (MHz)	Tissue Type	Liquid Temp. (℃)	Conductivity (σ)	Permittivity (ε_r)	Conductivity Target (σ)	Permittivity Target (ε_r)	Delta (σ) (%)	Delta (ε_r) (%)	Limit (%)	Date
2450	MSL	22.5	2.025	52.242	1.95	52.70	3.85	-0.87	±5	2019/3/6
5250	MSL	22.7	5.460	47.168	5.36	48.95	1.87	-3.64	±5	2019/3/6
5600	MSL	22.7	5.916	46.526	5.77	48.50	2.53	-4.07	±5	2019/3/6
5750	MSL	22.7	6.116	46.257	5.94	48.28	2.96	-4.19	±5	2019/3/6

9.3 System Performance Check 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 below indicates the system performance check can meet the variation criterion and the plots can be referred to Appendix A of this report.

Date	Frequency (MHz)	Tissue Type	Input Power (mW)	Dipole S/N	Probe S/N	DAE S/N	Measured 10g SAR (W/kg)	Targeted 10g SAR (W/kg)	Normalized 10g SAR (W/kg)	Deviation (%)
2019/3/6	2450	MSL	250	D2450V2-736	EX3DV4 - SN3931	DAE4 Sn1399	6.24	24.40	24.96	2.30
2019/3/6	5250	MSL	100	D5GHzV2-1006	EX3DV4 - SN3931	DAE4 Sn1399	2.21	21.70	22.1	1.84
2019/3/6	5600	MSL	100	D5GHzV2-1006	EX3DV4 - SN3931	DAE4 Sn1399	2.32	22.50	23.2	3.11
2019/3/6	5750	MSL	100	D5GHzV2-1006	EX3DV4 - SN3931	DAE4 Sn1399	2.08	21.30	20.8	-2.35

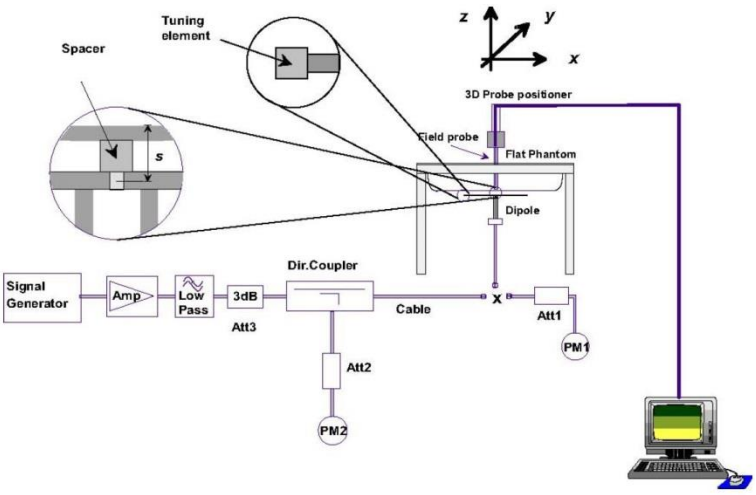


Fig 8.3.1 System Performance Check Setup

Fig 8.3.2 Setup Photo

10. Conducted RF Output Power (Unit: dBm)

<WLAN Conducted Power>

General Note:

1. For each antenna, transmit power in SISO operation is larger than (or equal to) the power in MIMO operation, RF exposure compliance of MIMO mode can be deduced from the compliance simultaneous transmission of antennas operating in SISO mode.
2. Per KDB 248227 D01v02r02, the simultaneous SAR provisions in KDB publication 447498 should be applied to determine simultaneous transmission SAR test exclusion for WiFi MIMO. If the sum of 1g single transmission chain SAR measurements is < 1.6W/kg and SAR peak to location ratio ≤ 0.04, no additional SAR measurements for MIMO.
3. Per KDB 248227 D01v02r02, SAR test reduction is determined according to 802.11 transmission mode configurations and certain exposure conditions with multiple test positions. In the 2.4 GHz band, separate SAR procedures are applied to DSSS and OFDM configurations to simplify DSSS test requirements. For OFDM, in both 2.4 and 5 GHz bands, an initial test configuration must be determined for each standalone and aggregated frequency band, according to the transmission mode configuration with the highest maximum output power specified for production units to perform SAR measurements. If the same highest maximum output power applies to different combinations of channel bandwidths, modulations and data rates, additional procedures are applied to determine which test configurations require SAR measurement. When applicable, an initial test position may be applied to reduce the number of SAR measurements required for next to the ear, UMPC mini-tablet or hotspot mode configurations with multiple test positions.
4. For 2.4 GHz 802.11b DSSS, either the initial test position procedure for multiple exposure test positions or the DSSS procedure for fixed exposure position is applied; these are mutually exclusive. For 2.4 GHz and 5 GHz OFDM configurations, the initial test configuration is applied to measure SAR using either the initial test position procedure for multiple exposure test position configurations or the initial test configuration procedures for fixed exposure test conditions. Based on the reported SAR of the measured configurations and maximum output power of the transmission mode configurations that are not included in the initial test configuration, the subsequent test configuration and initial test position procedures are applied to determine if SAR measurements are required for the remaining OFDM transmission configurations. In general, the number of test channels that require SAR measurement is minimized based on maximum output power measured for the test sample(s).
5. For OFDM transmission configurations in the 2.4 GHz and 5 GHz bands, When the same maximum power is specified for multiple transmission modes in a frequency band, the largest channel bandwidth, lowest order modulation, lowest data rate and lowest order 802.11a/g/n/ac mode is used for SAR measurement, on the highest measured output power channel for each frequency band.
6. DSSS and OFDM configurations are considered separately according to the required SAR procedures. SAR is measured in the initial test position using the 802.11 transmission mode configuration required by the DSSS procedure or initial test configuration and subsequent test configuration(s) according to the OFDM procedures.18 The initial test position procedure is described in the following:
   a. When the reported SAR of the initial test position is ≤ 0.4 W/kg, further SAR measurement is not required for the other test positions in that exposure configuration and 802.11 transmission mode combinations within the frequency band or aggregated band.
   b. When the reported SAR of the test position is > 0.4 W/kg, SAR is repeated for the 802.11 transmission mode configuration tested in the initial test position to measure the subsequent next closet/smallest test separation distance and maximum coupling test position on the highest maximum output power channel, until the report SAR is ≤ 0.8 W/kg or all required test position are tested.
   c. For all positions/configurations, 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.

<2.4GHz WLAN ANT 1>

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
2.4GHz WLAN	802.11b 1Mbps	1	2412	21.30	21.50	99.12
		6	2437	21.20	21.50	
		11	2462	21.10	21.50	
	802.11g 6Mbps	1	2412	16.60	17.00	95.60
		6	2437	20.60	21.00	
		11	2462	19.40	20.00	
	802.11n-HT20 MCS0	1	2412	16.60	17.00	95.30
		6	2437	19.10	19.50	
		11	2462	16.10	16.50	
	802.11n-HT40 MCS0	3	2422	13.10	13.50	91.43
		6	2437	18.10	18.50	
		9	2452	12.90	13.00	
	802.11ac-VHT20 MCS0	1	2412	16.60	17.00	95.07
		6	2437	19.70	20.00	
		11	2462	16.20	16.50	
	802.11ac-VHT40 MCS0	3	2422	13.20	13.50	91.89
		6	2437	18.60	19.00	
		9	2452	13.00	13.00	

<2.4GHz WLAN ANT 2>

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
2.4GHz WLAN	802.11b 1Mbps	1	2412	21.10	21.50	99.44
		6	2437	21.00	21.50	
		11	2462	21.00	21.50	
	802.11g 6Mbps	1	2412	16.60	17.00	95.59
		6	2437	20.50	21.00	
		11	2462	16.20	16.50	
	802.11n-HT20 MCS0	1	2412	16.30	16.50	95.30
		6	2437	19.20	19.50	
		11	2462	15.90	16.00	
	802.11n-HT40 MCS0	3	2422	12.90	13.00	91.60
		6	2437	18.00	18.50	
		9	2452	12.80	13.00	
	802.11ac-VHT20 MCS0	1	2412	16.40	16.50	95.31
		6	2437	19.60	20.00	
		11	2462	16.00	16.00	
	802.11ac-VHT40 MCS0	3	2422	13.00	13.00	91.68
		6	2437	18.50	19.00	
		9	2452	12.90	13.00	

<2.4GHz WLAN ANT 1+2>

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
2.4GHz WLAN	802.11b 1Mbps	1	2412	24.31	24.50	99.36
		6	2437	24.21	24.50	
		11	2462	24.16	24.50	
	802.11g 6Mbps	1	2412	20.21	20.50	95.60
		6	2437	23.66	24.00	
		11	2462	19.36	19.50	
	802.11n-HT20 MCS0	1	2412	19.56	20.00	95.06
		6	2437	22.36	22.50	
		11	2462	19.11	19.50	
	802.11n-HT40 MCS0	3	2422	16.11	16.50	91.68
		6	2437	21.16	21.50	
		9	2452	15.96	16.00	
	802.11ac-VHT20 MCS0	1	2412	19.66	20.00	95.07
		6	2437	22.81	23.00	
		11	2462	19.21	19.50	
	802.11ac-VHT40 MCS0	3	2422	16.21	16.50	91.61
		6	2437	21.66	22.00	
		9	2452	16.06	16.50	

<5GHz WLAN ANT1>

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.2GHz WLAN	802.11a 6Mbps	36	5180	14.20	14.50	95.82
		40	5200	15.00	15.00	
		44	5220	15.10	15.50	
		48	5240	15.30	15.50	
	802.11n-HT20 MCS0	36	5180	13.90	14.50	95.93
		40	5200	15.20	15.50	
		44	5220	15.50	16.00	
		48	5240	15.40	15.50	
	802.11n-HT40 MCS0	38	5190	10.20	10.50	91.12
		46	5230	16.30	16.50	
	802.11ac-VHT20 MCS0	36	5180	14.10	14.50	95.94
		40	5200	15.50	15.50	
		44	5220	15.60	16.00	
		48	5240	15.50	15.50	
	802.11ac-VHT40 MCS0	38	5190	10.30	10.50	92.25
		46	5230	16.40	16.50	
	802.11ac-VHT80 MCS0	42	5210	11.50	11.50	85.61

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.3GHz WLAN	802.11a 6Mbps	52	5260	15.60	16.00	95.82
		56	5280	15.30	15.50	
		60	5300	14.10	14.50	
		64	5320	13.00	13.00	
	802.11n-HT20 MCS0	52	5260	16.00	16.00	95.93
		56	5280	15.70	16.00	
		60	5300	14.20	14.50	
		64	5320	13.40	13.50	
	802.11n-HT40 MCS0	54	5270	16.30	17.00	91.12
		62	5310	12.30	12.50	
	802.11ac-VHT20 MCS0	52	5260	16.10	16.50	95.94
		56	5280	15.80	16.00	
		60	5300	14.30	14.50	
		64	5320	13.50	13.50	
	802.11ac-VHT40 MCS0	54	5270	16.50	17.00	92.25
		62	5310	12.50	12.50	
	802.11ac-VHT80 MCS0	58	5290	11.00	11.00	85.61

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.5GHz WLAN	802.11a 6Mbps	100	5500	14.50	14.50	95.82
		116	5580	17.20	17.50	
		132	5660	17.40	18.00	
		140	5700	17.10	17.50	
	802.11n-HT20 MCS0	100	5500	13.90	14.00	95.93
		116	5580	17.00	17.50	
		132	5660	17.30	17.50	
		140	5700	16.90	17.00	
	802.11n-HT40 MCS0	102	5510	14.60	15.00	91.12
		110	5550	16.50	17.00	
		134	5670	16.60	17.00	
	802.11ac-VHT20 MCS0	100	5500	14.00	14.00	95.94
		116	5580	17.10	17.50	
		132	5660	17.40	17.50	
		140	5700	17.00	17.00	
	802.11ac-VHT40 MCS0	102	5510	14.70	15.00	92.25
		110	5550	16.60	17.00	
		134	5670	16.70	17.00	
	802.11ac-VHT80 MCS0	106	5530	13.60	14.00	85.61

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.8GHz WLAN	802.11a MCS0	149	5745	17.50	18.00	95.82
		157	5785	17.40	17.50	
		165	5825	17.50	18.00	
	802.11n-HT20 MCS0	149	5745	17.00	17.50	95.93
		157	5785	16.90	17.00	
		165	5825	17.00	17.50	
	802.11n-HT40 MCS0	151	5755	16.40	16.50	91.12
		159	5795	16.20	17.50	
	802.11ac-VHT20 MCS0	149	5745	17.30	17.00	95.94
		157	5785	17.20	17.50	
		165	5825	17.20	16.50	
	802.11ac-VHT40 MCS0	151	5755	16.60	16.50	92.25
		159	5795	16.60	17.00	
	802.11ac-VHT80 MCS0	155	5775	16.80	17.00	85.61

<5GHz WLAN ANT2>

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.2GHz WLAN	802.11a 6Mbps	36	5180	14.00	14.00	95.92
		40	5200	15.20	15.50	
		44	5220	15.30	15.50	
		48	5240	15.20	15.50	
	802.11n-HT20 MCS0	36	5180	13.80	14.00	95.13
		40	5200	15.20	17.50	
		44	5220	15.40	15.50	
		48	5240	15.10	15.50	
	802.11n-HT40 MCS0	38	5190	10.20	10.50	92.19
		46	5230	16.40	16.50	
	802.11ac-VHT20 MCS0	36	5180	13.90	14.00	95.96
		40	5200	15.40	15.50	
		44	5220	15.50	15.50	
		48	5240	15.20	15.50	
	802.11ac-VHT40 MCS0	38	5190	10.30	10.50	92.61
		46	5230	16.50	16.50	
	802.11ac-VHT80 MCS0	42	5210	11.60	12.00	85.93

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.3GHz WLAN	802.11a 6Mbps	52	5260	15.30	16.00	95.92
		56	5280	15.00	15.00	
		60	5300	13.90	14.50	
		64	5320	12.70	13.00	
	802.11n-HT20 MCS0	52	5260	15.50	16.00	95.13
		56	5280	15.40	15.50	
		60	5300	14.00	14.50	
		64	5320	12.80	13.50	
	802.11n-HT40 MCS0	54	5270	16.30	17.00	92.19
		62	5310	11.80	12.00	
	802.11ac-VHT20 MCS0	52	5260	15.60	16.00	95.96
		56	5280	15.50	15.50	
		60	5300	14.10	14.50	
		64	5320	13.00	13.50	
	802.11ac-VHT40 MCS0	54	5270	16.40	17.00	92.61
		62	5310	11.90	12.00	
	802.11ac-VHT80 MCS0	58	5290	11.60	12.00	85.93

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.5GHz WLAN	802.11a 6Mbps	100	5500	14.40	14.50	95.92
		116	5580	17.10	17.50	
		132	5660	17.50	17.50	
		140	5700	17.00	17.50	
	802.11n-HT20 MCS0	100	5500	13.80	14.00	95.13
		116	5580	16.90	17.50	
		132	5660	17.20	17.50	
		140	5700	16.70	17.00	
	802.11n-HT40 MCS0	102	5510	14.30	15.00	92.19
		110	5550	16.60	17.00	
		134	5670	16.40	17.00	
	802.11ac-VHT20 MCS0	100	5500	13.90	14.00	95.96
		116	5580	17.00	17.50	
		132	5660	17.10	17.50	
		140	5700	17.00	17.00	
	802.11ac-VHT40 MCS0	102	5510	14.40	15.00	92.61
		110	5550	16.70	17.00	
		134	5670	16.50	17.00	
	802.11ac-VHT80 MCS0	106	5530	13.80	14.00	85.93

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.8GHz WLAN	802.11a MCS0	149	5745	17.60	18.00	95.92
		157	5785	17.50	17.50	
		165	5825	17.50	17.50	
	802.11n-HT20 MCS0	149	5745	17.00	17.50	95.13
		157	5785	17.20	17.50	
		165	5825	17.10	17.50	
	802.11n-HT40 MCS0	151	5755	16.40	16.50	92.19
		159	5795	16.40	17.00	
	802.11ac-VHT20 MCS0	149	5745	17.40	17.50	95.96
		157	5785	17.30	17.50	
		165	5825	17.10	17.50	
	802.11ac-VHT40 MCS0	151	5755	16.50	16.50	92.61
		159	5795	16.50	17.00	
	802.11ac-VHT80 MCS0	155	5775	16.90	17.00	85.93

<5GHz WLAN ANT1+2>

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.2GHz WLAN	802.11a 6Mbps	36	5180	17.21	17.50	95.83
		40	5200	18.21	18.50	
		44	5220	18.31	18.50	
		48	5240	18.46	18.50	
	802.11n-HT20 MCS0	36	5180	17.01	17.50	95.54
		40	5200	18.26	20.50	
		44	5220	18.61	19.00	
		48	5240	18.36	18.50	
	802.11n-HT40 MCS0	38	5190	13.31	13.50	91.15
		46	5230	19.46	19.50	
	802.11ac-VHT20 MCS0	36	5180	17.11	19.50	95.54
		40	5200	18.26	18.50	
		44	5220	18.71	19.00	
		48	5240	18.46	18.50	
	802.11ac-VHT40 MCS0	38	5190	13.41	13.50	92.22
		46	5230	19.56	20.00	
	802.11ac-VHT80 MCS0	42	5210	14.66	15.00	85.61

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.3GHz WLAN	802.11a 6Mbps	52	5260	18.56	19.00	95.83
		56	5280	18.47	18.50	
		60	5300	17.26	17.50	
		64	5320	15.96	16.00	
	802.11n-HT20 MCS0	52	5260	18.87	19.00	95.54
		56	5280	18.81	19.00	
		60	5300	17.21	17.50	
		64	5320	16.27	16.50	
	802.11n-HT40 MCS0	54	5270	19.41	20.00	91.15
		62	5310	15.31	15.50	
	802.11ac-VHT20 MCS0	52	5260	18.97	19.00	95.54
		56	5280	18.90	19.00	
		60	5300	17.31	17.50	
		64	5320	16.37	16.50	
	802.11ac-VHT40 MCS0	54	5270	19.51	20.00	92.22
		62	5310	15.46	15.50	
	802.11ac-VHT80 MCS0	58	5290	14.47	15.00	85.61

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.5GHz WLAN	802.11a 6Mbps	100	5500	17.51	17.50	95.83
		116	5580	20.26	20.50	
		132	5660	20.66	20.50	
		140	5700	20.16	20.50	
	802.11n-HT20 MCS0	100	5500	16.96	17.00	95.54
		116	5580	20.21	20.50	
		132	5660	20.31	20.50	
		140	5700	20.06	20.50	
	802.11n-HT40 MCS0	102	5510	17.56	18.00	91.15
		110	5550	19.66	20.00	
		134	5670	19.76	20.00	
	802.11ac-VHT20 MCS0	100	5500	17.06	17.50	95.54
		116	5580	20.31	20.50	
		132	5660	20.31	20.50	
		140	5700	20.21	20.50	
	802.11ac-VHT40 MCS0	102	5510	17.66	18.00	92.22
		110	5550	19.76	20.00	
		134	5670	19.86	20.00	
	802.11ac-VHT80 MCS0	106	5530	16.86	17.00	85.61

	Mode	Channel	Frequency (MHz)	Average power (dBm)	Tune-Up Limit	Duty Cycle %
5.8GHz WLAN	802.11a MCS0	149	5745	20.76	21.00	95.83
		157	5785	20.66	20.50	
		165	5825	20.71	21.00	
	802.11n-HT20 MCS0	149	5745	20.16	20.50	95.54
		157	5785	20.26	20.50	
		165	5825	20.11	20.50	
	802.11n-HT40 MCS0	151	5755	19.41	19.50	91.15
		159	5795	19.46	20.00	
	802.11ac-VHT20 MCS0	149	5745	20.46	20.50	95.54
		157	5785	20.31	20.50	
		165	5825	20.26	20.50	
	802.11ac-VHT40 MCS0	151	5755	19.71	19.50	92.22
		159	5795	19.66	20.00	
	802.11ac-VHT80 MCS0	155	5775	19.96	20.00	85.61

11. Bluetooth Exclusions Applied

Mode Band	Max Average power(dBm)	
	BR/EDR	LE
2.4GHz Bluetooth	0.5	0.5

Note:

1. Per KDB 447498 D01v06, the 1-g and 10-g SAR test exclusion thresholds for 100 MHz to 6 GHz at *test separation distances* ≤ 50 mm are determined by:
   [(*max. power of channel, including tune-up tolerance, mW*)/(*min. test separation distance, mm*)] ·[√f(GHz)] ≤ 3.0 for 1-g SAR and ≤ 7.5 for 10-g extremity SAR
   - f(GHz) is the RF channel transmit frequency in GHz
   - Power and distance are rounded to the nearest mW and mm before calculation
   - The result is rounded to one decimal place for comparison

Bluetooth Max Power (dBm)	Separation Distance (mm)	Frequency (GHz)	exclusion thresholds
0.5	< 5	2.48	0.35

Note:

Per KDB 447498 D01v06, when the minimum test separation distance is < 5 mm, a distance of 5 mm is applied to determine SAR test exclusion. The test exclusion threshold is 0.35 which is <= 3, SAR testing is not required.

12. SAR Test Results

General Note:

1. Per KDB 447498 D01v06, 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: 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:
   - ≤ 0.8 W/kg or 2.0 W/kg, for 1-g or 10-g respectively, when the transmission band is ≤ 100 MHz
   - ≤ 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
3. Per KDB 865664 D01v01r04, for each frequency band, repeated SAR measurement is required only when the measured SAR is ≥0.8W/kg.

WLAN Note:

1. Per KDB 248227 D01v02r02, for 2.4GHz 802.11g/n SAR testing 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.
2. Per KDB 248227 D01v02r02, U-NII-1 SAR testing is not required when the U-NII-2A band highest reported SAR for a test configuration is ≤ 1.2 W/kg, SAR is not required for U-NII-1 band.
3. When the reported SAR of the test position is > 0.4 W/kg, SAR is repeated for the 802.11 transmission mode configuration tested in the initial test position to measure the subsequent next closet/smallest test separation distance and maximum coupling test position on the highest maximum output power channel, until the report SAR is ≤ 0.8 W/kg or all required test position are tested.
4. For all positions / configurations, 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.
5. For WLAN SAR testing was performed on single antenna RF power in SISO mode is larger or equal to the single antenna RF power in MIMO mode, and for RF exposure assessment of MIMO mode simultaneous transmission exclusion analysis was performed with SAR test results of each antenna in SISO mode.
6. Per KDB 248227 D01v02r02, the simultaneous SAR provisions in KDB publication 447498 should be applied to determine simultaneous transmission SAR test exclusion for WiFi MIMO. If the sum of 1g single transmission chain SAR measurements is < 1.6W/kg and SAR peak to location ratio ≤ 0.04, no additional SAR measurements for MIMO.
7. During SAR testing the WLAN transmission was verified using a spectrum analyzer.

12.1 Extremity SAR

<WLAN SAR>

Plot No.	Band	Mode	Test Position	Gap (mm)	Antenna	Ch.	Freq. (MHz)	Average Power (dBm)	Tune-Up Limit (dBm)	Tune-up Scaling Factor	Duty Cycle %	Duty Cycle Scaling Factor	Power Drift (dB)	Measured 10g SAR (W/kg)	Reported 10g SAR (W/kg)
01	WLAN2.4GHz	802.11b 1Mbps	Back	0mm	Ant 1	1	2412	21.30	21.50	1.047	99.12	1.009	0.09	0.138	0.146
	WLAN2.4GHz	802.11b 1Mbps	Back	0mm	Ant 1	6	2437	21.20	21.50	1.072	99.12	1.009	0.01	0.112	0.121
	WLAN2.4GHz	802.11b 1Mbps	Back	0mm	Ant 1	11	2462	21.10	21.50	1.096	99.12	1.009	-0.08	0.127	0.141
	WLAN2.4GHz	802.11b 1Mbps	Back	0mm	Ant 2	1	2412	21.10	21.50	1.096	99.44	1.006	-0.09	0.108	0.119
02	WLAN5GHz	802.11n-HT40 MCS0	Back	0mm	Ant 1	54	5270	16.30	17.00	1.175	91.12	1.097	-0.13	0.030	0.039
	WLAN5GHz	802.11n-HT40 MCS0	Back	0mm	Ant 1	62	5310	12.30	12.50	1.047	91.12	1.097	-0.12	0.006	0.007
	WLAN5GHz	802.11n-HT40 MCS0	Back	0mm	Ant 2	54	5270	16.30	17.00	1.175	95.92	1.043	-0.12	0.025	0.031
03	WLAN5GHz	802.11a 6Mbps	Back	0mm	Ant 1	132	5660	17.40	18.00	1.148	95.82	1.044	-0.11	0.042	0.050
	WLAN5GHz	802.11a 6Mbps	Back	0mm	Ant 1	100	5500	14.50	14.50	1.000	95.82	1.044	-0.1	0.019	0.020
	WLAN5GHz	802.11a 6Mbps	Back	0mm	Ant 1	116	5580	17.20	17.50	1.072	95.82	1.044	0.01	0.025	0.028
	WLAN5GHz	802.11a 6Mbps	Back	0mm	Ant 1	140	5700	14.30	14.50	1.047	95.82	1.044	0.08	0.038	0.042
	WLAN5GHz	802.11a 6Mbps	Back	0mm	Ant 2	132	5660	17.40	17.50	1.023	95.92	1.043	-0.03	0.021	0.022
04	WLAN5GHz	802.11a 6Mbps	Back	0mm	Ant 1	149	5745	17.50	18.00	1.122	95.82	1.044	-0.08	0.063	0.074
	WLAN5GHz	802.11a 6Mbps	Back	0mm	Ant 1	157	5785	17.40	17.50	1.023	95.82	1.044	0.05	0.033	0.035
	WLAN5GHz	802.11a 6Mbps	Back	0mm	Ant 1	165	5825	17.50	18.00	1.122	95.82	1.044	0.02	0.039	0.046
	WLAN5GHz	802.11a 6Mbps	Back	0mm	Ant 2	149	5745	17.60	18.00	1.096	95.92	1.043	0.01	0.053	0.061

13. Simultaneous Transmission Analysis

NO.	Simultaneous Transmission Configurations	Extremity
1.	WLAN ANT1 + WLAN ATN2	Yes
2.	Bluetooth ANT1 + WLAN ATN2	Yes

General Note:

1. WLAN and Bluetooth share the same antenna1, and cannot transmit simultaneously.
2. EUT will choose either WLAN 2.4GHz or WLAN 5GHz according to the network signal condition; therefore, 2.4GHz WLAN and 5GHz WLAN will not operate simultaneously at any moment.
3. Per KDB 447498 D01v06, simultaneous transmission SAR is compliant if,
   i) Scalar SAR summation < 1.6W/kg.
   ii) SPLSR = (SAR1 + SAR2)^1.5 / (min. separation distance, mm), and the peak separation distance is determined from the square root of [(x1-x2)2 + (y1-y2)2 + (z1-z2)2], where (x1, y1, z1) and (x2, y2, z2) are the coordinates of the extrapolated peak SAR locations in the zoom scan.
   iii) If SPLSR ≤ 0.04, simultaneously transmission SAR measurement is not necessary.
   iv) Simultaneously transmission SAR measurement, and the reported multi-band SAR < 1.6W/kg.
4. For simultaneous transmission analysis, Bluetooth SAR is estimated per KDB 447498 D01v06 based on the formula below.
   i) (*max. power of channel, including tune-up tolerance, mW*)/(*min. test separation distance, mm*)]·[√f(GHz)/*x*] W/kg for *test separation distances* ≤ 50 mm; where *x* = 7.5 for 1-g SAR, and *x* = 18.75 for 10-g SAR.
   ii) When the minimum separation distance is < 5mm, the distance is used 5mm to determine SAR test exclusion.
   iii) 0.4 W/kg for 1-g SAR and 1.0 W/kg for 10-g SAR, when the *test separation distances* is > 50 mm.

Bluetooth Max Power	Exposure Position	All Positions
0.5dBm	Estimated SAR (W/kg)	0.019 W/kg

13.1 Extremity Exposure Conditions

Exposure Position	1	2	3	4	5	1+2 Summed 10g SAR (W/kg)	3+4 Summed 10g SAR (W/kg)	2+5 Summed 10g SAR (W/kg)	4+5 Summed 10g SAR (W/kg)
	2.4GHz WLAN Ant 1	2.4GHz WLAN Ant 2	5GHz WLAN Ant 1	5GHz WLAN Ant 2	Bluetooth Ant 1				
	10g SAR (W/kg)	10g SAR (W/kg)	10g SAR (W/kg)	10g SAR (W/kg)	Estimated 10g SAR (W/kg)				
Back	0.146	0.119	0.074	0.061	0.019	**0.265**	**0.135**	**0.138**	**0.080**

Test Engineer： Randy Lin and White Huang

14. Uncertainty Assessment

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

15. References

[1] FCC 47 CFR Part 2 “Frequency Allocations and Radio Treaty Matters; General Rules and Regulations”

[2] ANSI/IEEE Std. C95.1-1992, “IEEE Standard for Safety Levels with Respect to Human Exposure to Radio Frequency Electromagnetic Fields, 3 kHz to 300 GHz”, September 1992

[3] IEEE Std. 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”, Sep 2013

[4] SPEAG DASY System Handbook

[5] FCC KDB 248227 D01 v02r02, “SAR Guidance for IEEE 802.11 (WiFi) Transmitters”, Oct 2015.

[6] FCC KDB 447498 D01 v06, “Mobile and Portable Device RF Exposure Procedures and Equipment Authorization Policies”, Oct 2015

[7] FCC KDB 865664 D01 v01r04, "SAR Measurement Requirements for 100 MHz to 6 GHz", Aug 2015.

[8] FCC KDB 865664 D02 v01r02, “RF Exposure Compliance Reporting and Documentation Considerations” Oct 2015.