Test Report

Applicant	：	MediaTek Inc.
Applicant Address	：	No. 1, Dusing 1st Rd. Hsinchu Science Park, Hsinchu City, Taiwan
Product Name	：	1TX 11ax(WiFi6E)BW160+BT/BLE Combo Card
Trade Name	：	MediaTek
Model Number	：	MT7902
Applicable Standard	：	47 CFR §2.1093
Received Date	：	Dec. 28, 2022
Test Period	：	Jan. 11 ~ Jan. 19, 2023
Issued Date	：	Feb. 17, 2023

Issued by

Approved By ： ________________________

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ilac-MRA
TAF Testing Laboratory 1330

Taiwan Accreditation Foundation accreditation number: 1330
Test Firm MRA designation number: TW0010

Note:

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Revision History

Rev.	Issue Date	Revisions	Revised By
00	Feb. 17, 2023	Initial Issue	Rowan Hsieh

Contents

1. General Information

1.1 Reference Testing Standards

Standard	Description	Version
47 CFR §2.1093	Radiofrequency radiation exposure evaluation: portable devices	-
IEC TR 63170	Measurement procedure for the evaluation of power density related to human exposure to radio frequency fields from wireless communication devices operating between 6 GHz and 100 GHz	2018
IEC/IEEE 63195-1	Assessment of power density of human exposure to radio frequency fields from wireless devices in close proximity to the head and body (frequency range of 6 GHz to 300 GHz) – Part 1: Measurement procedure	2022
IEC/IEEE 62209-1528	Measurement procedure for the assessment of specific absorption rate of human exposure to radio frequency fields from hand-held and body-mounted wireless communication devices – Part 1528: Human models, instrumentation, and procedures (Frequency range of 4 MHz to 10 GHz)	2020
IEEE 1528	Determining the Peak Spatial-Average Specific Absorption Rate (SAR) in the Human Head from Wireless Communications Devices: Measurement Techniques	2013
IEEE C95.1	IEEE Standard for Safety Levels with Respect to Human Exposure to Electric, Magnetic, and Electromagnetic Fields, 0 Hz to 300 GHz	1992
KDB 248227 D01	SAR guidance for IEEE 802.11 (Wi-Fi) transmitters	v02r02
KDB 447498 D04	RF exposure procedures and equipment authorization policies for mobile and portable devices	v01
KDB 616217 D04	SAR evaluation considerations for laptop, notebook and tablet computers	v01r02
KDB 865664 D01	SAR measurement requirement for 100 MHz to 6 GHz	v01r04
KDB 865664 D02	RF exposure compliance reporting and documentation considerations	v01r02

1.2 Testing Location

Site Name: Site Name: Eurofins E&E Wireless Taiwan Co., Ltd.

Site Address: ■ No. 140-1, Changan Street, Bade District, Taoyuan City 334025, Taiwan (R.O.C.)

Site Address: □ No. 2, Wuquan 5th Rd. Wugu Dist., New Taipei City, Taiwan (R.O.C.)

2. Description of Device Under Test (DUT)

Applicant	MediaTek Inc. No. 1, Dusing 1st Rd. Hsinchu Science Park, Hsinchu City, Taiwan
Product Name	1TX 11ax(WiFi6E)BW160+BT/BLE Combo Card
Trade Name	MediaTek
Model Number	MT7902
SN No.	NBNTCX00504248D
FCC ID	RAS-MT7902
Host Information	Product Name: Notebook PC Trade Name: ASUS Model Name: UM3504D, BM3504D, RM3504D, UM3504DA, BM3504DA, RM3504DA All models are electrically identical, different model names are for marketing purpose.
Frequency Range	WLAN 2.4 GHz Band：2412 - 2472 MHz WLAN 5.2 GHz Band：5180 - 5240 MHz WLAN 5.3 GHz Band：5260 - 5320 MHz WLAN 5.6 GHz Band：5500 - 5720 MHz WLAN 5.8 GHz Band：5745 - 5825 MHz WLAN 5.9 GHz Band：5845 - 5885 MHz WLAN 6.2 GHz Band：5955 - 6415 MHz WLAN 6.5 GHz Band：6435 - 6515 MHz WLAN 6.7 GHz Band：6535 - 6855 MHz WLAN 7.0 GHz Band：6875 - 7115 MHz Bluetooth：2402 - 2480 MHz
Supported Modulations	WLAN 2.4 GHz : 802.11 b / g / n / ax HT20 / HT40 / VHT20 / VHT40 / HE20 / HE40
	WLAN 5 GHz : 802.11 a / n / ac / ax HT20 / HT40 / VHT20 / VHT40 / VHT80 / VHT160 / HE20 / HE40 / HE80 / HE160
	WLAN 6 GHz : 802.11a / ax HE40 / HE80 / HE160
	Bluetooth : BR / EDR / LE
Device Category	Portable Device
Module Name	Mediatek, MT7902

Note:

1. The above information of DUT was declared by manufacturer. Please refer to the specifications or user's manual for more detailed description.

Antenna list:

Antenna Source	ANT	Manufacturer	Part No. (Vendor)	Type	Frequency	Max. Gain (dBi)
1	Chain 0	LUXSHARE-ICT	LA9RF468-CS-H	PIFA Antenna	2402 - 2480	-0.23
					5150 - 5250	3.46
					5250 - 5350	3.46
					5470 - 5725	4.46
					5725 - 5850	4.46
					5850 - 5925	4.47
					5925 - 6425	4.15
					6425 - 6525	3.32
					6525 - 6875	3.32
					6875 - 7125	2.46
	Chain 1	LUXSHARE-ICT	LA9RF467-CS-H	PIFA Antenna	2402 - 2480	0.18
					5150 - 5250	2.98
					5250 - 5350	3.49
					5470 - 5725	4.30
					5725 - 5850	4.13
					5850 - 5925	4.28
					5925 - 6425	4.24
					6425 - 6525	4.04
					6525 - 6875	4.28
					6875 - 7125	3.98
2	Chain 0	INPAQ	MDA-LE-01-008	PIFA Antenna	2402 - 2480	-0.44
					5150 - 5250	3.41
					5250 - 5350	3.41
					5470 - 5725	3.51
					5725 - 5850	4.39
					5850 - 5925	4.39
					5925 - 6425	4.09
					6425 - 6525	2.90
					6525 - 6875	2.90
					6875 - 7125	2.44
	Chain 1	INPAQ	MDA-LE-02-017	PIFA Antenna	2402 - 2480	-0.31
					5150 - 5250	2.72
					5250 - 5350	2.54
					5470 - 5725	3.37
					5725 - 5850	3.97
					5850 - 5925	4.12
					5925 - 6425	4.12
					6425 - 6525	3.93
					6525 - 6875	3.87
					6875 - 7125	3.87

Note：
1. Antenna Source 1 (LUXSHARE-ICT antenna) and Antenna Source 2 (INPAQ antenna) are the same type of antenna, only different in manufacturer.
2. The Chain 0 is connected to AUX port / Chain 1 is connected to Main port of module.

3. Summary of Maximum Value

Equipment Class	Mode	Highest Reported SAR	
		Body standalone $SAR_{1\,g}$ (W/kg)	Simultaneous Transmission SAR (W/kg)
DTS	WLAN 2.4 GHz ANT Main	1.10	1.10
	WLAN 2.4 GHz ANT Aux	1.04	
NII	WLAN 5 GHz ANT Main	1.08	1.56
	WLAN 5 GHz ANT Aux	1.08	
6XD	WLAN 6 GHz ANT Main	0.78	1.26
	WLAN 6 GHz ANT Aux	0.39	
DSS / DTS	Bluetooth ANT Main	0.64	1.56
	Bluetooth ANT Aux	0.48	

Equipment Class	Mode	Highest Standalone Transmission	Highest Simultaneous Transmission
		Averaging Area [4 cm^2] Total PD (mW/cm^2)	Total Exposure Ratio
6XD	WLAN 6 GHz	0.583	0.95

Note:

1. The SAR limit for general population / uncontrolled exposure is specified in FCC 47 CFR part 2 (2.1093) and ANSI/IEEE C95.1-1992.
2. The test procedures, as described in American National Standards, Institute ANSI/IEEE C95.1 were employed and they specify the maximum exposure limit of tissue for portable devices being used within 20 cm between user and EUT in the uncontrolled environment. A description of the product and operating configuration, detailed summary of the test results, methodology and procedures used in the equipment used are included within this test report.
3. The evaluation requirements, as described in 47 CFR Part §1.310 were employed and they specify the maximum exposure limit for general population / uncontrolled exposure is 1.0 mW/cm^2 (equal to 10 W/m^2) for 1.5 GHz to 100 GHz.
4. According to the TCB Worshop Oct. 2018 notes, the average power density results are presented using averaging areas of 4 cm^2.
5. Total exposure ratio (TER) calculated by taking ratio of reported SAR divided by SAR limit and adding it to measured power density divided by power density limit. Numerical sum of the two ratios should be less than 1.

4. Introduction

4.1 SAR Definition

Specific Absorption Rate (SAR) is defined as 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:

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

SAR measurement can be related to the electrical field in the tissue by

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

Where：

σ = conductivity of the tissue (S/m)

ρ = mass density of the tissue (kg/m^3)

E = RMS electric field strength (V/m)

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

4.2 Power Density Definition

Power density (PD) is defined as the rates of energy transfer per area for an electromagnetic filed.
According to the IEC TR 63170, the following formula is used to determine the local power density:

$$\mathbf{S} = \frac{1}{2}\Re(\mathbf{E} \times \mathbf{H}) \cdot \hat{\boldsymbol{n}}$$

And the spatial-average power denity distribution on the evaluate surface is determined as the following equation:

$$\mathbf{S_{av}} = \frac{1}{2A}\Re \cdot \left(\int \mathbf{E} \times \mathbf{H} \cdot \hat{\mathbf{n}}\, \mathbf{dA}\right)$$

Where:
E is the complex electric field peak phasor and H is the complex conjugate magnetic field peak phasor, respectively. *A* is the spatial averae area spefied by the applicable exposure or regulatory requirement.
Power density is expressed in unit of watt per square meter (W/m^2).

4.3 RF Exposure Limits

Table 1 Safety Limits for Controlled / Uncontrolled Environment Exposure

SAR Exposure Limit		
	General Population / Uncontrolled Exposure [1] (W/kg)	**Occupational / Controlled Exposure [2] (W/kg)**
Spatial Peak SAR [3] (head or Body)	1.60	8.00
Spatial Peak SAR [4] (Whole Body)	0.08	0.40
Spatial Peak SAR [5] (Hands / Feet / Ankle / Wrist)	4.00	20.00
Power Density Exposure Limit (1,500 - 100,000 MHz)		
	General Population / Uncontrolled Exposure (mW/cm^2) [6]	**Occupational / Controlled Exposure (mW/cm^2)**
Power Density (S)	1.0	5.0

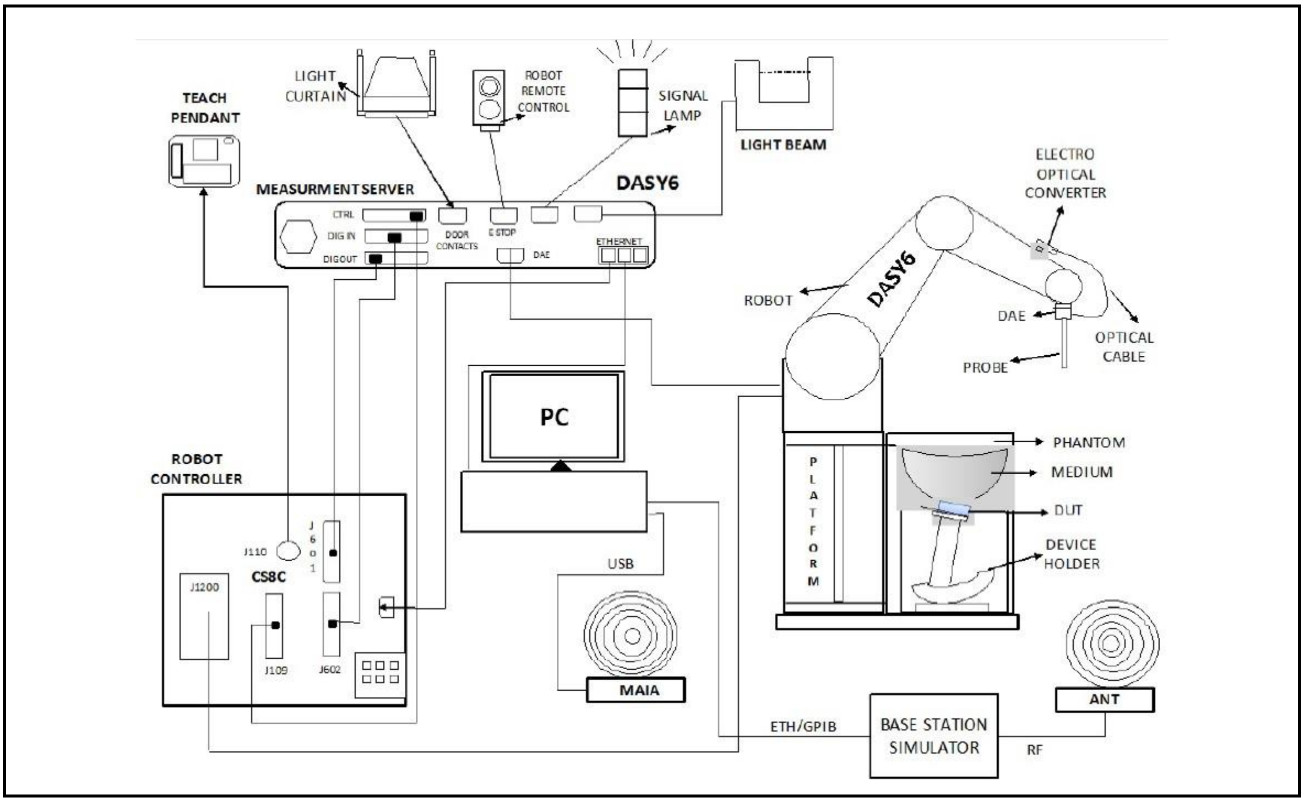
Notes：

1. **General Population / Uncontrolled Environments** are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure.
2. **Occupational / 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).
3. 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.
4. The Spatial Average value of the SAR averaged over the whole body.
5. 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.
6. 1 mW/cm^2 = 10 W/m^2.

5. System Describtion

5.1 SAR Measurement System

The DASY system in SAR Configuration is shown below:



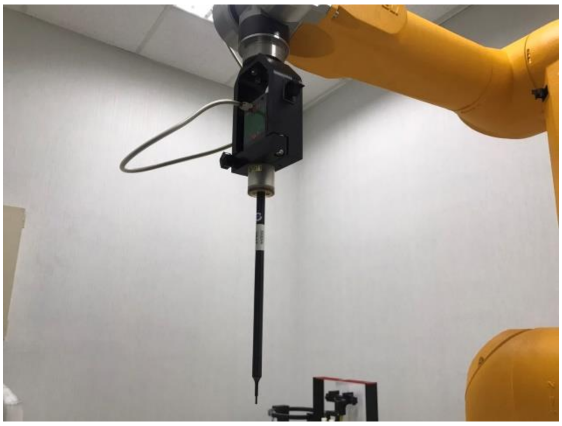
The system for performing compliance tests consists of the following items:

1. A standard high precision 6-axis robot (Stäubli TX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
2. An isotropic field probe optimized and calibrated for the targeted measurements.
3. 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.
4. 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.
5. 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.
6. The Light Beam used is for probe alignment. This improves the (absolute) accuracy of the probe positioning.
7. A computer running Win7/Win8/Win10 professional operating system and DASY software.
8. Remote controls with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
9. The phantom, the device holder and other accessories according to the targeted measurement.
10. Tissue simulating liquid mixed according to the given recipes.
11. The validation dipole has been calibrated within and the system performance check has been successful.

<DASY E-Field Probe System>

The SAR measurements were conducted with the dosimetric probe (manufactured by SPEAG), designed in the classical triangular configuration and optimized for dosimetric evaluation. The probes is constructed using the thick film technique; with printed resistive lines on ceramic substrates. The probe is equipped with an optical multi-fiber line ending at the front of the probe tip. It is connected to the EOC box on the robot arm and provides an automatic detection of the phantom surface. Half of the fibers are connected to a pulsed infrared transmitter, the other half to a synchronized receiver. As the probe approaches the surface, the reflection from the surface produces a coupling from the transmitting to the receiving fibers. This reflection increases first during the approach, reaches maximum and then decreases. If the probe is flatly touching the surface, the coupling is zero. The distance of the coupling maximum to the surface is independent of the surface reflectivity and largely independent of the surface to probe angle. The DASY software reads the reflection during a software approach and looks for the maximum using a 2nd order fitting. The approach is stopped when reaching the maximum.

Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Frequency	4 MHz to 10 GHz Linearity: ± 0.2 dB (30 MHz to 10 GHz)
Directivity	±0.1 dB in TSL (rotation around probe axis) ±0.3 dB in TSL (rotation normal to probe axis)
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
Calibration	ISO/IEC 17025 calibration service available

	
EX3DV4 E-Field Probe	**Probe setup on robot**

<Data Acquisition Electronic (DAE) System>

Model	DAE4	
Construction	Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop.	
Measurement Range	-100 to +300 mV (16 bit resolution and two range settings: 4 mV, 400 mV)	
Input Offset Voltage	< 5 μV (with auto zero)	
Input Bias Current	< 50 fA	
Dimensions	60 x 60 x 68 mm	

<Robot>

Positioner	Stäubli Unimation Corp.	
Robot Model	TX90XL	
Number of Axes	6	
Nominal Load	5 kg	
Reach	1450 mm	
Repeatability	± 0.035 mm	

<Device Holder>

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

	
Device Holder 1	Device Holder 2

<Oval Flat Phantom – ELI>

The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (Oval Flat) phantom defined in IEEE 1528, IEC 62209-2 and IEC/IEEE 62209-1528. It enables the dosimetric evaluation of wireless portable device usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points with the robot.

Shell Thickness	2 ±0.2 mm	
Filling Volume	Approx. 30 liters	
Dimensions	190×600×400 mm (H × L × W)	

<SAM Phantom>

The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528, IEC 62209-1 and IEC/IEEE 62209-1528. It enables the dosimetric evaluation of left and right hand phone usage as well as body-mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot.

Shell Thickness	2 ±0.2 mm	
Filling Volume	Approx. 25 liters	
Dimensions	Length: 1000 mm Width: 500 mm Height: adjustable feet	

5.2 Tissue Simulating Liquids (TSL)

<Tissue Dielectric Parameters in IEEE 1528-2013 and IEC/IEEE 62209-1528>

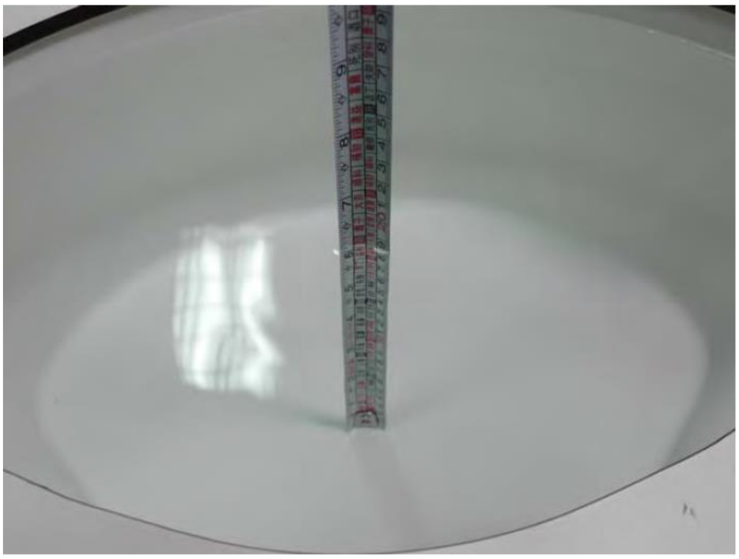
The following table incorporates the tissue dielectric parameters of head recommended by IEEE 1528-2013 and IEC/IEEE 62209-1528. These head parameters are derived from planar layer models simulating the highest expected SAR for the dielectric properties and tissue thickness variations in human head. Other head and body tissue parameters that have not been specified are derived from the tissue dielectric parameters which computed by the 4-Cole-Cole equation according to the above-mentioned standards.

Table 2 Dielectric properties of the tissue-equivalent liquid material

Frequency (MHz)	Relative Permittivity (ε_r)	Conductivity (σ)
30	55.0	0.75
150	52.3	0.76
300	45.3	0.87
450	43.5	0.87
750	41.9	0.89
835	41.5	0.90
900	41.5	0.97
1450	40.5	1.20
1800	40.0	1.40
1900	40.0	1.40
1950	40.0	1.40
2000	40.0	1.40
2100	39.8	1.49
2450	39.2	1.80
2600	39.0	1.96
3000	38.5	2.40
3500	37.9	2.91
4000	37.4	3.43
4500	36.8	3.94
5000	36.2	4.45
5200	36.0	4.66
5400	35.8	4.86
5600	35.5	5.07
5800	35.3	5.27
6000	35.1	5.48
6500	34.5	6.07
7000	33.9	6.65
7500	33.3	7.24
8000	32.7	7.84
8500	32.1	8.46
9000	31.6	9.08
9500	31.0	9.71
10000	30.4	10.4

<Liquid Depth>

The depth of tissue-equivalent liquid in a phantom must be ≧ 15.0 cm to ensure that the probe is immersed sufficiently in the tissue medium.



Tissue-equivalent Liquid Height

<Test Site Environment>

Item	Requirement	Actual
Temperature (°C)	18 - 25	21 - 23

<Liquid Check>

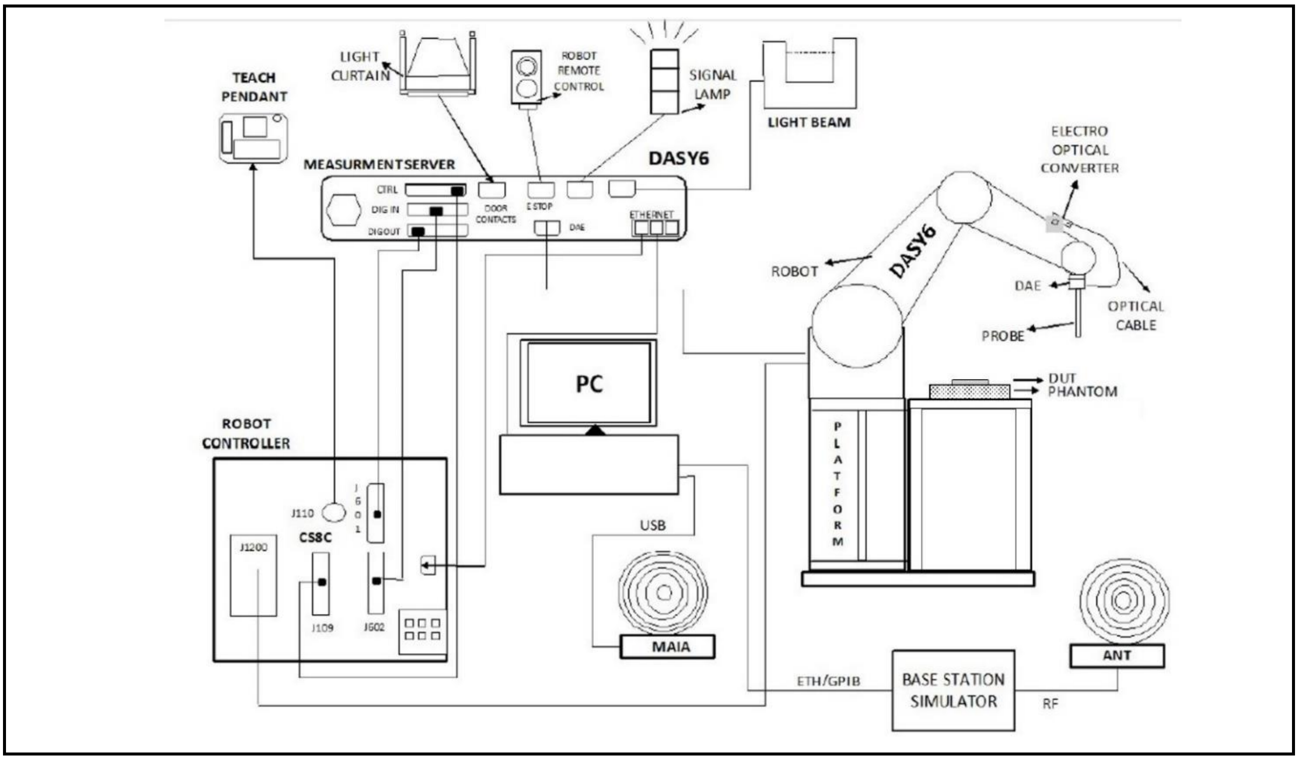
1. The dielectric parameters of the liquids were verified prior to the SAR evaluation using a DAKS 3.5 Probe Kit.
2. The SAR testing with IEC tissue parameters as an alternative option to Head and body parameters. The head TSL were applied to body SAR tests with restrictions below:

Tissue Temp (°C)	Head / Body	Frequency	Cond. σ	Perm. εr	target Cond. σ	target Perm. εr	σ (Delta)(%)	εr (Delta)(%)	Limit (%)	Date
22.3	Head	5180 MHz	4.58	35.65	4.64	36.02	-1.33	-1.02	±5	Jan. 11, 2023
22.3	Head	5190 MHz	4.59	35.64	4.65	36.01	-1.38	-1.03	±5	Jan. 11, 2023
22.3	Head	5200 MHz	4.59	35.62	4.66	36.00	-1.41	-1.06	±5	Jan. 11, 2023
22.3	Head	5220 MHz	4.61	35.58	4.68	35.98	-1.47	-1.12	±5	Jan. 11, 2023
22.3	Head	5230 MHz	4.62	35.55	4.69	35.97	-1.47	-1.16	±5	Jan. 11, 2023
22.3	Head	5240 MHz	4.63	35.53	4.70	35.96	-1.41	-1.21	±5	Jan. 11, 2023
22.3	Head	5250 MHz	4.65	35.50	4.71	35.95	-1.36	-1.24	±5	Jan. 11, 2023
22.3	Head	5260 MHz	4.66	35.49	4.72	35.94	-1.31	-1.27	±5	Jan. 11, 2023
22.3	Head	5270 MHz	4.67	35.47	4.73	35.93	-1.27	-1.28	±5	Jan. 11, 2023
22.3	Head	5280 MHz	4.68	35.46	4.74	35.92	-1.27	-1.29	±5	Jan. 11, 2023
22.3	Head	5290 MHz	4.69	35.44	4.75	35.91	-1.30	-1.30	±5	Jan. 11, 2023
22.3	Head	5300 MHz	4.70	35.42	4.76	35.90	-1.35	-1.33	±5	Jan. 11, 2023
22.3	Head	5310 MHz	4.70	35.40	4.77	35.89	-1.40	-1.36	±5	Jan. 11, 2023
22.3	Head	5320 MHz	4.71	35.38	4.78	35.88	-1.43	-1.40	±5	Jan. 11, 2023
22.3	Head	5500 MHz	4.90	35.04	4.97	35.65	-1.28	-1.71	±5	Jan. 11, 2023
22.3	Head	5510 MHz	4.91	35.03	4.98	35.64	-1.35	-1.72	±5	Jan. 11, 2023
22.3	Head	5530 MHz	4.92	34.98	5.00	35.61	-1.49	-1.77	±5	Jan. 11, 2023
22.3	Head	5550 MHz	4.94	34.92	5.02	35.58	-1.50	-1.86	±5	Jan. 11, 2023
22.3	Head	5570 MHz	4.97	34.87	5.04	35.55	-1.39	-1.91	±5	Jan. 11, 2023
22.3	Head	5580 MHz	4.98	34.86	5.05	35.53	-1.34	-1.88	±5	Jan. 11, 2023
22.3	Head	5610 MHz	5.01	34.83	5.08	35.49	-1.36	-1.86	±5	Jan. 11, 2023
22.3	Head	5620 MHz	5.02	34.81	5.09	35.48	-1.41	-1.88	±5	Jan. 11, 2023
22.3	Head	5630 MHz	5.03	34.79	5.10	35.47	-1.45	-1.91	±5	Jan. 11, 2023
22.3	Head	5660 MHz	5.06	34.71	5.13	35.44	-1.44	-2.05	±5	Jan. 11, 2023
22.3	Head	5670 MHz	5.07	34.69	5.14	35.43	-1.41	-2.08	±5	Jan. 11, 2023
22.3	Head	5690 MHz	5.09	34.66	5.16	35.41	-1.36	-2.13	±5	Jan. 11, 2023
22.3	Head	5700 MHz	5.10	34.64	5.17	35.40	-1.37	-2.15	±5	Jan. 11, 2023
22.3	Head	5710 MHz	5.11	34.62	5.18	35.39	-1.39	-2.17	±5	Jan. 11, 2023
22.3	Head	5720 MHz	5.12	34.60	5.19	35.38	-1.41	-2.19	±5	Jan. 11, 2023
22.5	Head	5745 MHz	5.14	34.56	5.22	35.36	-1.48	-2.27	±5	Jan. 12, 2023
22.5	Head	5755 MHz	5.15	34.53	5.23	35.35	-1.50	-2.31	±5	Jan. 12, 2023
22.5	Head	5775 MHz	5.17	34.49	5.25	35.33	-1.47	-2.37	±5	Jan. 12, 2023
22.5	Head	5785 MHz	5.18	34.48	5.26	35.32	-1.44	-2.39	±5	Jan. 12, 2023
22.5	Head	5795 MHz	5.19	34.46	5.27	35.31	-1.42	-2.40	±5	Jan. 12, 2023
22.5	Head	5825 MHz	5.22	34.43	5.30	35.28	-1.49	-2.42	±5	Jan. 12, 2023
22.5	Head	5815 MHz	5.21	34.44	5.29	35.29	-1.48	-2.40	±5	Jan. 12, 2023
22.5	Head	5835 MHz	5.23	34.41	5.31	35.27	-1.52	-2.44	±5	Jan. 12, 2023
22.5	Head	5845 MHz	5.24	34.39	5.32	35.26	-1.50	-2.47	±5	Jan. 12, 2023

Tissue Temp (°C)	Head / Body	Frequency	Cond. σ	Perm. εr	target Cond. σ	target Perm. εr	σ (Delta)(%)	εr (Delta)(%)	Limit (%)	Date
22.5	Head	5855 MHz	5.25	34.37	5.33	35.25	-1.48	-2.50	±5	Jan. 12, 2023
22.5	Head	5865 MHz	5.26	34.35	5.34	35.24	-1.43	-2.52	±5	Jan. 12, 2023
22.5	Head	5875 MHz	5.27	34.34	5.35	35.23	-1.42	-2.53	±5	Jan. 12, 2023
22.5	Head	5885 MHz	5.28	34.33	5.36	35.22	-1.40	-2.53	±5	Jan. 12, 2023
22.5	Head	5905 MHz	5.30	34.30	5.38	35.20	-1.46	-2.55	±5	Jan. 12, 2023
22.4	Head	2412 MHz	1.78	39.61	1.77	39.27	0.58	0.87	±5	Jan. 13, 2023
22.4	Head	2422 MHz	1.79	39.56	1.78	39.25	0.70	0.79	±5	Jan. 13, 2023
22.4	Head	2437 MHz	1.80	39.52	1.79	39.22	0.87	0.75	±5	Jan. 13, 2023
22.4	Head	2452 MHz	1.82	39.46	1.80	39.20	0.93	0.66	±5	Jan. 13, 2023
22.4	Head	2462 MHz	1.83	39.42	1.81	39.18	0.90	0.61	±5	Jan. 13, 2023
22.4	Head	2467 MHz	1.84	39.40	1.82	39.18	0.93	0.56	±5	Jan. 13, 2023
22.4	Head	2472 MHz	1.84	39.38	1.82	39.17	0.96	0.54	±5	Jan. 13, 2023
22.4	Head	2402 MHz	1.77	39.66	1.76	39.28	0.47	0.97	±5	Jan. 13, 2023
22.4	Head	2441 MHz	1.81	39.50	1.79	39.22	0.88	0.72	±5	Jan. 13, 2023
22.4	Head	2480 MHz	1.85	39.35	1.83	39.16	0.96	0.49	±5	Jan. 13, 2023
22.7	Head	6025 MHz	5.54	35.77	5.51	35.07	0.55	2.00	±5	Jan. 18, 2023
22.7	Head	6185 MHz	5.65	35.78	5.70	34.88	-0.83	2.58	±5	Jan. 18, 2023
22.7	Head	6345 MHz	5.99	35.17	5.89	34.69	1.74	1.38	±5	Jan. 18, 2023
22.7	Head	6465 MHz	6.11	35.14	6.03	34.54	1.26	1.72	±5	Jan. 18, 2023
22.7	Head	6505 MHz	6.12	34.99	6.08	34.49	0.76	1.45	±5	Jan. 18, 2023
22.7	Head	6545 MHz	6.19	34.77	6.12	34.45	1.02	0.93	±5	Jan. 18, 2023
22.7	Head	6665 MHz	6.33	34.49	6.26	34.30	1.07	0.57	±5	Jan. 18, 2023
22.7	Head	6825 MHz	6.54	34.44	6.45	34.11	1.46	0.97	±5	Jan. 18, 2023
22.7	Head	6945 MHz	6.63	34.05	6.59	33.97	0.68	0.25	±5	Jan. 18, 2023
22.7	Head	6985 MHz	6.67	33.96	6.63	33.92	0.56	0.11	±5	Jan. 18, 2023
22.7	Head	7025 MHz	6.71	33.94	6.68	33.87	0.48	0.19	±5	Jan. 18, 2023

5.3 Power Density Measurement System

The DASY system in Configuration is shown below:

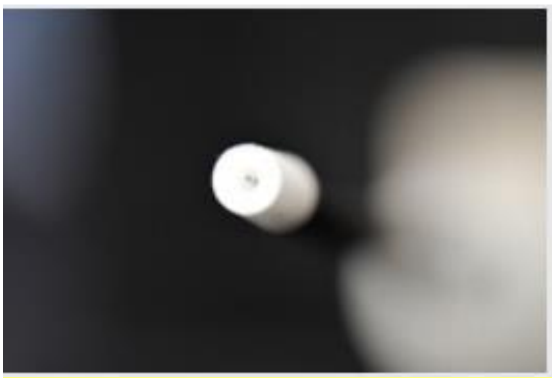
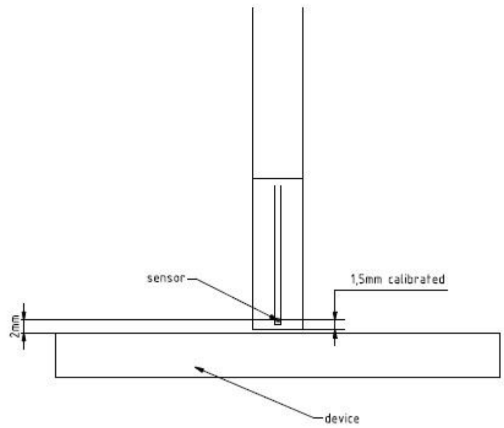


The DASY system for performing compliance tests consists of the following items:

1. A standard high precision 6-axis robot (Stäubli TX family) with controller, teach pendant and software. An arm extension for accommodating the data acquisition electronics (DAE).
2. A dosimetric probe, i.e., an isotropic E-field probe optimized and calibrated. The probe is equipped with an optical surface detector system.
3. 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.
4. 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.
5. A probe alignment unit which improves the (absolute) accuracy of the probe positioning.
6. A computer running Win7/Win8/Win10 professional operating system and DASY software.
7. Remote controls with teach pendant and additional circuitry for robot safety such as warning lamps, etc.
8. The mmWave phantom.
9. Validation dipole kits allowing validating the proper functioning of the system.

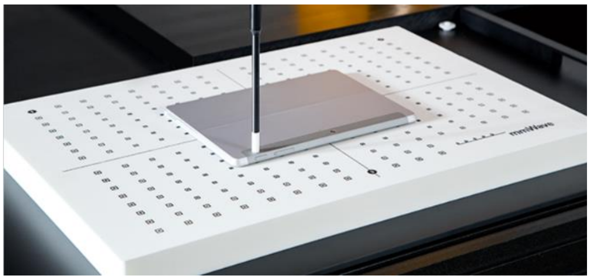
<DASY E-Field Probe System>

The EUmmWV3 probe is based on the pseudo-vector probe design, which not only measures the field magnitude but also derives its polarization ellipse. This probe concept also has the advantage that the sensor angle errors or distortions of the field by the substrate can be largely nullified by calibration.This is particularly important as, at these very high frequencies, field distortions by the substrate are dependent on the wavelength. It has two dipoles optimally arranged to obtain pseudo-vector information. It has minimum 3 measurements/point, 120º rotated around probe axis. Sensors (0.8 mm length) printed on glass substrate protected by high density foam. Low perturbation of the measured field. Requires positioner which can do accurate probe rotation.

Frequency Range	750 MHz - 110 GHz
Dynamic Range	< 20 V/m - 10'000 V/m with PRE-10 (min < 50 V/m - 3000 V/m)
Position Precision	< 0.2 mm
Dimensions	Overall length: 337 mm (Tip: 20 mm) Tip diameter: encapsulation 8 mm (internal sensor < 1mm) Distance from probe tip to dipole centers: < 2 mm Sensor displacement to probe's calibration point: < 0.3 mm
Applications	Electric field measurements of 5G devices and other mm-wave transmitters operating above 10 GHz in <2 mm distance from device (free-space) Power density, magnetic field, and far-field analysis using total field reconstruction (cDASY6 5G or ICEy-mmW module required)
compatibility	cDASY6 + 5G-Module SW1.0 and higher
	
E-Field mm-Wave Probe	**Sensor to DUT Surface**

<mmWave phantom>

The mmWave phantom approximates free-space conditions, allowing to evaluate not only the antenna side of the device but also the front (screen) or any opposite-radiating side of wireless devices operating above 10 GHz without distorting the radiofrequency (RF) field. It consists of a 40 mm thick Rohacell plate used as a test bed which has a loss tangent (tan δ) ≤0.05 and a relative permittivity (εr) ≤1.2. The high-performance RF absorbers are placed below the foam.



<Data Acquisition Electronic (DAE)>

The data acquisition electronics (DAE) consist of a highly sensitive electrometer-grade preampli er with auto-zeroing, a channel and gain-switching multiplexer, a fast 16-bit AD-converter, 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 input impedance of DAE box is 200MOhm; the inputs are symmetric and oating. Common mode rejection is above 80 dB.

Model	DAE4
Construction	Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop.
Measurement Range	-100 to +300 mV (16 bit resolution and two range settings: 4 mV, 400 mV)
Input Offset Voltage	< 5 µV (with auto zero)
Input Bias Current	< 50 fA
Dimensions	60 x 60 x 68 mm

<Robot>

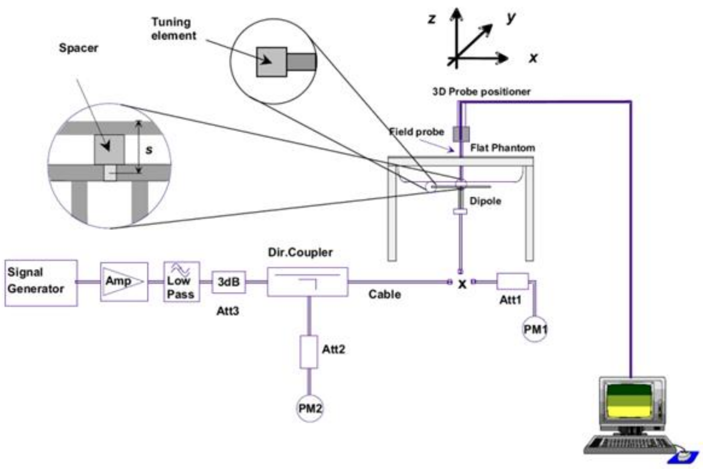
Positioner	Stäubli Unimation Corp.
Robot Model	TX90XL
Number of Axes	6
Nominal Load	5 kg
Reach	1450 mm
Repeatability	± 0.035 mm

6. System Verification

6.1 SAR System Verification

<Symmetric Dipoles for SAR System Verification>

Construction	Symmetrical dipole with λ/4 balun enables measurement of feed point impedance with NWA matched for use near flat phantoms filled with head simulating solutions Includes distance holder and tripod adaptor Calibration Calibrated SAR value for specified position and input power at the flat phantom in head simulating solutions.
Return Loss	> 20 dB at specified verification position.
Options	Dipoles for other frequencies or solutions and other calibration conditions are available upon request.



System Verification Setup Diagram


Validation Kit

6.1.1 SAR Verification Summary

Prior to the assessment, the validation data compared to the original value provided by SPEAG should be within its specifications of ±10%. The measured SAR will be normalized to 1 W input power. The result indicates the system check can meet the variation criterion and plots can be referred to Appendix B of this report.

Mixture Type	Frequency (MHz)	Power (dBm)	Probe Model / Serial No.	Dipole Model / Serial No.	SAR_{1g} (W/kg)	1 W Normalize SAR_{1g} (W/kg)	1 W Target SAR1 g (W/kg)	SAR_{10g} (W/kg)	1 W Normalize SAR_{10g} (W/kg)	1 W Target SAR_{10g} (W/kg)	Deviation 1 g (%)	Deviation 10 g (%)	Date
Head	2450	17 dBm	EX3DV4 – SN7756	D2450V2 – SN712	2.59	51.68	52.80	1.21	24.14	24.40	-2.1%	-1.1%	Jan. 13, 2023
Head	5250	17 dBm	EX3DV4 – SN7647	D5250V2 – SN1021	3.93	78.41	78.10	1.1	21.95	22.10	0.4%	-0.7%	Jan. 11, 2023
Head	5600	17 dBm	EX3DV4 – SN7647	D5600V2 – SN1021	4.2	83.80	82.00	1.15	22.95	23.20	2.2%	-1.1%	Jan. 11, 2023
Head	5750	17 dBm	EX3DV4 – SN7647	D5750V2 – SN1021	3.72	74.22	77.30	1.02	20.35	21.50	-4.0%	-5.3%	Jan. 12, 2023
Head	5800	17 dBm	EX3DV4 – SN7756	D5800V2 – SN1021	3.87	77.22	78.70	1.12	22.35	22.30	-2.3%	0.7%	Jan. 12, 2023
Head	6500	20 dBm	EX3DV4 – SN3847	D6500V2 – SN1016	27.7	277.00	291.00	5.13	51.30	53.70	-4.8%	-4.5%	Jan. 18, 2023

Mixture Type	Frequency (MHz)	Power	Probe Model / Serial No.	Dipole Model / Serial No.	1 W Normalize Meas. 4 cm² PD (W/m²)	Target 4 cm² PD (W/m²)	PD Deviation (%)	Date
PD	6500	20 dBm	EX3DV4 – SN3847	D6500V2 – SN1016	1230.00	1310.00	-6.1%	Jan. 18, 2023

6.2 Power Density System Verification

The system performance check verifies that the system operates within its specifications.

The system check is successful if the difference between the normalized measured local power density and the numerically validated target value is within the reported expanded uncertainty of the measurement system.

The recommended settings for measurement of verification sources are listed in the following:

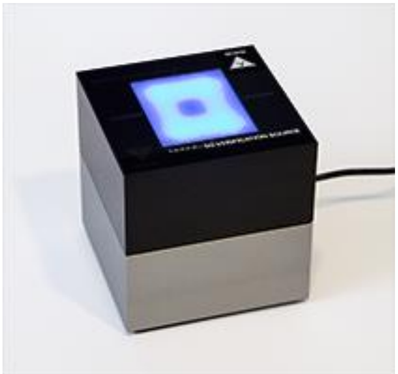
Settings for Measurement of Verification Sources			
Frequency[GHz]	**Grid step**	**Grid extent X/Y [mm]**	**Measurement points**
10	0.125 (λ/8)	60 / 60	18 × 18
30	0.25 (λ/4)	60 / 60	26 × 26
45	0.25 (λ/4)	42 / 42	28 × 28
60	0.25 (λ/4)	32.5 / 32.5	28 × 28
90	0.25 (λ/4)	30 / 30	38 × 38

<System Varification Souce>

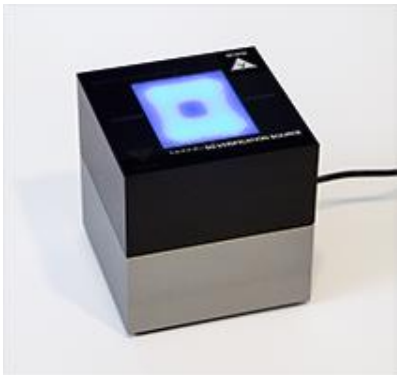
The verification sources apply to system check or verification at specific mmWave frequencies. The sources comprise horn-antennas and very stable signal generators.

Frequency accuracy	10 GHz at 10 mm from the antenna
E-field polarization	Linear
Input Power	Max. 20 W
Conector	SMA
Weight	700 g
Operation	requires a stable source with known forward power to perform system performance check or validation

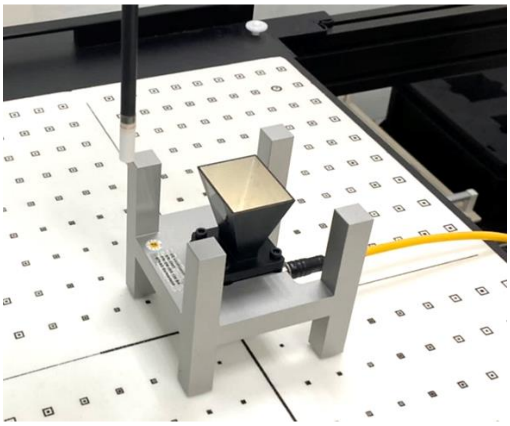
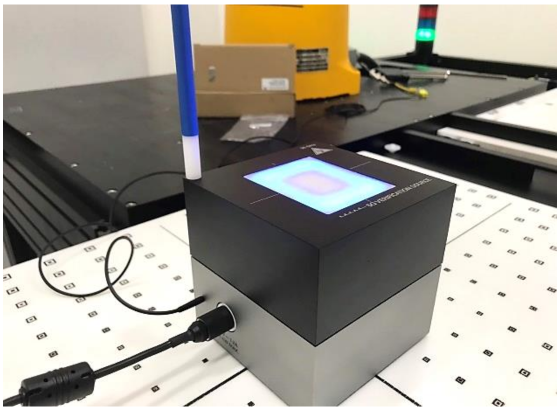
Calibrated Frequency	30 GHz at 10mm from the antenna (5.55 mm from the case surface)
Frequency accuracy	± 100 MHz
E-field polarization	Linear
Harmonics	-20 dBc
Total radiated power	14 dBm
Power stability	0.05 dB
Power consumption	5 W
Size	100 × 100 × 100 mm
Weight	1 kg



Calibrated Frequency	60 GHz at 10mm from the antenna (5.55 mm from the case surface)
Frequency accuracy	± 100 MHz
E-field polarization	± 100 MHz
Harmonics	Linear
Total radiated power	-20 dBc
Harmonics	14 dBm
Power stability	0.1 dB
Power consumption	5 W
Size	100 × 100 × 100 mm
Weight	1 kg



6.2.1 Power Density Verification Summary

System Verification Setup photo

Prior to the assessment, the validation data compared to the original value provided by SPEAG should be within its specifications of ± 0.66 dB. The ± 0.66 dB deviation threshold represents the expanded uncertainty for system performance checks using SPEAG's mmWave verification sources. The power density distribution was verified through visual inspection as per Nov. 2017 TCBC Workshop Notes, both spatially (shape) and numerically (level) have no noticeable differences. The following result indicates the system check can meet the variation criterion and plots can be referred to Appendix B of this report.

Frequency (MHz)	Probe Model / Serial No.	Dipole Model / Serial No.	Averaging Area [4 cm²] Measured Total PD (W/m²)	Averaging Area [4 cm²] Target Total PD (W/m²)	PD Deviation (%)	Date
10G	EUmmWV3 – SN9403	5G Verification Source 10 GHz – 2003	158.67	153.00	3.7%	Jan. 19, 2023

Note:

The measured total PD was the average of psPDn+, psPDtot+ and psPDmod+, which refers to the demonstration from calibration certificate.

7. Test Equipment List

SAR02-BD test site					
Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Cal. Date	Cal.Period
SPEAG	2450 MHz System Validation Kit	D2450V2	712	Jun. 30, 2022	1 year
SPEAG	5 GHz System Validation Kit	D5GHzV2	1021	Dec. 22, 2022	1 year
SPEAG	6.5 GHz System Validation Kit	D6.5GHzV2	1016	Aug. 23, 2022	1 year
SPEAG	5G Verification Source	10 GHz	2003	Feb. 28, 2022	1 year
SPEAG	Dosimetric E-Field Probe	EUmmWV3	9403	Dec. 07, 2022	1 year
SPEAG	Dosimetric E-Field Probe	EX3DV4	3847	Mar. 24, 2022	1 year
SPEAG	Dosimetric E-Field Probe	EX3DV4	7647	Apr. 27, 2022	1 year
SPEAG	Dosimetric E-Field Probe	EX3DV4	7756	Aug. 26, 2022	1 year
SPEAG	Data Acquisition Electronics	DAE4	779	Jul. 19, 2022	1 year
SPEAG	Data Acquisition Electronics	DAE4	541	Mar. 23, 2022	1 year
SPEAG	Data Acquisition Electronics	DAE4	1253	Dec. 16, 2022	1 year
SPEAG	Measurement Server	SE UPS 031 AA	1025	NCR	
SPEAG	Measurement Server	SE UMS 028 BB	1488	NCR	
SPEAG	Measurement Server	SE UMS 011 BB	1241	NCR	
SPEAG	Device Holder	N/A	N/A	NCR	
SPEAG	Phantom	ELI V5.0	1133	NCR	
SPEAG	Phantom	ELI V4.0	1036	NCR	
SPEAG	Phantom	ELI V5.0	1175	NCR	
SPEAG	5G Phantom	5G	OX-030	NCR	
SPEAG	Robot	Staubli TX90XL	F16/54FTA1/A/01	NCR	
SPEAG	Robot	Staubli TX90XL	F07/564ZA1/A/01	NCR	
SPEAG	Robot	Staubli TX90XL	F11/5G9EA1/A/01	NCR	
SPEAG	Software	cDASY6 V16.0.0.116	N/A	NCR	
SPEAG	Software	DASY52 V52.10.4.1535	N/A	NCR	
SPEAG	Software	SEMCAD X V14.6.14(7501)	N/A	NCR	
SPEAG	Network Analyzer	DAKS_VNA R140	0010318	May. 23, 2022	1 year
SPEAG	Dielectric Probe Kit	DAKS-3.5	1101	May. 23, 2022	1 year
HILA	Digital Thermometer	TM-906A	1500033	Nov. 03, 2022	1 year
Agilent	Power Sensor	8481H	3318A20779	May. 26, 2022	1 year
Agilent	Power Meter	EDM Series E4418B	GB40206143	May. 26, 2022	1 year
R&S	Power Sensor	NRP8S	111511	Nov. 29, 2022	1 year
R&S	Power Sensor	NRP8S	111512	Nov. 29, 2022	1 year
R&S	Power Sensor	NRP50S	101511	Nov. 29, 2022	1 year
Agilent	Signal Generator	E8257D	MY44320425	Feb. 15, 2022	1 year
Keysight	Spectrum Analyzer	N9010B	MY59071418	Mar. 16, 2022	1 year
Mini-Circuits	Dual Directional Coupler	ZCDC20-5R263-S+	E69806	NCR	
Mini-Circuits	Power Amplifier	EMC014225P	980292	NCR	
Mini-Circuits	Power Amplifier	EMC2830P	980293	NCR	
EMCI	Power Amplifier	EMC0618-P	980833	NCR	
Attenuator	INMET	18AH-03	S180301	NCR	
Attenuator	INMET	18AH-10	S181001	NCR	
Attenuator	INMET	18AH-20	S182001	NCR	

Testing Engineer: Ted hsieh / Rocky Wang / Gary Chao / Ryan Chen

8. Measurement Procedure

8.1 SAR Measurement Procedure

The measurement procedures are as follows:

1. The DUT is installed engineering testing software that provides continuous transmitting signal.
2. Measure output power through RF cable and power meter
3. Set scan area, grid size and other setting on the DASY software
4. Find out the largest SAR result on these testing positions of each band
5. Measure SAR results for other channels in worst SAR testing position if the 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:

1. Power reference measurement
2. Area scan
3. Zoom scan
4. Power drift measurement

8.1.1 Area & Zoom Scan Procedures

First Area Scan is used to locate the approximate location(s) of the local peak SAR value(s). The measurement grid within an Area Scan is defined by the grid extent, grid step size and grid offset. Next, in order to determine the EM field distribution in a three-dimensional spatial extension, Zoom Scan is required. The Zoom Scan measures points and step size follow as below. The Zoom Scan is performed around the highest E-field value to determine the averaged SAR-distribution.

The measure settings are referred to KDB 865664 D01v01r04 :

			≤ 3 GHz	> 3 GHz
Maximum distance from closest measurement point (geometric center of probe sensors) to phantom surface			5 mm ± 1 mm	½·δ·ln(2) mm ± 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.	
Maximum zoom scan spatial resolution: Δx_{Area}, Δy_{Area}			≤ 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	≤ 1.5·$\Delta z_{Zoom}(n-1)$ mm	
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 IEEE Std 1528-2013 for details. * When zoom scan is required and the reported SAR from the area scan based 1-g SAR estimation procedures of KDB Publication 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.				

8.1.2 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 1 g aggregate SAR, the DUT 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.

8.1.3 Power Drift Monitoring

All SAR testing is under the DUT 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 DUT 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.

8.1.4 Spatial Peak SAR Evaluation

The procedure for spatial peak SAR evaluation has been implemented according to the test standard. It can be conducted for 1 g and 10 g, 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 1 g and 10 g cubes with the highest averaged SAR values. For that purpose, the center of the measured volume is aligned to the interpolated peak SAR value of a previously performed area scan.
The entire evaluation of the spatial peak values is performed within the post-processing engine (SEMCAD). The system always gives the maximum values for the 1 g and 10 g cubes. The algorithm to find the cube with highest averaged SAR is divided into the following stages:

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

8.2 Power Density Measurement Procedure

8.2.1 Power Density Assessment Based on E-field

According to the IEEE/IEC 63195-1, within a short distance from the transmitting source, power density is determined based on both electric and magnetic fields. Generally, the magnitude and phase of two components of either the E-field or H-field are needed on a sufficiently large surface to fully characterize the total E-field and H-field distributions. The measurement points are chosen according to the requirements of the methodology used. The following procedure was used:

(1) Measure the E-field on the measurement surface at a reference location where the field is well above the noise level. This reference level will be used at the end of this procedure to assess output power drift of the DUT during the measurement.

(2) Scan the electric field on the measurement surface. The requirements of measurement surface dimensions and spatial resolution are dependent on the measurement system and assessment methodology applied. Measurements are therefore conducted according to the instructions provided by SPEAG user's mannual.

(3) Measurement spatial resolution can depend on the measured field characteristic and measurement methodology used by the system. Planar scanners typically require a step size of less than λ /2.

(4) Calculated H-field from measured field by using reconstruction algorithm since only E-field is directly measured on the evaluation surface. Reconstruction algorithms can also be used to obtain field information from the measured data. In substance, reconstruction algorithms are the set of algorithms, mathematical techniques and procedures that are applied to the measured field on the measurement surface to determine E- and H-field (amplitude and phase) on the evaluation surface.

(5) Determine the spatial-average power density distribution on the evaluation surface by the following formula. The spatial averaging area, A, is specified by the applicable exposure limits or regulatory requirements. The average area was specified according to regulatory requirements.

$$\mathbf{S_{av}} = \frac{\mathbf{1}}{\mathbf{2}A}\Re \cdot \left(\int \mathbf{E} \times \mathbf{H} \cdot \hat{\mathbf{n}}\, \mathbf{dA} \right)$$

(6) The maximum spatial-average and/or local power density on the evaluation surface is the final quantity to determine compliance against applicable limits. The spatial averaging area, $4cm^2$, is specified by the Oct. 2018 TCB Workshop notes requirements.

(7) Measure the E-field on the measurement surface position at the reference location chosen in step A). The power drift of the DUT is estimated as the difference between the squared amplitude of the field values taken in steps a) and g). When the drift is smaller than ± 5 %, this term should be considered in the uncertainty budget. Drifts larger than 5 % due to the design and operating characteristics of the device should be accounted for or addressed according to regulatory requirements to determine compliance.

8.2.2 Total Field and Power Density Reconstruction

Computation of the power density in general requires knowledge of the electric (E-) and magnetic (H-) field amplitudes and phases in the plane of incidence. Reconstruction of these quantities from pseudo-vector E-field measurements is feasible, as they are constrained by Maxwell's equations. The manufacturer SPEAG have developed a reconstruction approach based on the Gerchberg-Saxton algorithm, which benefits from the availability of the E-field polarization ellipse information obtained with the EUmmWV3 probe. This reconstruction algorithm, together with the ability of the probe to measure extremely close to the source without perturbing the field, permits reconstruction of the E- and H-fields, as well as of the power density, on measurement planes located as near as λ/5 away.

9. Measurement Uncertainty

9.1 SAR Measurement Uncertainty

Measurement Uncertainty (0.3-3 GHz)								
Uncertainty Component	**Tol.**	**Prob. Dist.**	**Div.**	**Ci - 1g**	**Ci - 10g**	**ui - 1g (%)**	**ui - 10g (%)**	**vi**
Measurement System								
Probe calibration	12.0	N	2	1	1	6.0	6.0	∞
Probe Calibration Drift	1.7	R	1.732	1	1	1.0	1.0	∞
Other Probe+Electronic	0.7	N	1	1	1	0.7	0.7	∞
Probe Linearity	4.7	R	1.732	1	1	2.7	2.7	∞
Broadband Signal	3.0	R	1.732	1	1	1.7	1.7	∞
Probe Isotropy	7.6	R	1.732	1	1	4.4	4.4	∞
RF Ambient	1.8	N	1	1	1	1.8	1.8	∞
Probe Positioning	0.006 mm	N	1	0.14	0.14	0.1	0.1	∞
Data Processing	1.2	N	1	1	1	1.2	1.2	∞
Phantom and Device Errors								
Conductivity (meas.)DAK	2.5	N	1	0.78	0.71	2.0	1.8	∞
Conductivity (temp.)	3.3	R	1.732	0.78	0.71	1.5	1.4	∞
Phantom Shell Permittivity	14	R	1.732	0	0	0.0	0.0	∞
Distance DUT - TSL	2	N	1	2	2	4.0	4.0	∞
Device Positioning	1	N	1	1	1	1.0	1.0	∞
Device Holder	3.6	N	1	1	1	3.6	3.6	∞
DUT Modulation	2.4	R	1.732	1	1	1.4	1.4	∞
Time-average SAR	1.7	R	1.732	1	1	1.0	1.0	∞
DUT Drift	2.5	N	1	1	1	2.5	2.5	∞
Correction to the SAR Results								
Deviation to Target	1.9	N	1	1	0.84	1.9	1.6	∞
SAR scaling	0.0	R	1.732	1	1	0.0	0.0	∞
Combined Standard Uncertainty					RSS	11.0	10.9	
Expanded Uncertainty (95% confidence interval)					k =2	21.9	21.7	

Measurement Uncertainty (3-6 GHz)								
Uncertainty Component	**Tol.**	**Prob. Dist.**	**Div.**	**Ci - 1g**	**Ci - 10g**	**ui - 1g (%)**	**ui - 10g (%)**	**vi**
Measurement System								
Probe Calibration	13.1	N	2	1	1	6.55	6.55	∞
Probe Calibration Drift	1.7	R	1.732	1	1	1.0	1.0	∞
Other Probe+Electronic	1.2	N	1	1	1	1.2	1.2	∞
Probe Linearity	4.7	R	1.732	1	1	2.7	2.7	∞
Broadband Signal	2.6	R	1.732	1	1	1.5	1.5	∞
Probe Isotropy	7.6	R	1.732	1	1	4.4	4.4	∞
RF Ambient	1.8	N	1	1	1	1.8	1.8	∞
Probe Positioning	0.005 mm	N	1	0.29	0.29	0.15	0.15	∞
Data Processing	2.3	N	1	1	1	2.3	2.3	∞
Phantom and Device Errors								
Conductivity (meas.)DAK	2.5	N	1	0.78	0.71	2.0	1.8	∞
Conductivity (temp.)	3.4	R	1.732	0.78	0.71	1.5	1.4	∞
Phantom Shell Permittivity	14	R	1.732	0.25	0.25	2.0	2.0	∞
Distance DUT - TSL	2	N	1	2	2	4.0	4.0	∞
Device Positioning	1	N	1	1	1	1.0	1.0	∞
Device Holder	3.6	N	1	1	1	3.6	3.6	∞
DUT Modulation	2.4	R	1.732	1	1	1.4	1.4	∞
Time-average SAR	1.7	R	1.732	1	1	1.0	1.0	∞
DUT Drift	2.5	N	1	1	1	2.5	2.5	∞
Correction to the SAR Results								
Deviation to Target	1.9	N	1	1	0.84	1.9	1.6	∞
SAR scaling	0.0	R	1.732	1	1	0.0	0.0	∞
Combined Standard Uncertainty					RSS	11.6	11.6	
Expanded Uncertainty (95% confidence interval)					k =2	23.2	23.0	

Measurement Uncertainty (6-10 GHz)								
Uncertainty Component	**Tol.**	**Prob. Dist.**	**Div.**	**Ci - 1g**	**Ci - 10g**	**ui - 1g (%)**	**ui - 10g (%)**	**vi**
Measurement System								
Probe calibration	18.6	N	2	1	1	9.3	9.3	∞
Probe Calibration Drift	1.7	R	1.732	1	1	1.0	1.0	∞
Other Probe+Electronic	2.4	N	1	1	1	2.4	2.4	∞
Probe Linearity	4.7	R	1.732	1	1	2.7	2.7	∞
Broadband Signal	2.8	R	1.732	1	1	1.6	1.6	∞
Probe Isotropy	7.6	R	1.732	1	1	4.4	4.4	∞
RF Ambient Condition	1.8	N	1	1	1	1.8	1.8	∞
Probe Positioning	0.005mm	N	1	0.50	0.50	0.25	0.25	∞
Data Processing	3.5	N	1	1	1	3.5	3.5	∞
Phantom and Device Errors								
Conductivity (meas.)DAK	2.5	N	1	0.78	0.71	2.0	1.8	∞
Conductivity (temp.)	2.4	R	1.732	0.78	0.71	1.1	1.0	∞
Phantom Shell Permittivity	14.0	R	1.732	0.5	0.5	4.0	4.0	∞
Distance DUT - TSL	2	N	1	2	2	4.0	4.0	∞
Device Positioning	1	N	1	1	1	1.0	1.0	∞
Device Holder	3.6	N	1	1	1	3.6	3.6	∞
DUT Modulation	2.4	R	1.732	1	1	1.4	1.4	∞
Time-average SAR	1.7	R	1.732	1	1	1.0	1.0	∞
DUT Drift	2.5	N	1	1	1	2.5	2.5	∞
Correction to the SAR Results								
Deviation to Target	1.9	N	1	1	0.84	1.9	1.6	∞
SAR scaling	0.0	R	1.732	1	1	0.0	0.0	∞
Combined Standard Uncertainty					RSS	14.2	14.1	
Expanded Uncertainty (95% confidence interval)					k =2	28.4	28.3	

9.2 Power Density Measurement Uncertainty

Measurement Uncertainty for PD						
Error Description	**Uncertainty Value (± dB)**	**Prob Dist.**	**Div.**	**(C_i)**	**Standard Uncertainty (± dB)**	**V_{if}**
Measurement System						
Probe calibration	0.49	N	1	1	0.49	∞
Isotropy	0.50	R	1.732	1	0.29	∞
System Linearity	0.20	R	1.732	1	0.12	∞
System Detectection Limit	0.04	R	1.732	1	0.02	∞
Amplitude and phase noise	0.04	R	1.732	1	0.02	∞
Data Acquisition	0.03	N	1	1	0.03	∞
Probe Positioning Repeatability	0.04	R	1.732	1	0.02	∞
Probe Positioning Offset	0.30	R	1.732	1	0.17	∞
Field Reconstruction	0.60	R	1.732	1	0.35	∞
Test Sample Related						
Power Drift of Measurement	0.21	R	1.732	1	0.12	∞
Modulation Response	0.40	R	1.732	1	0.23	∞
Integration Time	0	R	1.732	1	0	∞
Response Time	0	R	1.732	1	0	∞
RF Ambient Noise	0.04	R	1.732	1	0.02	∞
RF Ambient Reflection	0.04	R	1.732	1	0.02	∞
Combined Std. Uncertainty					0.76	
Expanded Std. Uncertainty (K=2)					1.52	

10. Measurement Evaluation

10.1 Positioning of the DUT in Relation to the Phantom

According to KDB 616217 D04:

1. 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.
2. Some 2-in-1 tablets may operate with the display folded on top of the keyboard. Most recent tablets are designed with an interactive display that may not require a physical keyboard. Both configurations are used in similar manners and require SAR evaluation for the back surface and edges of the tablet. For keyboards that can be unfolded like a laptop, the procedures for laptop platform should also be applied.

10.2 SAR Testing with RF Transmitter

10.2.1 SAR Testing with WLAN

A Wi-Fi device must be configured to transmit continuously at the required data rate, channel bandwidth and signal modulation, using the highest transmission duty factor supported by the test mode tools for SAR measurement. The test frequencies established using test mode must correspond to the actualchannel frequencies.
For WLAN SAR testing, the DUT has installed WLAN engineering testing software which can provide continuous transmitting RF signal. And the RF signal utilized in SAR measurement has almost 100 % duty cycle and crest factor is 1.

- The card was operated utilizing proprietary software (QATool Dbg) and each channel was measured using a broadband power meter to determine the maximum average power.

SAR test reduction for 802.11 Wi-Fi transmission mode configurations are considered separately for DSSS and OFDM. An initial test position is determined to reduce the number of tests required for certain exposure configurations with multiple test positions. An initial test configuration is determined for each frequency band and aggregated band according to maximum output power, channel bandwidth, wireless mode configurations and other operating parameters to streamline the measurement requirements. For 2.4 GHz DSSS, either the initial test position or DSSS procedure is applied to reduce the number of SAR tests; these are mutually exclusive. For OFDM, an initial test position is only applicable to next to the ear, UMPC mini-tablet and hotspot mode configurations, which is tested using the initial test configuration to facilitate test reduction. For other exposure conditions with a fixed test position, SAR test reduction is determined using only the initial test configuration.

The multiple test positions require SAR measurements in head, hotspot mode or UMPC mini-tablet configurations may be reduced according to the highest reported SAR determined using the initial test position(s) by applying the DSSS or OFDM SAR measurement procedures in the required wireless mode test configuration(s). The initial test position(s) is measured using the highest measured maximum output power channel in the required wireless mode test configuration(s). When the reported SAR for 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 wireless mode combination within the frequency band or aggregated band. DSSS and OFDM configurations are considered separately according to the required SAR procedures.
- > 0.4 W/kg, SAR is repeated using the same wireless mode test 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 reported SAR is ≤ 0.8 W/kg or all required test positions are tested.

※ For subsequent test positions with equivalent test separation distance or when exposure is dominated by coupling conditions, the position for maximum coupling condition should be tested.
※ When it is unclear, all equivalent conditions must be tested.

- For all positions/configurations tested using the initial test position and subsequent test positions, when the reported SAR is > 0.8 W/kg, measure the SAR for these positions/configurations on the subsequent next highest measured output power channel(s) until the reported SAR is ≤ 1.2 W/kg or all required test channels are considered.

※ The additional power measurements required for this step should be limited to those necessary for identifying subsequent highest output power channels to apply the test reduction.

- When the specified maximum output power is the same for both UNII 1 and UNII 2A, begin SAR measurements in UNII 2A with the channel with the highest measured output power. If the reported SAR for UNII 2A is ≤ 1.2 W/kg, SAR is not required for UNII 1; otherwise treat the remaining bands separately and test them independently for SAR.

- When the specified maximum output power is different between UNII 1 and UNII 2A, begin SAR with the band that has the higher specified maximum output. If the highest reported SAR for the band with the highest specified power is ≤ 1.2 W/kg, testing for the band with the lower specified output power is not required; otherwise test the remaining bands independently for SAR.

To determine the initial test position, Area Scans were performed to determine the position with the Maximum Value of SAR (measured). The position that produced the highest Maximum Value of SAR is considered as the worst case position; thus used as the initial test position.

- After an initial test configuration is determined, if multiple test channels have the same measured maximum output power, the channel chosen for SAR measurement is determined according to the following:
  (1) The channel closest to mid-band frequency is selected for SAR measurement.
  (2) For channels with equal separation from mid-band frequency; for example, high and low channels or two mid-band channels, the higher frequency (number) channel is selected for SAR measurement.
  These channel selection procedures apply to both the initial test configuration and subsequent test configuration(s) selection.

< U-NII 6-7 GHz SAR Testing Consideration>

WIFI6E SAR and Power Density measurements were implemented according to the U-NII 6-7 GHz Interim Procedures described in Oct. 2020 TCB workshop.

- A minimum of 5 test channels across full 5925 to 7125 MHz band were used.
- The SAR evaluations using 6-7 GHz parameters were perfomed per IEC/IEEE 62209-1528, and the Absorbed Power Density (APD) were reported based on SAR measurements.
  According to DASY Application Note, the APD is evaluated numerically using the FDTD method of Sim4Life V5.2. For comparison with the basic restrictions, the APD is averaged over square surface areas of 1 cm^2 and 4 cm^2 in the lowermost voxel layer of a flat phantom at a frequency of 6.5 GHz. The phantom consists of a dielectric shell of 2 mm thickness and a relative permittivity ε_r = 3.7. It is filled with a tissue-simulating liquid with ε_r = 34.5 and σ = 6.07 S/m.

10.3 Conducted Power Measurements

Refer to Appendix A.

10.4 Antenna location

Refer to Appendix E.

10.5 Test Results

10.5.1 SAR Test Result

Index.	Band	Modulation	Channel	Frequency (MHz)	Test Position	Spacing (mm)	SAR_{1g} (W/kg)	Meas. Conducted Power (dBm)	Tune-up (dBm)	Duty Cycle (%)	Reported SAR_{1g} (W/kg)	Antenna	Antenna Manufacturer
	WLAN 2.4 GHz	802.11b	1	2412	Bottom of laptop	0	0.859	14.61	15.5	99.56	1.06	ANT Main	LUXSHARE-ICT
10	WLAN 2.4 GHz	802.11b	6	2437	Bottom of laptop	0	0.886	14.59	15.5	99.56	1.10	ANT Main	LUXSHARE-ICT
	WLAN 2.4 GHz	802.11b	6	2437	Bottom of laptop	0	0.882	14.59	15.5	99.56	1.09	ANT Main	INPAQ
	WLAN 2.4 GHz	802.11b	11	2462	Bottom of laptop	0	0.868	14.58	15.5	99.56	1.08	ANT Main	LUXSHARE-ICT
	WLAN 2.4 GHz	802.11b	12	2467	Bottom of laptop	0	0.887	14.71	15.5	99.56	1.07	ANT Main	LUXSHARE-ICT
	WLAN 2.4 GHz	802.11b	13	2472	Bottom of laptop	0	0.904	14.73	15.5	99.56	1.08	ANT Main	LUXSHARE-ICT
	WLAN 2.4 GHz	802.11b	1	2412	Bottom of laptop	0	0.616	14.55	15.5	99.37	0.77	ANT Aux	LUXSHARE-ICT
	WLAN 2.4 GHz	802.11b	6	2437	Bottom of laptop	0	0.579	14.52	15.5	99.37	0.73	ANT Aux	LUXSHARE-ICT
	WLAN 2.4 GHz	802.11b	11	2462	Bottom of laptop	0	0.7	14.54	15.5	99.37	0.88	ANT Aux	LUXSHARE-ICT
	WLAN 2.4 GHz	802.11b	12	2467	Bottom of laptop	0	0.808	14.65	15.5	99.37	0.99	ANT Aux	LUXSHARE-ICT
11	WLAN 2.4 GHz	802.11b	13	2472	Bottom of laptop	0	0.873	14.76	15.5	99.37	1.04	ANT Aux	LUXSHARE-ICT
	WLAN 2.4 GHz	802.11b	13	2472	Bottom of laptop	0	0.853	14.76	15.5	99.37	1.02	ANT Aux	INPAQ
	Bluetooth	GFSK	0	2402	Bottom of laptop	0	0.391	13.25	13.5	77.33	0.54	ANT Main	LUXSHARE-ICT
	Bluetooth	GFSK	39	2441	Bottom of laptop	0	0.456	13.23	13.5	77.33	0.63	ANT Main	LUXSHARE-ICT
12	Bluetooth	GFSK	78	2480	Bottom of laptop	0	0.468	13.24	13.5	77.33	0.64	ANT Main	LUXSHARE-ICT
	Bluetooth	GFSK	78	2480	Bottom of laptop	0	0.457	13.24	13.5	77.33	0.63	ANT Main	INPAQ
	Bluetooth	GFSK	0	2402	Bottom of laptop	0	0.274	13.14	13.5	76.51	0.39	ANT Aux	LUXSHARE-ICT
13	Bluetooth	GFSK	39	2441	Bottom of laptop	0	0.334	13.12	13.5	76.51	0.48	ANT Aux	LUXSHARE-ICT
	Bluetooth	GFSK	39	2441	Bottom of laptop	0	0.328	13.12	13.5	76.51	0.47	ANT Aux	INPAQ
	Bluetooth	GFSK	78	2480	Bottom of laptop	0	0.263	13.08	13.5	76.51	0.38	ANT Aux	LUXSHARE-ICT
	WLAN 5 GHz	802.11ac VHT160	50	5250	Bottom of laptop	0	0.694	11.94	12.5	93.75	0.84	ANT Main	LUXSHARE-ICT
1	WLAN 5 GHz	802.11ac VHT80	58	5290	Bottom of laptop	0	0.708	11.63	12.5	92.50	0.94	ANT Main	LUXSHARE-ICT
	WLAN 5 GHz	802.11ac VHT80	58	5290	Bottom of laptop	0	0.687	11.63	12.5	92.50	0.91	ANT Main	INPAQ
	WLAN 5 GHz	802.11ac VHT160	50	5250	Bottom of laptop	0	0.495	11.87	12.5	92.31	0.62	ANT Aux	LUXSHARE-ICT
2	WLAN 5 GHz	802.11ac VHT80	58	5290	Bottom of laptop	0	0.795	11.51	12.5	92.50	1.08	ANT Aux	LUXSHARE-ICT
	WLAN 5 GHz	802.11ac VHT80	58	5290	Bottom of laptop	0	0.765	11.51	12.5	92.50	1.04	ANT Aux	INPAQ
3	WLAN 5 GHz	802.11ac VHT160	114	5570	Bottom of laptop	0	0.881	10.89	11.5	93.75	1.08	ANT Main	LUXSHARE-ICT
	WLAN 5 GHz	802.11ac VHT160	114	5570	Bottom of laptop	0	0.849	10.89	11.5	93.75	1.04	ANT Main	INPAQ
	WLAN 5 GHz	802.11ac VHT80	138	5690	Bottom of laptop	0	0.694	10.75	11.5	92.50	0.89	ANT Main	LUXSHARE-ICT
	WLAN 5 GHz	802.11ac VHT160	114	5570	Bottom of laptop	0	0.471	10.84	11.5	92.31	0.59	ANT Aux	LUXSHARE-ICT
4	WLAN 5 GHz	802.11ac VHT80	138	5690	Bottom of laptop	0	0.482	10.72	11.5	92.50	0.62	ANT Aux	LUXSHARE-ICT
	WLAN 5 GHz	802.11ac VHT80	138	5690	Bottom of laptop	0	0.474	10.72	11.5	92.50	0.61	ANT Aux	INPAQ
6	WLAN 5 GHz	802.11ac VHT160	163	5815	Bottom of laptop	0	0.78	11.69	12.5	93.75	1.00	ANT Main	LUXSHARE-ICT
	WLAN 5 GHz	802.11ac VHT160	163	5815	Bottom of laptop	0	0.765	11.69	12.5	93.75	0.98	ANT Main	INPAQ
	WLAN 5 GHz	802.11ac VHT80	171	5855	Bottom of laptop	0	0.706	11.85	12.5	92.50	0.89	ANT Main	LUXSHARE-ICT
7	WLAN 5 GHz	802.11ac VHT160	163	5815	Bottom of laptop	0	0.635	11.64	12.5	92.31	0.84	ANT Aux	LUXSHARE-ICT
	WLAN 5 GHz	802.11ac VHT160	163	5815	Bottom of laptop	0	0.627	11.64	12.5	92.31	0.83	ANT Aux	INPAQ
	WLAN 5 GHz	802.11ac VHT80	171	5855	Bottom of laptop	0	0.541	11.81	12.5	92.50	0.69	ANT Aux	LUXSHARE-ICT

Index.	Band	Modulation	Channel	Frequency (MHz)	Test Position	Spacing (mm)	SAR_{1g} (W/kg)	Meas. Conducted Power (dBm)	Tune-up (dBm)	Duty Cycle (%)	Reported SAR_{1g} (W/kg)	Antenna	APD W/m^2 ($4cm^2$)	Reported APD W/m^2 ($4cm^2$)	Antenna Manufacturer
100	WLAN 6 GHz	802.11ax HE160	79	6345	Bottom of laptop	0	0.504	9.19	9.5	94.44	0.57	ANT Main	3.48	3.96	LUXSHARE-ICT
101	WLAN 6 GHz	802.11ax HE160	15	6025	Bottom of laptop	0	0.333	9.04	9.5	94.44	0.39	ANT Main	2.41	2.84	LUXSHARE-ICT
102	WLAN 6 GHz	802.11ax HE160	111	6505	Bottom of laptop	0	0.675	9.15	9.5	94.44	0.77	ANT Main	4.57	5.25	LUXSHARE-ICT
103	WLAN 6 GHz	802.11ax HE160	143	6665	Bottom of laptop	0	0.683	9.16	9.5	94.44	0.78	ANT Main	4.53	5.19	LUXSHARE-ICT
	WLAN 6 GHz	802.11ax HE160	143	6665	Bottom of laptop	0	0.598	9.16	9.5	94.44	0.68	ANT Main	4.22	4.83	INPAQ
104	WLAN 6 GHz	802.11ax HE160	207	6985	Bottom of laptop	0	0.519	9.17	9.5	94.44	0.59	ANT Main	3.36	3.84	LUXSHARE-ICT
105	WLAN 6 GHz	802.11ax HE160	15	6025	Bottom of laptop	0	0.347	9.21	9.5	94.28	0.39	ANT Aux	2.37	2.69	LUXSHARE-ICT
	WLAN 6 GHz	802.11ax HE160	15	6025	Bottom of laptop	0	0.301	9.21	9.5	94.28	0.34	ANT Aux	3.01	3.41	INPAQ
106	WLAN 6 GHz	802.11ax HE160	79	6345	Bottom of laptop	0	0.299	9.09	9.5	94.28	0.35	ANT Aux	2.96	2.05	LUXSHARE-ICT
107	WLAN 6 GHz	802.11ax HE160	111	6505	Bottom of laptop	0	0.292	8.87	9.5	94.28	0.36	ANT Aux	2.17	2.66	LUXSHARE-ICT
108	WLAN 6 GHz	802.11ax HE160	175	6825	Bottom of laptop	0	0.3	9.06	9.5	94.28	0.35	ANT Aux	2.04	2.40	LUXSHARE-ICT
109	WLAN 6 GHz	802.11ax HE160	207	6985	Bottom of laptop	0	0.303	8.84	9.5	94.28	0.37	ANT Aux	2.11	2.61	LUXSHARE-ICT

10.5.2 Power Density Test Result

Index.	Band	Modulation	Channel	Frequency (MHz)	Test Position	Spacing (mm)	sPDn 4 cm² (W/m²)	sPDtot 4 cm² (W/m²)	E peak (V/m)	H peak (A/m)	Power Drift	Date	Meas. Conducted Power (dBm)	Tune-up (dBm)	Duty Cycle (%)	Scaling sPDn 4 cm² (W/m²)	Scaling sPDtot 4 cm² (W/m²)	Antenna	Date
110	WLAN 6 GHz	802.11ax HE160	79	6345	Bottom of laptop	2	2.25	5.13	85.3	0.637	-0.07	2023/1/19	9.19	9.5	94.44	2.56	5.83	Ant Main	2023/1/19
111	WLAN 6 GHz	802.11ax HE160	15	6025	Bottom of laptop	2	1.47	3.35	72.9	0.601	-0.1	2023/1/19	9.04	9.5	94.44	1.73	3.94	Ant Main	2023/1/19
112	WLAN 6 GHz	802.11ax HE160	111	6505	Bottom of laptop	2	2.26	4.89	83.3	0.567	-0.03	2023/1/19	9.15	9.5	94.44	2.59	5.61	Ant Main	2023/1/19
113	WLAN 6 GHz	802.11ax HE160	143	6665	Bottom of laptop	2	1.76	4.75	90.2	0.445	-0.1	2023/1/19	9.16	9.5	94.44	2.02	5.44	Ant Main	2023/1/19
114	WLAN 6 GHz	802.11ax HE160	207	6985	Bottom of laptop	2	1.29	3.19	77.5	0.431	-0.02	2023/1/19	9.17	9.5	94.44	1.47	3.64	Ant Main	2023/1/19
115	WLAN 6 GHz	802.11ax HE160	15	6025	Bottom of laptop	2	1.82	4.82	61.3	0.495	0.03	2023/1/19	9.21	9.5	94.28	2.06	5.47	Ant Aux	2023/1/19
116	WLAN 6 GHz	802.11ax HE160	79	6345	Bottom of laptop	2	1.72	4.06	58.9	0.369	-0.05	2023/1/19	9.09	9.5	94.28	2.01	4.73	Ant Aux	2023/1/19
117	WLAN 6 GHz	802.11ax HE160	111	6505	Bottom of laptop	2	1.19	2.61	53.2	0.419	0	2023/1/19	8.87	9.5	94.28	1.46	3.20	Ant Aux	2023/1/19
118	WLAN 6 GHz	802.11ax HE160	175	6825	Bottom of laptop	2	0.807	2.09	46.3	0.383	-0.07	2023/1/19	9.06	9.5	94.28	0.95	2.45	Ant Aux	2023/1/19
119	WLAN 6 GHz	802.11ax HE160	207	6985	Bottom of laptop	2	1.03	2.43	51.1	0.356	0.06	2023/1/19	8.84	9.5	94.28	1.27	3.00	Ant Aux	2023/1/19

Note:

1. The test spacing is the distance between probe sensor and DUT surface.
2. The test duty cycle was approached 100 % to facilitate test measurements only. It was confirmed by the manufacturer that the device was not over driven at this test duty cycle, to facilitate linear scaling in the test report.
3. 1.0 W/m^2 = 0.1 mW/cm^2.

10.6 SAR Measurement Variability

According to KDB 865664 D01v01r04, 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. When both head and body tissue-equivalent media are required for SAR measurements in a frequency band, the variability measurement procedures should be applied to the tissue medium with the highest measured SAR, using the highest measured SAR configuration for that tissue-equivalent medium.

The following procedures are applied to determine if repeated measurements are required:

1. The original highest measured Reported SAR 1-g is ≧ 0.80 W/kg, repeated that measurement once.
2. Perform a second repeated measurement the ratio of the largest to the smallest SAR for the original and first repeated measurements is <1.2 W/kg, or when the original or repeated measurement is ≧ 1.45 W/kg (~10% from the 1-g SAR limit).

Index	Band	Modulation	Channel	Frequency (MHz)	Test Position	Spacing (mm)	Note	Original SAR_{1g} (W/kg)	First SAR_{1g} (W/kg)	First Ratio SAR_{1g}	Original SAR_{10g} (W/kg)	First SAR_{10g} (W/kg)	First Ratio SAR_{10g}
10	WLAN 2.4 GHz	802.11b	6	2437	Bottom of laptop	0	Index. #10_once	0.886	0.878	0.90%	0.316	0.312	1.27%
11	WLAN 2.4 GHz	802.11b	13	2472	Bottom of laptop	0	Index. #11_once	0.873	0.869	0.46%	0.315	0.313	0.63%
3	WLAN 5 GHz	802.11ac VHT160	114	5570	Bottom of laptop	0	Index. #3_once	0.881	0.871	1.14%	0.242	0.236	2.48%

10.7 Simultaneous Transmission Evaluation

10.7.1 Simultaneous Transmission Configurations

Condition(s)	Band					
	WLAN 5 GHz ANT Main	WLAN 5 GHz ANT Aux	WLAN 6 GHz ANT Main	WLAN 6 GHz ANT Aux	Bluetooth ANT Main	Bluetooth ANT Aux
1	V	-	-	-	-	V
2	-	V	-	-	V	-
3	-	-	V	-	-	V
4	-	-	-	V	V	-

<Total Exposure Ratio (TER)>

According to IEC TR 63170 and TCBC workshop, total Exposure Ratio (TER) is calculated by taking ratio of reported SAR divided by SAR limit and adding it to measured power density divided by power density limit.

$$\text{TER} = \sum_{n=1}^{N} \frac{SAR_n}{SAR_n\,,\ limit} + \sum_{m=1}^{M} \frac{S_{m,avg}}{S_{lim}\,,\ limit} < 1$$

Numerical sum of the two ratios should be less than 1.

The worst-case power density results for each test configuration among all antenna arrays were considered for Total Exposure Ratio (TER) analysis. The sum of TER were listed in the following subclause.

10.7.2 Simultaneous Transmission Result

When the sum of SAR_{1g} of all simultaneously transmitting antennas in an operating mode and exposure condition combination is within the SAR limit, SAR test exclusion applies to that simultaneous transmission configuration.

The sum of SAR_{1g} results and TER results are shown as below.

<Sum of SAR_{1g} Results>

Exposure Position	1	2	3	4	5	6	7	8	3+8	4+7	5+8	6+7
	WLAN 2.4 GHz ANT Main	WLAN 2.4 GHz ANT Aux	WLAN 5 GHz ANT Main	WLAN 5 GHz ANT Aux	WLAN 6 GHz ANT Main	WLAN 6 GHz ANT Aux	Bluetooth ANT Main	Bluetooth ANT Aux	$\sum SAR_{1g}$ (W/kg)	$\sum SAR_{1g}$ (W/kg)	$\sum SAR_{1g}$ (W/kg)	$\sum SAR_{1g}$ (W/kg)
	SAR_{1g} (W/kg)	SAR_{1g} (W/kg)	SAR_{1g} (W/kg)	SAR_{1g} (W/kg)	SAR_{1g} (W/kg)	SAR_{1g} (W/kg)	SAR_{1g} (W/kg)	SAR_{1g} (W/kg)				
Bottom of laptop at 0 mm	1.10	1.04	1.08	1.08	0.78	0.39	0.64	0.48	1.56	1.72	1.26	1.03

<Total Exposure Ratio (TER) Results>

Exposure Position	9	10	11	12	9+12	10+11
	WLAN 6 GHz ANT Main	WLAN 6 GHz ANT Aux	Bluetooth ANT Main	Bluetooth ANT Aux	Total Exposure Ratio	Total Exposure Ratio
	Total PD (W/m^2)	Total PD (W/m^2)	SAR_{1g} (W/kg)	1g SAR (W/kg)		
Bottom Face at 2 mm	5.83	5.47	0.64	0.48	0.88	0.95

Note: 1.0 W/m^2 = 0.1 mW/cm^2.

10.7.3 SAR to peak location separation (SPLSR)

According to KDB 447498, when the sum of SAR is greater than the limit, SAR test exclusion is determined by the SAR to peak location separation ratio (SPLSR), and the simultaneously transmitting antennas must be considered one pair at a time. The ratio is determined by **(SAR1+SAR2)$^{1.5}$ / (separation distance between the peak SAR locations for the antenna pair, mm)**, round to two decimal digits, and must be ≦ 0.04 for all antenna pairs in the configuration to qualify for 1-g SAR test exclusion.

The Hybrid SPLSR procedure in Nov. 2019 TCB workshop and the guidance in Apr. 2022 TCB workshop were applied to the circumstance that simultaneous transmission SAR is > 1.6 W/kg and antenna pair is co-located.

WLAN 5 GHz ANT Aux + Bluetooth ANT Main					
Index.			2	+	12
Band	Modulation	Frequency (MHz)	Test Position	Antenna	Peak location separation ratio
WLAN 5 GHz	802.11ac VHT80	5290	Bottom of laptop	ANT Aux	0.01
Bluetooth	GFSK	2480	Bottom of laptop	ANT Main	
Reported SAR1 g (W/kg)	∑ Reported $SAR_{1 g}$ (W/Kg)	X (mm)	Y (mm)	Z (mm)	Antenna pair (mm)
1.08	1.72	-62.80	-164.60	-1.83	332.23
0.64		-66.00	167.60	1.04	

10.8 Requirements on the Uncertainty Evaluation

10.8.1 SAR Uncertainty Evaluation

Decision Rule

■ Uncertainty is not included.

☐ Uncertainty is included.

The highest measured 1-g SAR is less than 1.5 W/kg and the highest measured 10-g SAR is less than 3.75 W/kg. Therefore, per KDB Publication 865664 D01, the extended measurement uncertainty analysis described in IEEE 1528-2013 and IEC/IEEE 62209-1528 is not required.

10.8.2 Power Density Uncertainty Evaluation

Decision Rule

■ Uncertainty is not included.

☐ Uncertainty is included.

According to IEC/IEEE 63195, if the total uncertainty exceeds 2 dB, the measurement results must be adjusted according to IEC 62479. The total measurement uncertainty for DASY system is 1.51 dB. Therefore, the adjustment is not required.

11. Conclusion

The SAR test values and PD test values found for the device are separately below the maximum limit of 1.6 W/kg and 1.0 mW/cm^2.

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