Time-averaged SAR Validation Report

Report No.	:	**SFBARR-WTW-P23040352A**
Applicant	:	**MediaTek Inc.**
Address	:	**No. 1, Dusing 1st Rd., Hsinchu Science Park Hsinchu City 30078, Taiwan**
Product	:	**2TX 11be (WiFi7) BW160 + BT/BLE Combo Card**
FCC ID	:	**RAS-MT7925B22M**
Brand	:	**MediaTek**
Model No.	:	**MT7925B22M**
FCC Rule Part	:	**CFR §2.1093**
Standards	:	**IEEE Std 1528:2013, IEC TR 63170:2018, KDB 865664 D01 v01r04, KDB 865664 D02 v01r02, KDB 248227 D01 v02r02, KDB 447498 D01 v06 , KDB 616217 D04 v01r02**
Lab Address	:	**No. 47-2, 14th Ling, Chia Pau Vil., Lin Kou Dist., New Taipei City, Taiwan**
Test Location	:	**No. 19, Hwa Ya 2nd Rd., Wen Hwa Vil., Kwei Shan Dist., Taoyuan City, Taiwan**

CERTIFICATION: The above equipment have been tested by **Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch–Lin Kou Laboratories**, and found compliance with the requirement of the above standards. The test record, data evaluation & Equipment Under Test (EUT) configurations represented herein are true and accurate accounts of the measurements of the sample's SAR characteristics under the conditions specified in this report. It should not be reproduced except in full, without the written approval of our laboratory. The client should not use it to claim product certification, approval, or endorsement by TAF or any government agencies.

This report is issued as a supplementary report to BV CPS report no.: SFBARR-WTW-P23040352. The differences compared with original report is enable TAS algorithm to demonstrate the compliance.

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Approved By : Gordon Lin

Gordon Lin / Manager

ilac-MRA TAF Testing Laboratory 2021

FCC Accredited No.: TW0003

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Release Control Record

Report No.	Reason for Change	Date Issued
SFBARR-WTW-P23040352A	Initial release	Feb. 07, 2024

1. Description of Equipment Under Test

EUT Type	2TX 11BE (WIFI7) BW160 + BT/BLE Combo Card
FCC ID	RAS-MT7925B22M
Brand Name	MediaTek
Model Name	MT7925B22M
Tx Frequency Bands (Unit: MHz)	WLAN : 2412 ~ 2472, 5180 ~ 5320, 5500 ~ 5720, 5745 ~ 5895, 5925 ~ 6425, 6425 ~ 6525, 6525 ~ 6875, 6875 ~ 7125 Bluetooth : 2402 ~ 2480
Uplink Modulations	802.11b : DSSS 802.11a/g/n/ac : OFDM 802.11ax : OFDMA 802.11be : OFDMA Bluetooth : GFSK, π/4-DQPSK, 8DPSK
Antenna Type	Refer to Note as below
EUT Stage	Engineering Sample

Note:

1. The following antennas were provided to the EUT.

Ant. No.	RF Chain No.	Brand	Model	Antenna Net Gain (dBi)	Frequency range	Antenna Type	Connector Type
1	Chain0	PSA	RFMTA340718EML B302	3.18 4.92	2.4~2.4835GHz 5.15~5.895GHz	PIFA	i-pex (MHF)
	Chain1	PSA	RFMTA340718EML B302	3.18 4.92	2.4~2.4835GHz 5.15~5.895GHz	PIFA	i-pex (MHF)
2	Chain0	PSA	RFMTA311020EMM B301	1.71 4.82 4.76 4.29 4.61 4.09	2.4~2.4835GHz 5.15~5.895GHz 5.925~6.425GHz 6.425~6.525GHz 6.525~6.875GHz 6.875~7.125GHz	PIFA	i-pex (MHF)
	Chain1	PSA	RFMTA311020EMM B301	1.71 4.82 4.76 4.29 4.61 4.09	2.4~2.4835GHz 5.15~5.895GHz 5.925~6.425GHz 6.425~6.525GHz 6.525~6.875GHz 6.875~7.125GHz	PIFA	i-pex (MHF)
3	Chain0	PSA	RFMTA421230IMM B701	-13.92 -13.91 -13.91 -14.46	5.925~6.425 GHz 6.425~6.525 GHz 6.525~6.875 GHz 6.875~7.125 GHz	PIFA	i-pex (MHF)
	Chain1	PSA	RFMTA421230IMM B701	-13.92 -13.91 -13.91 -14.46	5.925~6.425 GHz 6.425~6.525 GHz 6.525~6.875 GHz 6.875~7.125 GHz	PIFA	i-pex (MHF)
4	Chain0	Cortec	AN2450-4902BRS	2.42 3.87	2.4~2.4835GHz 5.15~5.895GHz	Dipole	R-SMA
	Chain1	Cortec	AN2450-4902BRS	2.42 3.87	2.4~2.4835GHz 5.15~5.895GHz	Dipole	R-SMA

Ant. No.	RF Chain No.	Brand	Model	Antenna Net Gain (dBi)	Frequency range	Antenna Type	Connector Type
5	Chain0	VSO	JR2Q00340-1	1.62 3.2 3.93 3.61 3.61 3.14	2.4~2.4835 5.15~5.895 5.925~6.425 6.425~6.525 6.525~6.875 6.875~7.125	Dipole	RP SMA PLUG
	Chain1	VSO	JR2Q00340-1	1.62 3.2 3.93 3.61 3.61 3.14	2.4~2.4835 5.15~5.895 5.925~6.425 6.425~6.525 6.525~6.875 6.875~7.125	Dipole	RP SMA PLUG
6	Chain0	PSA	RFPCA460632IMM B701	-13.2 -13.67 -13.67 -13.09	5.925~6.425 6.425~6.525 6.525~6.875 6.875~7.125	Dipole	IPEX
	Chain1	PSA	RFPCA460632IMM B701	-13.2 -13.67 -13.67 -13.09	5.925~6.425 6.425~6.525 6.525~6.875 6.875~7.125	Dipole	IPEX

2. The above EUT information is declared by manufacturer and for more detailed features description please refers to the manufacturer's specifications or User's Manual.
3. Name of the band test details is as below description.

Name	Band
G band	2.4GHz
A band	one of the 5GHz band or 6GHz band
Note: A band select from the worst SAR value between 5G and 6G, and WLAN 6G was the final test by client's requirement.	

4. The above EUT information is declared by manufacturer and for more detailed features description please refers to the manufacturer's specifications or User's Manual.

Report Issue History Record:

Issue No.	Description	Date Issued
SFBARR-WTW-P23040352	Initial release	Jul. 25, 2023
SFBARR-WTW-P23040352A	Enable TAS algorithm to demonstrate the compliance	Feb. 07, 2024

2. Preface

The device manufactured by end product of firm support time-averaged SAR (TAS) algorithm which approved by FCC through KDB inquiry. For the transmitting elements integrated into device to transmit WLAN signals, the output power controlled by this algorithm and operate with a conservative configuration to ensure the RF exposure compliance. The TAS implementation limit the averaged output power level to below the maximum allowable power level.

The SAR compliance has been complied and it could be adopted and referred from BV CPS test report no.: SFBARR-WTW-P23040352. This report is the purpose of validating and verifying the time-averaged SAR (TAS) algorithm which implemented into device to make sure the device perform at compliant operation that FCC approved. The procedure of validation contains both of time-averaged specific absorption rate(SAR) and time-averaged power density (PD), which called as TA-SAR and TA-PD respectively.

The validations and test plans are determined with the worst condition of BV CPS test report no.: SFBARR-WTW-P23040352 to apply with the procedures approved by FCC, the test case will be established in accordance with the worst configuration of BV CPS test report no.: SFBARR-WTW-P23040352 for each validated scenario. The procedures of algorithm validated also contain power, SAR and PD measurements, to verity these scenarios define the operation of the algorithm in all operational states. The following validation scenarios would be performed in this report to apply with the algorithm.

3. Algorithm Demonstration

The algorithm of time-averaged SAR, TA-SAR; and time-averaged power density, TA-PD is defined and documented by MediaTek Inc and approved via KDB inquiry. The algorithm can't be changed or modified by host manufacturer and OEMs and implemented in MTK firmware which built in end product(eg, cell phone laptop computer) for validation by conducted power measurements. The host manufacturer only can experience test procedure to prove TAS result is pass under MTK's algorism.

The time-averaged RF exposure is to demonstrate compliance for safety limits and RF exposure is correlated to transmission power, the transmission power can be controlled to meet RF exposure limits defined as the specific absorption rate limit for transmit frequencies < 6GHz and power density limit for transmit frequencies > 6 GHz. For SAR limit. The proposed Time-Averaged Specific Absorption Rate (TA-SAR) algorithm manages TX power to ensure that time-averaged RF exposure is compliant all the time. For PD limit, the proposed Time-Averaged Power Density (TA-PD) algorithm controls TX power to ensure that at the time-averaged RF exposure is compliant as well. For Wi-Fi 6GHz band, the proposed TA-SAR algorithm and the proposed TA-PD algorithm also ensure the total exposure ratio limit between SAR and PD when simultaneously transmit.

The MediaTek Inc developed the TA-SAR and TA-PD algorithms to control instantaneous TX power for transmit frequencies under and above 6GHz bands respectively, the total time-averaged RF exposures (i.e., SAR and PD).

For the completeness of verifying that the proposed TA-SAR algorithm can realize compliance regarding RF exposure, several test scenarios are constructed as following table:

Scenario Item	Test Scenario	Description
1-1	Transmit mode changed between normal and sleep mode	2G SAR TX Mode Change between normal mode and sleep mode
1-2-1		6G PD TX Mode Change between normal mode and sleep mode
1-2-2		6G SAR TX Mode Change between normal mode and sleep mode
2	Band handover (Dual-Band Dual-Concurrent)	Test 2.4GHz/5GHz band change
3	Antenna switching	Change antenna index
4	ECI (Exposure Condition Index) changed	Test under ECI transition (e.g., Head → body worn)
5	Simultaneous SAR and PD	TER of 2.4GHz TA-SAR and 6GHz TA-SAR/TA-PD

There is no exposure condition index exist either. Hence, the test scenario 4 is not applicable in this case.

Notes :
1. DBDC : Dual Band Dual Concurrent

4. SAR Measurement System

4.1 Definition of Specific Absorption Rate (SAR)

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.

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

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

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

4.2 SPEAG DASY6 System

DASY6 system consists of high precision robot, probe alignment sensor, phantom, robot controller, controlled measurement server and near-field probe. The robot includes six axes that can move to the precision position of the DASY6 software defined. The DASY6 software can define the area that is detected by the probe. The robot is connected to controlled box. Controlled measurement server is connected to the controlled robot box. The DAE includes amplifier, signal multiplexing, AD converter, offset measurement and surface detection. It is connected to the Electro-optical coupler (EOC). The EOC performs the conversion form the optical into digital electric signal of the DAE and transfers data to the PC.

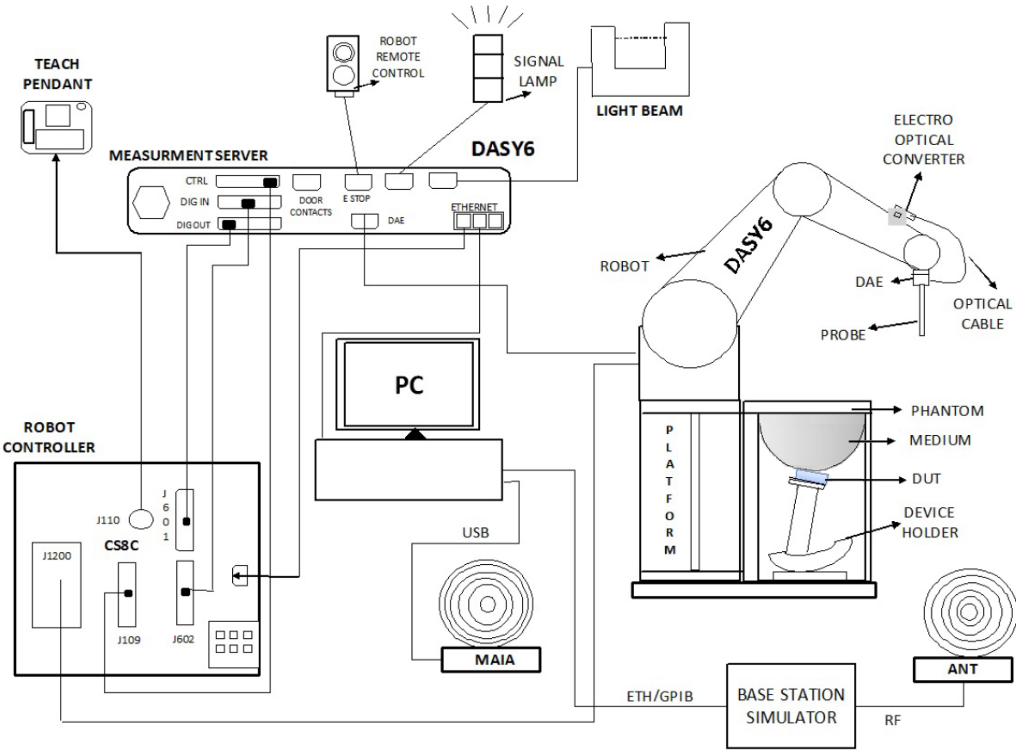


Fig-3.1 SPEAG DASY6 System Setup

4.2.1 Robot

The DASY6 system uses the high precision robots from Stäubli SA (France). For the 6-axis controller system, the robot controller version of CS8c from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability ±0.035 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)

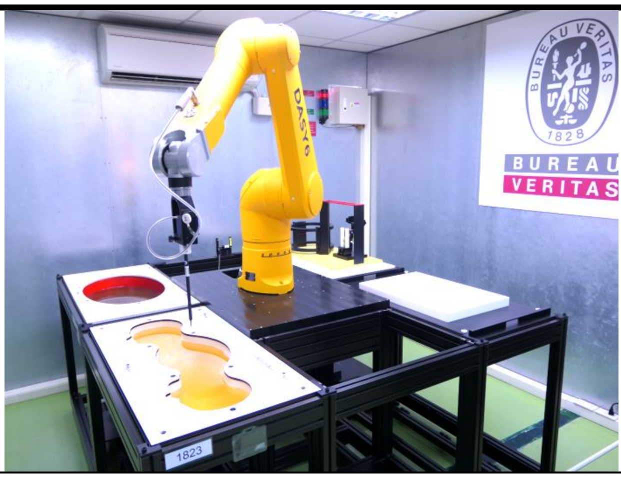


Fig-3.2 SPEAG DASY6 System

4.2.2 Probes

The SAR measurement is conducted with the dosimetric probe. 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.

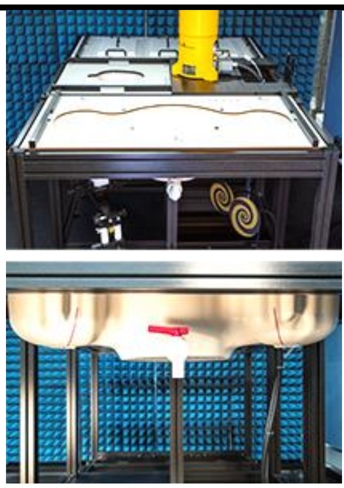
Model	EX3DV4
Construction	Symmetrical design with triangular core. Built-in shielding against static charges. PEEK enclosure material (resistant to organic solvents, e.g., DGBE).
Frequency	4 MHz to 10 GHz Linearity: ± 0.2 dB
Directivity	± 0.1 dB in TSL (rotation around probe axis) ± 0.3 dB in TSL (rotation normal to probe axis)
Dynamic Range	10 μW/g to 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

4.2.3 Data Acquisition Electronics (DAE)

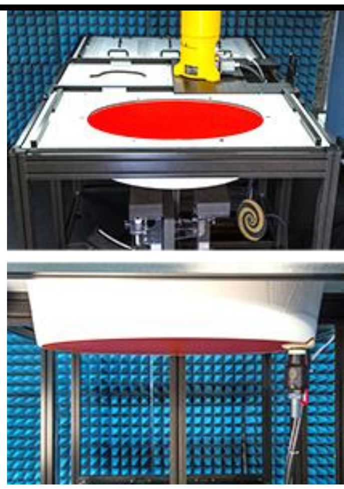
Model	DAE3, DAE4
Construction	Signal amplifier, multiplexer, A/D converter and control logic. Serial optical link for communication with DASY embedded system (fully remote controlled). Two step probe touch detector for mechanical surface detection and emergency robot stop.
Measurement Range	-100 to +300 mV (16 bit resolution and two range settings: 4mV, 400mV)
Input Offset Voltage	< 5μV (with auto zero)
Input Bias Current	< 50 fA
Dimensions	60 x 60 x 68 mm

4.2.4 Phantoms

Model	SAM-Twin Phantom
Construction	The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE Std 1528 and IEC 62209-1. It enables the dosimetric evaluation of left and right hand phone usage as well as body-mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by teaching three points with the robot.
Material	Vinylester, fiberglass reinforced (VE-GF)
Shell Thickness	2 ± 0.2 mm (6 ± 0.2 mm at ear point)
Dimensions	Length: 1000 mm Width: 500 mm Height: adjustable feet
Filling Volume	approx. 25 liters



Model	ELI
Construction	The ELI phantom is used for compliance testing of handheld and body-mounted wireless devices. ELI is fully compatible with the IEC 62209-2 standard and all known tissue simulating liquids. ELI has been optimized regarding its performance and can be integrated into our standard phantom tables. A cover prevents evaporation of the liquid. Reference markings on the phantom allow installation of the complete setup, including all predefined phantom positions and measurement grids, by teaching three points. The phantom is compatible with all SPEAG dosimetric probes and dipoles.
Material	Vinylester, fiberglass reinforced (VE-GF)
Shell Thickness	2.0 ± 0.2 mm (bottom plate)
Dimensions	Major axis: 600 mm Minor axis: 400 mm
Filling Volume	approx. 30 liters



4.2.5 Device Holder

Model	MD4HHTV5 - Mounting Device for Hand-Held Transmitters
Construction	In combination with the Twin SAM 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).
Material	Polyoxymethylene (POM)

Model	MDA4WTV5 - Mounting Device Adaptor for Ultra Wide Transmitters
Construction	An 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.
Material	Polyoxymethylene (POM)

Model	MDA4SPV6 - Mounting Device Adaptor for Smart Phones
Construction	The solid low-density MDA4SPV6 adaptor assuring no impact on the DUT radiation performance and is conform with any DUT design and shape.
Material	ROHACELL

Model	MD4LAPV5 - Mounting Device for Laptops and other Body-Worn Transmitters
Construction	In combination with the Twin SAM or ELI phantoms, the Mounting Device (Body-Worn) enables testing of transmitter devices according to IEC 62209-2 specifications. The device holder can be locked for positioning at a flat phantom section.
Material	Polyoxymethylene (POM), PET-G, Foam

4.2.6 System Validation Dipoles

Model	D-Serial
Construction	Symmetrical dipole with l/4 balun. Enables measurement of feed point impedance with NWA. Matched for use near flat phantoms filled with tissue simulating solutions.
Frequency	750 MHz to 5800 MHz
Return Loss	> 20 dB
Power Capability	> 100 W (f < 1GHz), > 40 W (f > 1GHz)

4.2.7 Power Source

Model	Powersource1
Signal Type	Continuous Wave
Operating Frequencies	600 MHz to 5850 MHz
Output Power	-5.0 dBm to +17.0 dBm
Power Supply	5V DC, via USB jack
Power Consumption	<3 W
Applications	System performance check and validation with a CW signal.

4.2.8 Tissue Simulating Liquids

For SAR measurement of the field distribution inside the phantom, the phantom must be filled with homogeneous tissue simulating liquid to a depth of at least 15 cm. 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. For body SAR testing, the liquid height from the center of the flat phantom to the liquid top surface is larger than 15 cm. The nominal dielectric values of the tissue simulating liquids in the phantom and the tolerance of 10 % are listed in Table-3.1.

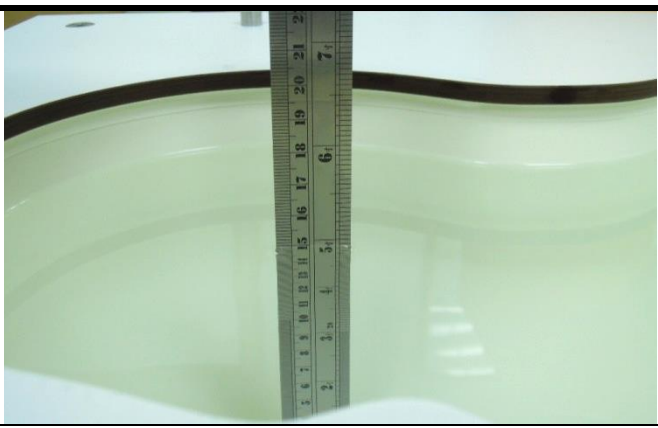


Photo of Liquid Height for Head Position

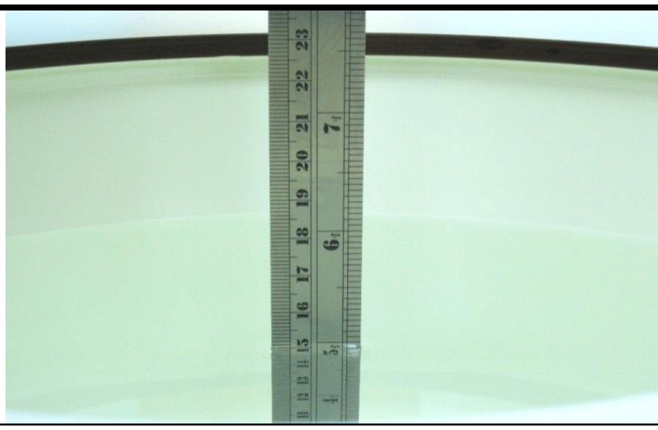


Photo of Liquid Height for Body Position

Table-3.1 Targets of Tissue Simulating Liquid

Frequency (MHz)	Target Permittivity	Range of ±10 %	Target Conductivity	Range of ±10 %
450	43.5	39.2 ~ 47.9	0.87	0.78 ~ 0.96
750	41.9	37.7 ~ 46.1	0.89	0.80 ~ 0.98
835	41.5	37.4 ~ 45.7	0.90	0.81 ~ 0.99
900	41.5	37.4 ~ 45.7	0.97	0.87 ~ 1.07
1450	40.5	36.5 ~ 44.6	1.20	1.08 ~ 1.32
1500	40.4	36.4 ~ 44.4	1.23	1.11 ~ 1.35
1640	40.2	36.2 ~ 44.2	1.31	1.18 ~ 1.44
1750	40.1	36.1 ~ 44.1	1.37	1.23 ~ 1.51
1800	40.0	36.0 ~ 44.0	1.40	1.26 ~ 1.54
1900	40.0	36.0 ~ 44.0	1.40	1.26 ~ 1.54
2000	40.0	36.0 ~ 44.0	1.40	1.26 ~ 1.54
2100	39.8	35.8 ~ 43.8	1.49	1.34 ~ 1.64
2300	39.5	35.6 ~ 43.5	1.67	1.50 ~ 1.84
2450	39.2	35.3 ~ 43.1	1.80	1.62 ~ 1.98
2600	39.0	35.1 ~ 42.9	1.96	1.76 ~ 2.16
3000	38.5	34.7 ~ 42.4	2.40	2.16 ~ 2.64
3500	37.9	34.1 ~ 41.7	2.91	2.62 ~ 3.20
4000	37.4	33.7 ~ 41.1	3.43	3.09 ~ 3.77
4500	36.8	33.1 ~ 40.5	3.94	3.55 ~ 4.33
5000	36.2	32.6 ~ 39.8	4.45	4.01 ~ 4.90
5200	36.0	32.4 ~ 39.6	4.66	4.19 ~ 5.13
5400	35.8	32.2 ~ 39.4	4.86	4.37 ~ 5.35
5600	35.5	32.0 ~ 39.1	5.07	4.56 ~ 5.58
5800	35.3	31.8 ~ 38.8	5.27	4.74 ~ 5.80
6000	35.1	31.6 ~ 38.6	5.48	4.93 ~ 6.03
6500	34.5	31.1 ~ 38.0	6.07	5.46 ~ 6.68

The dielectric properties of the tissue simulating liquids are defined in IEC 62209-1 and IEC 62209-2. The dielectric properties of the tissue simulating liquids were verified prior to the SAR evaluation using a dielectric assessment kit and a network analyzer.

Since the range of ±10 % of the required target values is used to measure relative permittivity and conductivity, the SAR correction procedure is applied to correct measured SAR for the deviations in permittivity and conductivity. Only positive correction has been used to scale up the measured SAR, and SAR result would not be corrected if the correction △SAR has a negative sign.

The following table gives the recipes for tissue simulating liquids.

Table-3.2 Recipes of Tissue Simulating Liquid

Tissue Type	Bactericide	DGBE	HEC	NaCl	Sucrose	Triton X-100	Water	Diethylene Glycol Mono-hexylether	Oxidized Mineral Oil
H750	0.2	-	0.2	1.5	56.0	-	42.1	-	-
H835	0.2	-	0.2	1.5	57.0	-	41.1	-	-
H900	0.2	-	0.2	1.4	58.0	-	40.2	-	-
H1450	-	43.3	-	0.6	-	-	56.1	-	-
H1640	-	45.8	-	0.5	-	-	53.7	-	-
H1750	-	47.0	-	0.4	-	-	52.6	-	-
H1800	-	44.5	-	0.3	-	-	55.2	-	-
H1900	-	44.5	-	0.2	-	-	55.3	-	-
H2000	-	44.5	-	0.1	-	-	55.4	-	-
H2300	-	44.9	-	0.1	-	-	55.0	-	-
H2450	-	45.0	-	0.1	-	-	54.9	-	-
H2600	-	45.1	-	0.1	-	-	54.8	-	-
H3500	-	8.0	-	0.2	-	20.0	71.8	-	-
H5G	-	-	-	-	-	17.2	65.5	17.3	-
H6G	-	-	-	-	-	-	56.0	-	44.0

4.3 SAR System Verification

The system check verifies that the system operates within its specifications. It is performed daily or before every SAR measurement. The system check uses normal SAR measurements in the flat section of the phantom with a matched dipole at a specified distance. The system verification setup is shown as below.

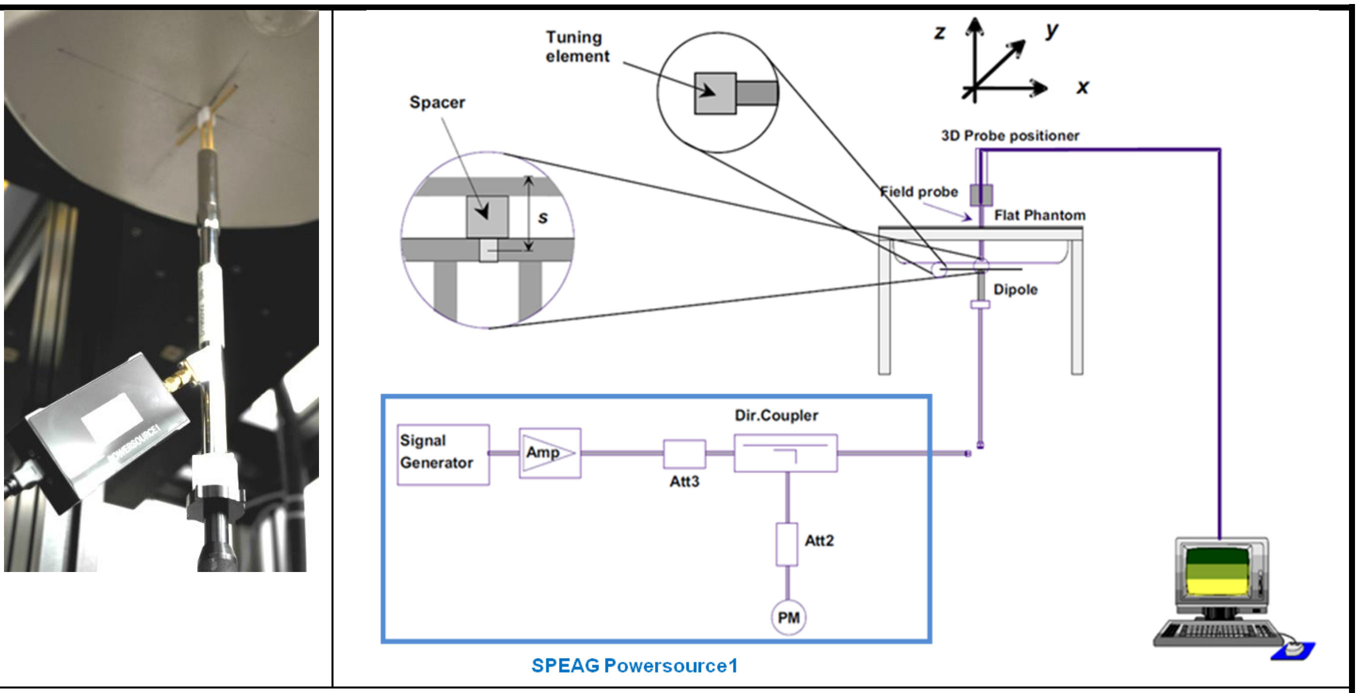


Fig-3.3a System Verification Setup for Frequency <= 6 GHz

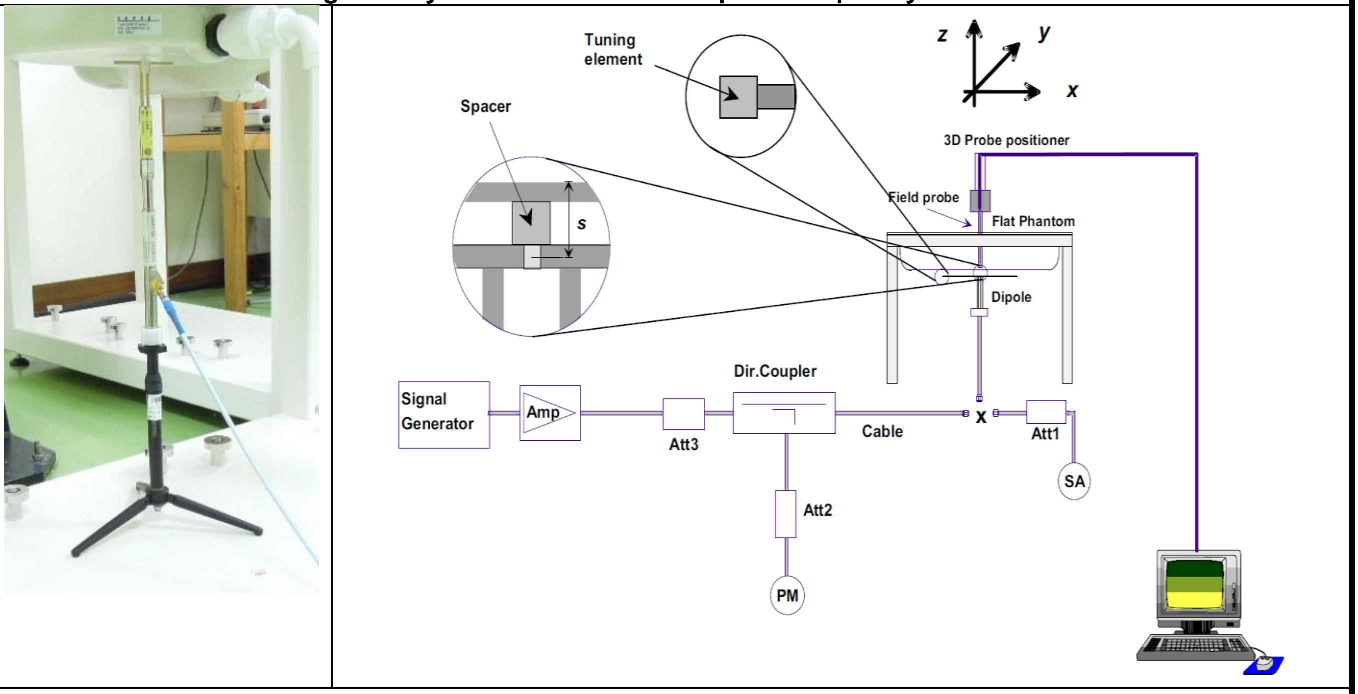


Fig-3.3b System Verification Setup for Frequency > 6 GHz

For frequency <= 6 GHz, the SPEAG Powersource1 is a portable and very stable RF source providing a continuous wave (CW) signal. It is designed for conducting SAR system checks and SAR system validation of DASY and is compatible with IEC/IEEE 62209-1528 and IEEE Std 1528 standards. The Powersource1 has been calibrated by SPEAG's ISO/IEC 17025-accredited calibration center. When using Powersource1, the setup can be simplified, as shown in Fig-3.3a. The signal purity is warranted by design. Since the Powersource1 is calibrated, no additional equipment is needed and the Powersource1 can directly be connected to the SMA connector of the dipole without a cable as all separate components (signal generator, amplifier, coupler and power meter) are built into the unit.

For frequency > 6 GHz, the setup is shown in Fig-3.3b. The validation dipole is placed beneath the flat phantom with the specific spacer in place. The distance spacer is touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The spectrum analyzer measures the forward power at the location of the system check dipole connector. The signal generator is adjusted for the desired forward power as 100 mW at the dipole connector and the power meter is read at that level. After connecting the cable to the dipole, the signal generator is readjusted for the same reading at power meter.

The validation dipole is placed beneath the flat phantom with the specific spacer in place. The distance spacer is touch the phantom surface with a light pressure at the reference marking and be oriented parallel to the long side of the phantom. The Powersource1 is adjusted for the desired forward power of 17 dBm or 20 dBm will be set for > 6 GHz at the dipole connector and the RF output power would be turned on. After system check testing, the SAR result will be normalized to 1W forward input power and compared with the reference SAR value derived from validation dipole certificate report. The deviation of system check should be within 10 %.

4.4 SAR Measurement Procedure

According to the SAR 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

The SAR measurement procedures for each of test conditions are as follows:

(a) Make EUT to transmit maximum output power
(b) Measure conducted output power through RF cable
(c) Place the EUT in the specific position of phantom
(d) Perform SAR testing steps on the DASY system
(e) Record the SAR value

4.4.1 Area Scan and Zoom Scan Procedure

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 is performed around the highest E-field value to determine the averaged SAR-distribution.

Measure the local SAR at a test point at 1.4 mm of the inner surface of the phantom recommended by SEPAG. The area scan (two-dimensional SAR distribution) is performed cover at least an area larger than the projection of the EUT or antenna. The measurement resolution and spatial resolution for interpolation shall be chosen to allow identification of the local peak locations to within one-half of the linear dimension of the corresponding side of the zoom scan volume. Following table provides the measurement parameters required for the area scan.

Parameter	$f \leq$ 3 GHz	3 GHz < $f \leq$ 10 GHz
Maximum distance from closest measurement point to phantom surface	5 ± 1	δ ln(2)/2 ±0.5
Maximum probe angle from probe axis to phantom surface normal at the measurement location	5° for flat phantom 30° for other phantom	5° for flat phantom 20° for other phantom
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 6 – 7 GHz: ≦7.5 mm

From the scanned SAR distribution, identify the position of the maximum SAR value, in addition identify the positions of any local maxima with SAR values within 2 dB of the maximum value that will not be within the zoom scan of other peaks. Additional peaks shall be measured only when the primary peak is within 2 dB of the SAR compliance limit (e.g. 1 W/kg for 1.6 W/kg, 1 g limit; or 1.26 W/kg for 2 W/kg, 10 g limit).

The zoom scan (three-dimensional SAR distribution) is performed at the local maxima locations identified in previous area scan procedure. The zoom scan volume must be larger than the required minimum dimensions. When graded grids are used, which only applies in the direction normal to the phantom surface, the initial grid separation closest to the phantom surface and subsequent graded grid increment ratios must satisfy the required protocols. The 1-g SAR averaging volume must be fully contained within the zoom scan measurement volume boundaries; otherwise, the measurement must be repeated by shifting or expanding the zoom scan volume. The similar requirements also apply to 10-g SAR measurements. Following table provides the measurement parameters required for the zoom scan.

Parameter		*f* ≦ 3 GHz	3 GHz < *f* ≦ 10 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 6 – 7 GHz: ≦3.4 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 6 – 7 GHz: ≦2 mm
	graded grids: $\Delta z_{Zoom}(1)$	≦4 mm	3 – 4 GHz: ≦3.0 mm 4 – 5 GHz: ≦2.5 mm 5 – 6 GHz: ≦2.0 mm 6 – 7 GHz: ≦1.7 mm
	$\Delta z_{Zoom}(n>1)$	≦$1.5 \cdot \Delta z_{Zoom}(n-1)$ 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 6 – 7 GHz: ≥22 mm

Per IEC 62209-2 AMD1, the successively higher resolution zoom scan is required if the zoom scan measured as defined above complies with both of the following criteria, or if the peak spatial-average SAR is below 0.1 W/kg, no additional measurements are needed:

(1) The smallest horizontal distance from the local SAR peaks to all points 3 dB below the SAR peak shall be larger than the horizontal grid steps in both x and y directions (Δx, Δy). This shall be checked for the measured zoom scan plane conformal to the phantom at the distance zM1.

(2) The ratio of the SAR at the second measured point (M2) to the SAR at the closest measured point (M1) at the x-y location of the measured maximum SAR value shall be at least 30 %.

If one or both of the above criteria are not met, the zoom scan measurement shall be repeated using a finer resolution. New horizontal and vertical grid steps shall be determined from the measured SAR distribution so that the above criteria are met. Compliance with the above two criteria shall be demonstrated for the new measured zoom scan.

4.4.2 Volume Scan Procedure

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.

4.4.3 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 drift more than 5%, the SAR will be retested.

4.4.4 Spatial Peak SAR Evaluation

The procedure for spatial peak SAR evaluation has been implemented according to the test standard. It can be conducted for 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

4.4.5 SAR Averaged Methods

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

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

5. Power Density Measurement System

5.1 Definition of Power Density

The power density for an electromagnetic field represents the rate of energy transfer per unit area. The local power density (i.e. Poynting vector) at a given spatial point is deduced from electromagnetic fields by the following formula:

$$S = \frac{1}{2}\text{Re}\{E \times H^*\} \cdot \vec{n}$$

Where: E is the complex electric field peak phasor and H is the complex conjugate magnetic field peak phasor.

The spatial-average power density distribution on the evaluation surface is determined per the IEC TR 63170. The spatial area, A is specified by the applicable exposure limit or regulatory requirements. The circular shape was used.

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

5.2 SPEAG DASY6 System

The SPEAG DASY6 system consists of high precision robot, probe alignment sensor, phantom, robot controller, controlled measurement server and near-field probe. The robot includes six axes that can move to the precision position of the DASY6 software defined. The DASY6 software can define the area that is detected by the probe. The robot is connected to controlled box. Controlled measurement server is connected to the controlled robot box. The DAE includes amplifier, signal multiplexing, AD converter, offset measurement and surface detection. It is connected to the Electro-optical coupler (ECO). The ECO performs the conversion form the optical into digital electric signal of the DAE and transfers data to the PC.

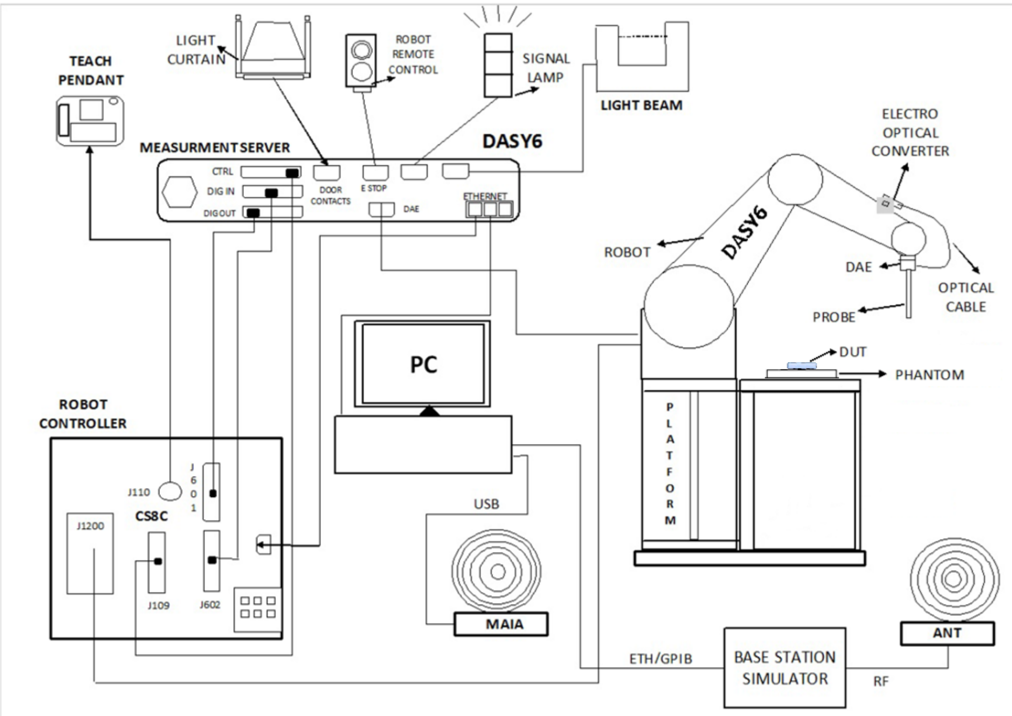


Fig-3.1 SPEAG DASY6 System Configuration

5.2.1 Robot

The DASY6 system uses the high precision robots from Stäubli SA (France). For the 6-axis controller system, the robot controller version of CS8c from Stäubli is used. The Stäubli robot series have many features that are important for our application:

- High precision (repeatability ±0.035 mm)
- High reliability (industrial design)
- Jerk-free straight movements
- Low ELF interference (the closed metallic construction shields against motor control fields)

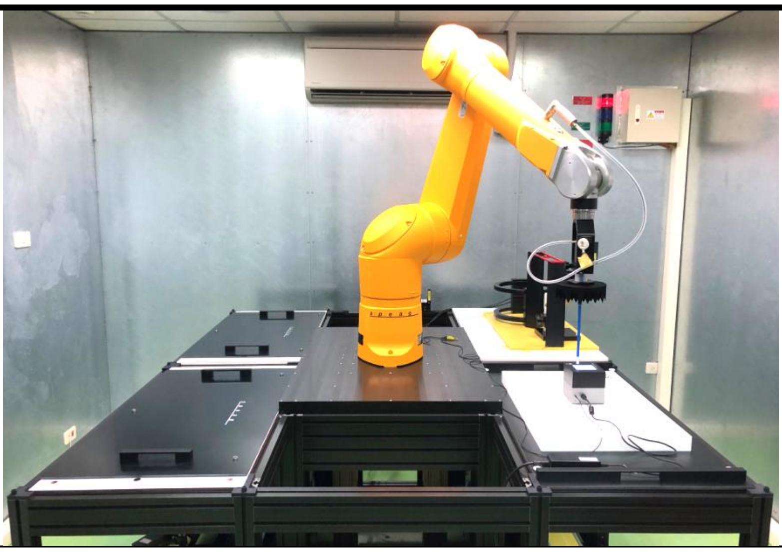


Fig-3.2 SPEAG DASY6 System

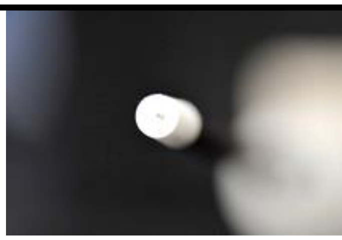
5.2.2 EUmmWV4 mm-Wave Probe

The EUmmWV4 probe is an electric (E) universal (U) field probe with two dipole sensors for field measurements at frequencies up to 110 GHz and as close as 2 mm from any field source or transmitter. The sensors consist of two diode-loaded small dipoles that provide the rectified voltage from the coupled E-field. From the voltages at three different orientations in the field at known angles, both the magnitude of the field component and the field polarization can be calculated. Due to the small size of the sensors, the probe can be used for measurements over an extremely wide frequency range from <1 GHz to 110 GHz. The probe sensors are protected by non-removable 8 mm high-density foam.

The EUmmWV4 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. The design entails two small 0.8 mm dipole sensors mechanically protected by high-density foam, printed on both sides of a 0.9 mm wide and 0.12 mm thick glass substrate. The body of the probe is specifically constructed to minimize distortion by the scattered fields.

The probe consists of two sensors with different angles arranged in the same plane in the probe axis. Three or more measurements of the two sensors are taken for different probe rotational angles to derive the amplitude and polarization information. These probes are the most flexible and accurate probes currently available for measuring field amplitude.

The probe design allows measurements at distances as small as 2 mm from the sensors to the surface of the device under test (DUT). The typical sensor to probe tip distance is 1.5 mm. The exact distance is calibrated.

Model	EUmmWV4	
Frequency	750 MHz to 110 GHz	
Dynamic Range	< 20 V/m - 10000 V/m with PRE-10 < 50 V/m - 3000 V/m minimum	
Linearity	< ±0.2 dB	
Hemispherical Isotropy	< 0.5 dB	
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	

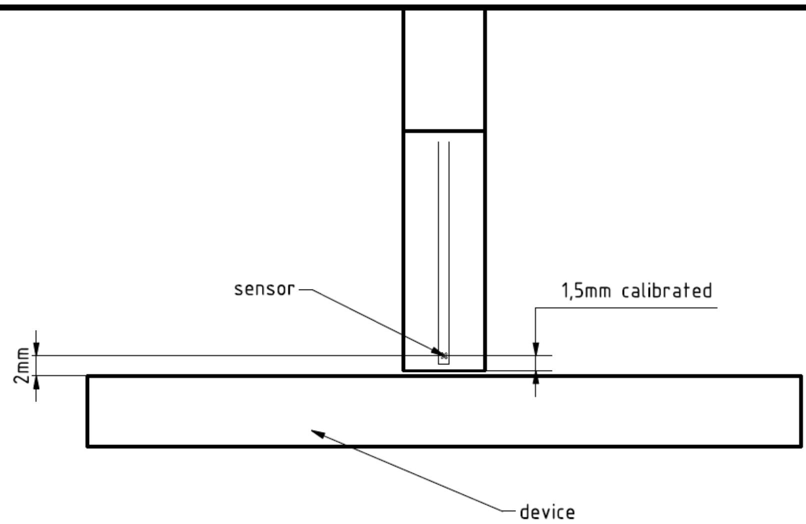
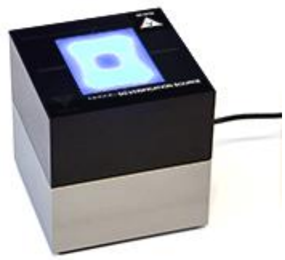


Illustration of Distance - Sensor to DUT Surface

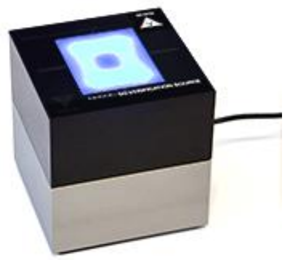
5.2.3 System Verification Sources

System verification device consists of a horn antenna with corresponding gun oscillator packaged within a cube-shaped housing and power supply provided.

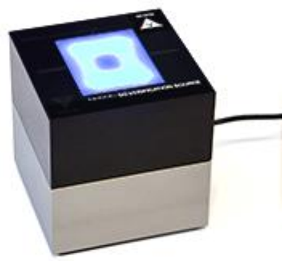
Model	System Verification for Ka-band
Calibrated Frequency	30 GHz at 10mm from the case surface
Frequency Accuracy	± 100 MHz
E-field Polarization	Linear
Harmonics	-20 dBc
Total Radiated Power	14 dBm
Power Stability	0.05 dB
Power Consumption	5 W
Size	100 x 100 x 100 mm
Weight	1 kg



Model	System Verification for V-band
Calibrated Frequency	60 GHz at 10mm from the case surface
Frequency Accuracy	± 100 MHz
E-field Polarization	Linear
Harmonics	-20 dBc
Total Radiated Power	20 dBm
Power Stability	0.1 dB
Power Consumption	5 W
Size	100 x 100 x 100 mm
Weight	1 kg



Model	System Verification for W-band
Calibrated Frequency	90 GHz at 10mm from the case surface
Frequency Accuracy	± 150 MHz
E-field Polarization	Linear
Harmonics	-20 dBc
Total Radiated Power	16 dBm
Power Stability	0.15 dB
Power Consumption	5 W
Size	100 x 100 x 100 mm
Weight	1 kg



5.3 Power Density System Verification

System check provides a fast and reliable method to routinely verify that the measurement system is operational with no system component failures, including probe defects, drifts or deviation from target performance requirements. A system check also verifies the repeatability of the measurement system before compliance testing.

The measurement of a verification source is started from 5G probe installed and the phantom taught. The verification source is placed on the 5G phantom. Due to the internal distance from the horn to the outer surface of the verification source, the measurement distance set in the software should be offset by -4.45 mm; e.g., for measurement of the verification source at 10 mm, the measurement distance set in the software should be 5.55 mm (10mm - 4.45 mm).

The system check is a complete measurement using simple well-defined reference sources. According to the DASY6 specification in the user's manual and SPEAG's recommendation, the deviation threshold of ±0.66 dB represents the expanded standard uncertainty for system performance check. The system check is successful if the measured results are within ±0.66 dB tolerances to the target value shown in the calibration certificate of the verification source. The instrumentation and procedures used for system check should ensure the system is ready for performing compliance tests.

System check using 10 GHz source to support 6-7GHz incident-PD results done with EUmmWV probe, the test procedure was following by the SPEAG AppNote Procedures for Device Operating at 6 – 10GHz.

Frequency [GHz]	Grid Step	Grid Extent X/Y [mm]	Measurement Points
10	0.25 (λ /4)	120 / 120	16 x 16

Table-3.1 Settings for Measurement of Verification Sources

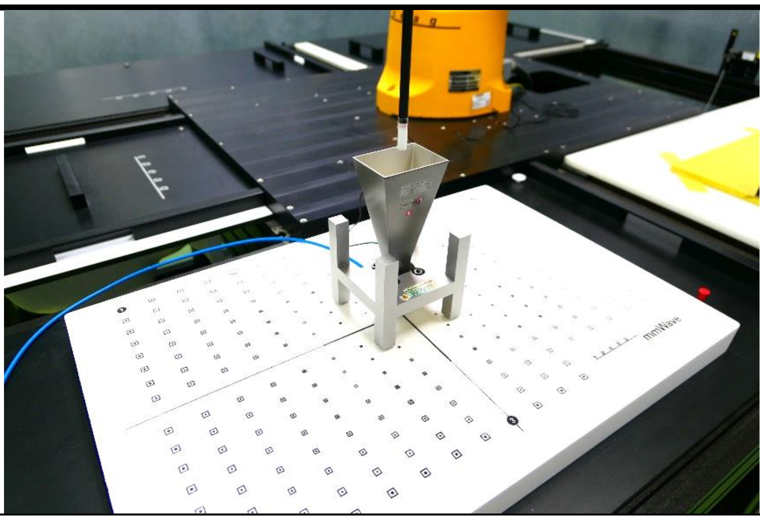


Fig-3.3 System Verification Setup

5.4 Power Density Measurement Procedure

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. Nevertheless, solutions based on direct measurement of E-field and H-field can be used to compute power density. When the measurement surface does not correspond to the evaluation surface, reconstruction algorithms are necessary to project or transform the fields from the measurement surface to the evaluation surface. The general measurement approach is summarized in following:

(a) 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.

(b) 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 the measurement system manufacturer.

(c) 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. When measurements are acquired in regions where evanescent modes are not negligible, smaller spatial resolution may be required. Similar criteria also apply to cylindrical scanning systems where the spatial resolution in the vertical direction should be less than λ / 2.

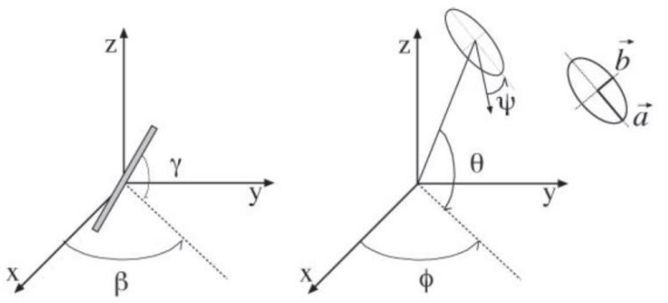
(d) Since only E-field is measured on the measurement system, the H-field is calculated from the measured field using a reconstruction algorithm. As power density requires knowledge of both amplitude and phase, reconstruction algorithms can also be used to obtain field information from the measured data (e.g. the phase from the amplitude if only the amplitude is measured). The measurement involves two planes with three different probe rotations on two measurement planes separated by λ / 4. The grid steps are optimized by the software based on the test frequency. The location of the lowest measurement plane is defined by the distance of first measurement layer from device under test entered by the user. In addition, when the measurement surface does not correspond to the evaluation surface, reconstruction algorithms are employed to project or transform the fields from the measurement surface to the evaluation surface. 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.

(e) To determine the spatial-average power density distribution on the evaluation surface. The spatial averaging area, A, is specified by the applicable exposure limits or regulatory requirements. If the shape of the area is not provided by the relevant regulatory requirements, a circular shape is recommended.

(f) 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 (f). 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.

5.4.1 Computation of the Electric Field Polarization Ellipse

For the numerical description of an arbitrarily oriented ellipse in three-dimensional space, five parameters are needed: the semi-major axis (a), the semi-minor axis (b), two angles describing the orientation of the normal vector of the ellipse (Φ, θ), and one angle describing the tilt of the semi-major axis (ψ). For the two extreme cases, i.e., circular and linear polarizations, three parameters only (a, Φ, and θ) are sufficient for the description of the incident field.



For the reconstruction of the ellipse parameters from measured data, the problem can be reformulated as a nonlinear search problem. The semi-major and semi-minor axes of an elliptical field can be expressed as functions of the three angles (Φ, θ, and ψ). The parameters can be uniquely determined towards minimizing the error based on least-squares for the given set of angles and the measured data. In this way, the number of free parameters is reduced from five to three, which means that at least three sensor readings are necessary to gain sufficient information for the reconstruction of the ellipse parameters. However, to suppress the noise and increase the reconstruction accuracy, it is desirable that the system of equations be over-determined. The solution use a probe consisting of two sensors angled by γ_1 and γ_2 toward the probe axis and to perform measurements at three angular positions of the probe, i.e., at β_1, β_2, and β_3, results in over-determinations by a factor of two. If there is a need for more information or increased accuracy, more rotation angles can be added.

The reconstruction of the ellipse parameters can be separated into linear and non-linear parts that are best solved by the givens algorithm combined with a downhill simplex algorithm. To minimize the mutual coupling, sensor angles are set with a shift of 90° ($\gamma_2 = \gamma_1 + 90°$), and, to simplify, the first rotation angle of the probe (β_1) can be set to 0°.

5.4.2 Total Field and Power Flux 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 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 EUmmWV4 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.

5.4.3 Power Flux Density Averaging

The average of the reconstructed power density is evaluated over a circular area in each measurement plane. The area of the circle is defined by the user; the default is 1 cm^2. The computed peak average value is displayed in the box at the top right. Note that the average is evaluated only for grid points where the averaging circle is completely filled with values; for points at the edge where the averaging circle is only partly filled with values, the average power density is set to zero. Two average power density values are computed:

1) $|\mathrm{Re}(S)|$ is the average total power density.
2) $\vec{n} \cdot \mathrm{Re}(S)$ is the average incident power density.

6. Validation of Test Scenario

6.1 Scenario 1: Transmit mode changed between normal and sleep mode

The scenario tests Wi-Fi TX mode switching from normal throughput mode to sleep mode. Since Mediatek's TA-SAR feature operation is independent of bands and channels, selecting one band is sufficient to validate this feature. The criteria for band selection are based on the ***P_WF_SAR_limit*** values (corresponding to ***WF_SAR_design_limit)*** and are described as below:

Tx changes from normal mode to sleep mode

Select one band/channel with least ***P_WF_SAR_limit*** among all supported bands and the ***P_WF_SAR_limit*** value is below P_WF_SAR_MAX.

Only one band/channel needs to be tested if all the bands have the same ***P_WF_SAR_limit.***

Only one band/channel needs to be tested if only one band has ***P_WF_SAR_limit*** below P_WF_SAR_MAX.

If the same least ***P_WF_SAR_limit*** applies to multiple bands, select the band with the highest

measured 1gSAR at ***P_WF_SAR_limit.***

If ***P_WF_SAR_limit*** values of all bands are over P_WF_SAR_MAX, there is no need to test these bands

TX power is measured, recorded, and processed by the following steps:

Steps 1~4: Measure and record TX power versus time for test scenario 1.

Step 1: Start *PWF_SAR_limit* calibration mode and measure *PWF_SAR_limit* for the selected band.

Step 2: Establish radio link with AP in the selected band and enable TA-SAR.

Step 3: Configure pre-defined TX power sequence to DUT and measure TX power versus time.

Step 4: Wi-Fi TX switches modes.

Initial Wi-Fi normal mode: Configure pre-defined TX power sequence to DUT for selected band and then DUT transmits packets after 400s.

Switch to Wi-Fi sleep mode: Wi-Fi switches to sleep mode about 10s and no packets are transmitted.

Wi-Fi wakes up to normal mode: Wi-Fi wakes up from sleep mode and DUT re-transmits packets for at least the specified time duration.

Step 5: Convert the measured conducted TX power into SAR.
Step 6-1: Plot results, make one power perspective plot containing

6-1-1. Instantaneous TX power

6-1-2. Requested power (test sequence)

6-1-3. Calculated time-averaged power

6-1-4.Calculated time-averaged power limits

Step 6-2: Make one SAR perspective plot containing

6-2-1. Calculated time-averaged 1gSAR or 10gSAR

6-2-2. FCC limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)

Convert the measured conducted TX power from Step 4 into 1gSAR or 10gSAR value using the following equation. Perform the running time average to power and 1gSAR or 10g SAR to determine time-averaged value versus time as follows.

$$\mathrm{SAR}(\tau) = \frac{\mathrm{conducted}_{\mathrm{inst}_{\mathrm{SAR}_{\mathrm{TX}_{\mathrm{power}(\tau)}}}}}{\mathrm{P}_{\mathrm{WF}_{\mathrm{SAR}_{\mathrm{limit}}}}} \times \mathrm{WF\_SAR\_design\_limit}$$

Where

(τ) = Instantaneous 1gSAR or 10gSAR versus time

$P_{WF\_SAR\_limit}$ is measured from step 1 and $WF\_SAR\_design\_limit$ is measured worst case SAR value at $P_{WF\_SAR\_limit}$.

$$\mathrm{Time\_avg\_SAR}(t) = \frac{1}{\mathrm{T_{SAR}}} \int_{t-\mathrm{T_{SAR}}}^{t} \mathrm{SAR}(\tau)\,d\tau$$

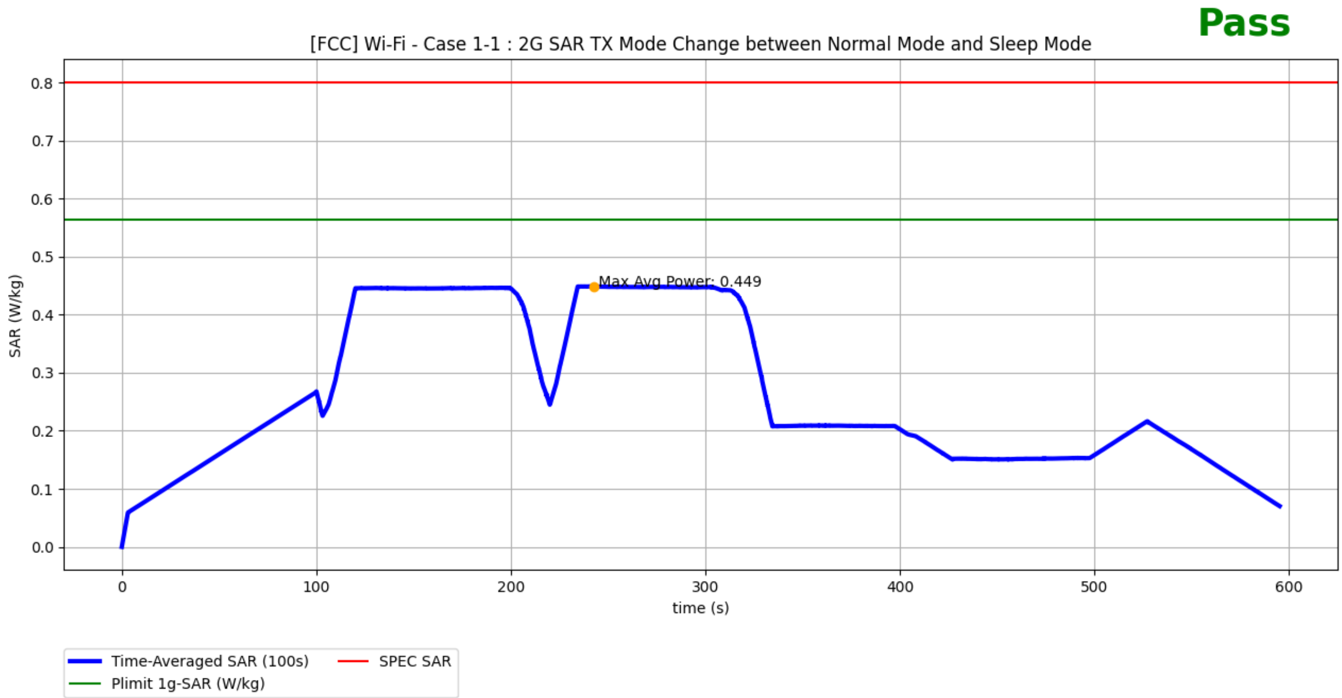
Where

$Time\_avg\_(t)$ is Time average SAR versus time

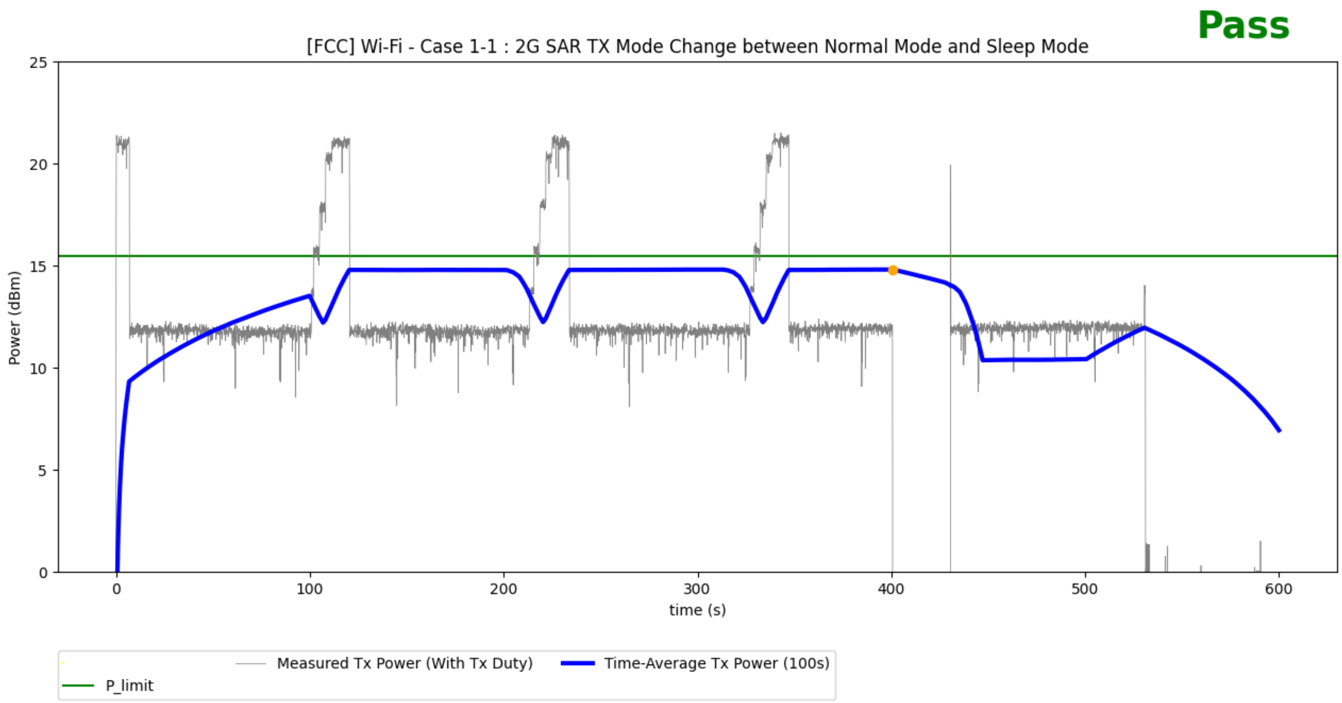
6.1.1 Case 1-1 : TX Mode Change between Normal Mode and Sleep Mode for 2.4GHz SAR

The test configurations are:
2.4G CCK 5.5M 400s → 10s sleep → 2.4G CCK 5.5M 100s
2.4G Pmax of CCK5.5M = 22.5dBm
P_Limit = 15.5dBm
1g-SAR of P_Limit = 0.564 W/Kg
Spec SAR = 0.8 W/kg

SAR:
Max TA Power:0.449(W/kg)



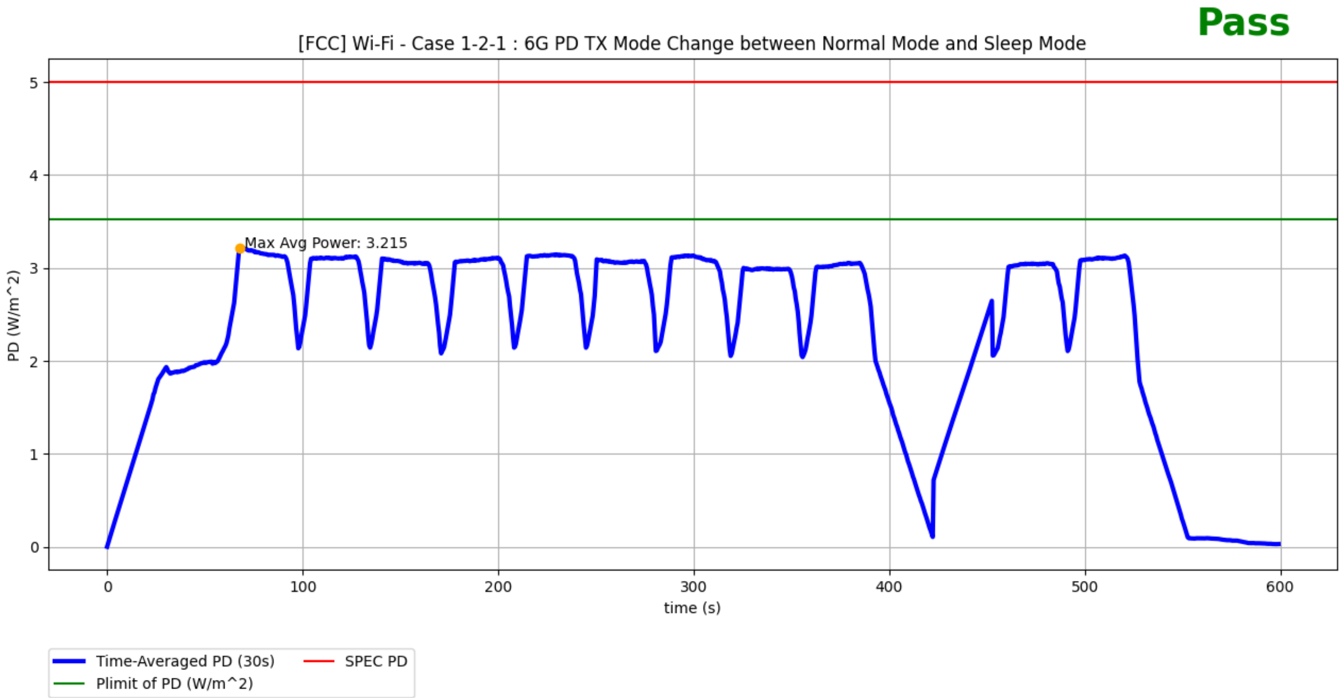
Conducted power:
Max TA Power:14.829(dBm)



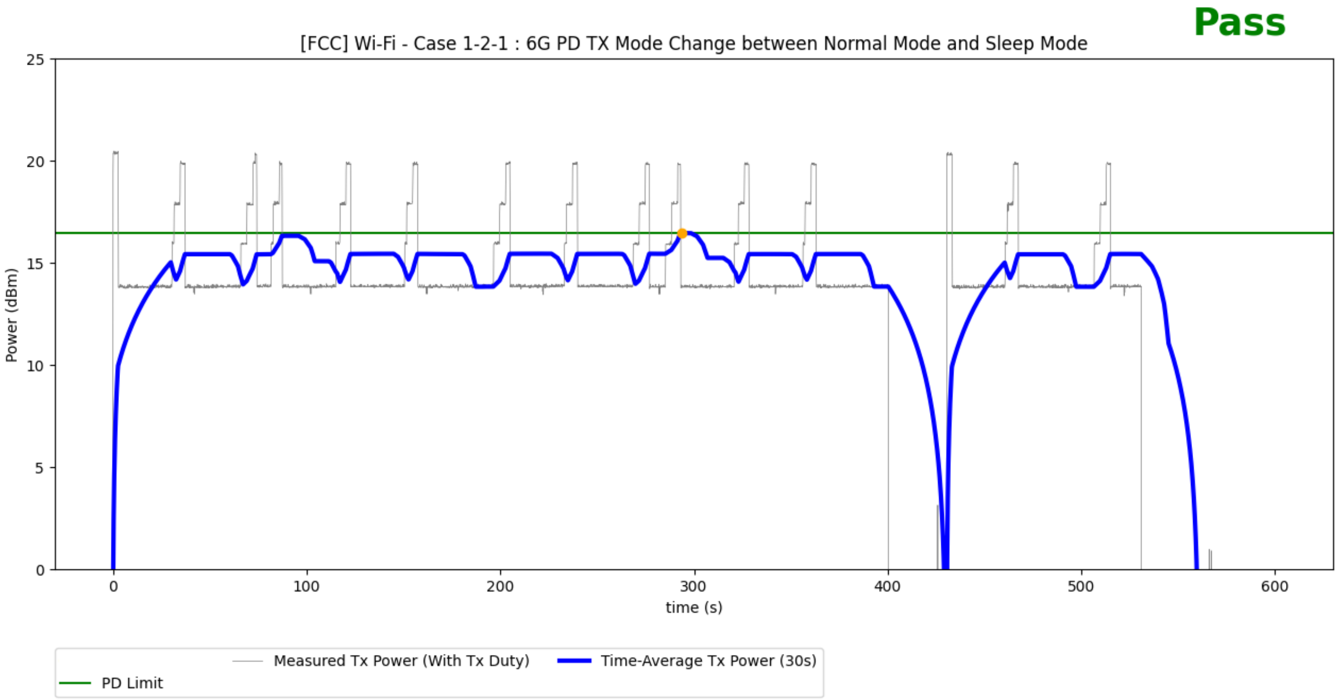
6.1.2 Case 1-2-1 : TX Mode Change between Normal Mode and Sleep Mode for 6GHz Power Density

The test configurations are:
6G OFDM 6M 400s → 10s sleep → 6G OFDM 6M 100s
WLAN6G Pmax of OFDM 6M = 21.5 dBm
P_Limit = 16.5 dBm
PD of P_Limit = 3.52 W/m^2
Spec PD = 5.0 W/m^2

PD:
Max TA Power:3.215(W/m^2)



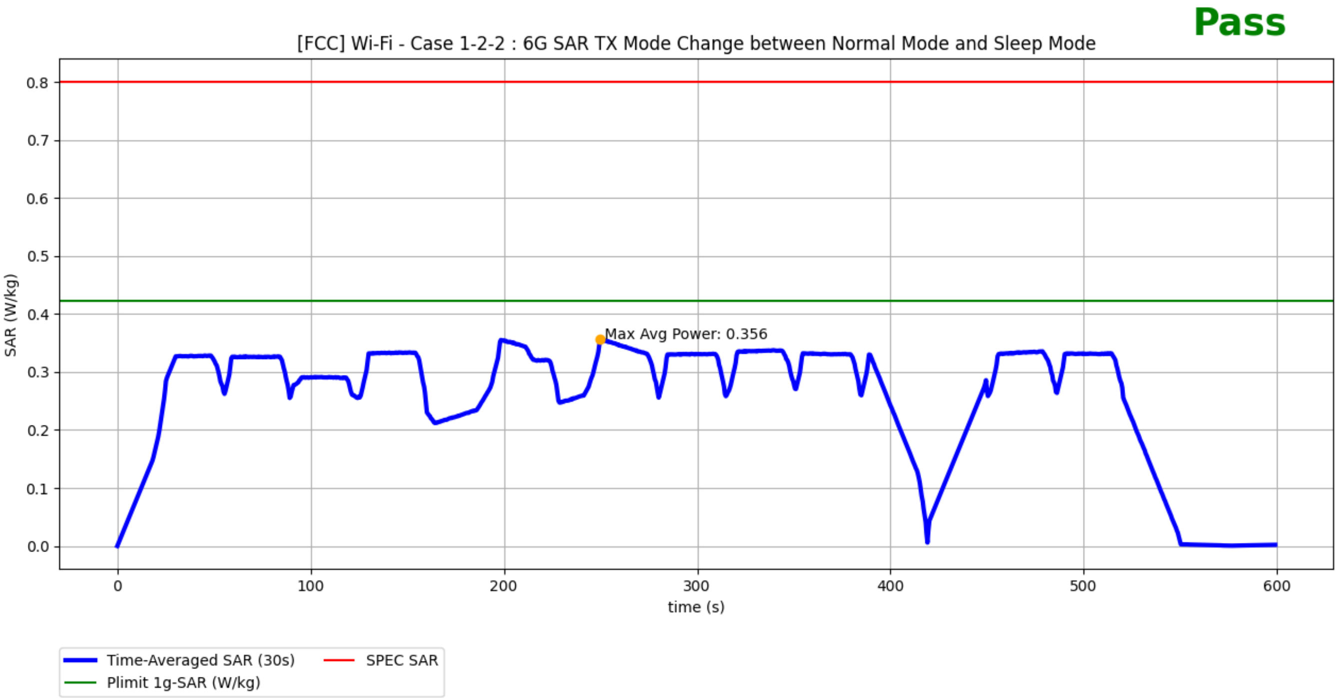
Conducted power:
Max TA Power:16.47(dBm)



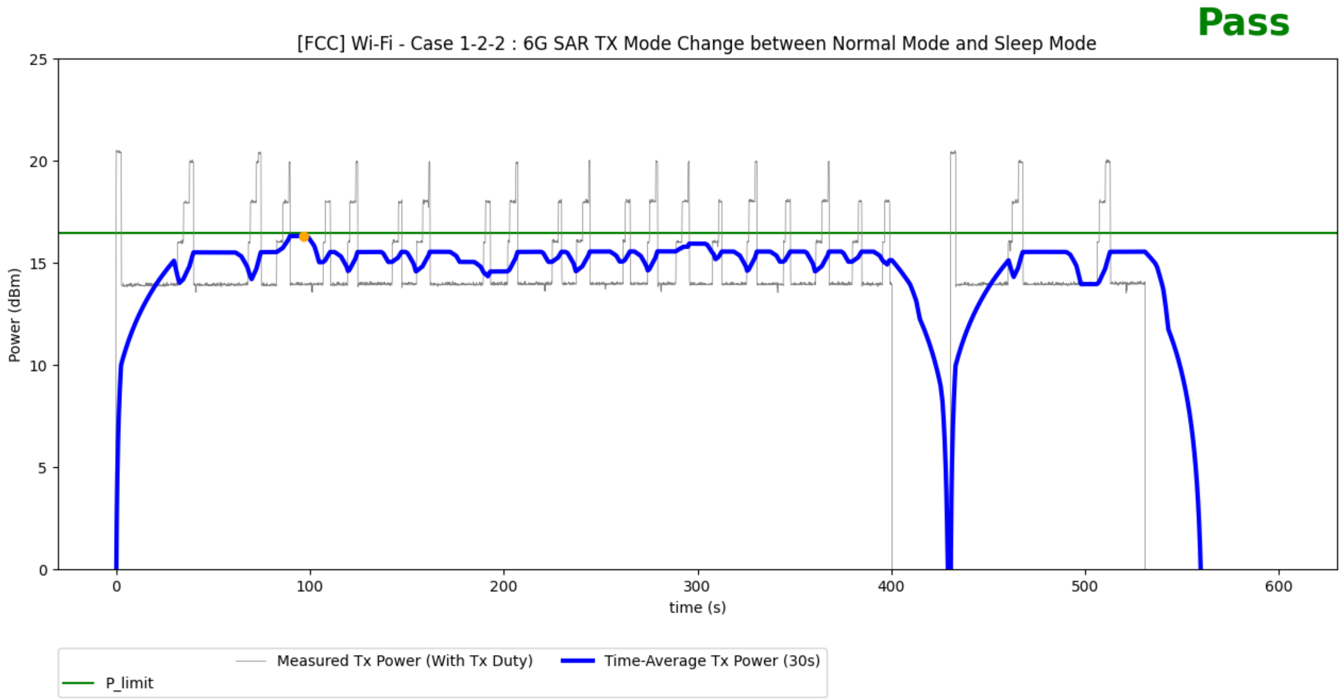
6.1.3 Case 1-2-2 : TX Mode Change between Normal Mode and Sleep Mode for 6GHz SAR

The test configurations are:
6G OFDM 6M 400s → 10s sleep → 6G OFDM 6M 100s
6G Pmax of OFDM 6M = 21.5 dBm
P_Limit =16.5 dBm
1g-SAR of P_Limit = 0.423 W/kg
Spec SAR = 0.8 W/kg

SAR:
Max TA Power:0.356(W/kg)



Conducted power:
Max TA Power:16.327(dBm)



6.2 Scenario 2: Band Handover

The scenario tests Wi-Fi 2.4GHz and 5GHz band handover and DBDC mode. The test configuration switchesfrom Wi-Fi 2.4GHz band to Wi-Fi 5GHz band and then switches to 2.4GHz/5GHz DBDC mode.

- For Wi-Fi 2.4GHz band, select the channel with least *P_WF_SAR_limit* value and below *P_WF_SAR_MAX*. If the same least *P_WF_SAR_limit* applies to multiple bands, select the channel withthe highest measured 1gSAR at *P_WF_SAR_limit*.
- For Wi-Fi 5GHz band, select the channel with least *P_WF_SAR_limit* value and below *P_WF_SAR_MAX*.If the same least *P_WF_SAR_limit* applies to multiple bands, select the channel with the highest measured 1gSAR at *P_WF_SAR_limit*.

TX power is measured, recorded, and processed by the following steps:

- Steps 1~4: Measure and record TX power versus time for test scenario 2.
  - Step 1: Start $P_{WF\_SAR\_limit}$ calibration mode and measure $P_{WF\_SAR\_limit}$ for both the selected bands/channels. (2.4GHz and 5GHz)
  - Step 2: Establish radio link with AP in the selected band and enable TA-SAR.
  - Step 3: Configure pre-defined TX power sequence to DUT and measure TX power versus time.
  - Step 4: Wi-Fi TX switches bands.

    Initial 2.4GHz band connection: Configure pre-defined TX power sequence to DUT for 2.4GHz band and then DUT transmits packets for 400s.

    Band switch to 5GHz band connection: Wi-Fi switches to the 5GHz band for 400s.

    Dual band mode (DBDC) connection: Wi-Fi connects to 2.4GHz and 5GHz bands simultaneously for 400s.
- Step 5: Convert the measured conducted TX power into SAR.

Convert the measured conducted TX power from Step 4 into 1gSAR or 10gSAR value using the following equation. Perform the running time average to power and 1gSAR or 10g SAR to determine time-averaged value versus time as follows.

Instantaneous 1gSAR or 10gSAR versus time: $SAR\_1(r)$ (band1), $SAR\_2(r)$ (band2)

$$SAR\_1(r) = \frac{conducted\_inst\_SAR\_TX\_power\_1(r)}{PWF\_SAR\_limit\_1} \text{ x } WF\_SAR\_design\_limit\_1$$

$$SAR\_2(r) = \frac{conducted\_inst\_SAR\_TX\_power\_2(r)}{PWF\_SAR\_limit\_2} \text{ x } WF\_SAR\_design\_limit\_2$$

where $PWF\_SAR\_limit\_1$ and $PWF\_SAR\_limit\_2$ are measured from step 1, $WF\_SAR\_design\_limit\_1$ and $WF\_SAR\_design\_limit\_2$ are measured worst case SAR values at $PWF\_SAR\_limit\_1$ and $PWF\_SAR\_limit\_2$, respectively.

Time average SAR versus time: $Time\_avg\_SAR(t)$

$$Time\_avg\_SAR(t) = \frac{1}{T_{SAR}}\left[\frac{\int_{t-T_{SAR}}^{t} SAR\_1(r)dr}{WF\_SAR\_REG\_limit\_1} + \frac{\int_{t-T_{SAR}}^{t} SAR\_2(r)dr}{WF\_SAR\_REG\_limit\_2}\right]$$

- Step 6: Plot results
  - A. Make one power perspective plot containing
    1. Instantaneous TX power
    2. Requested power
    3. Calculated time-averaged power
    4. Calculated time-averaged power limits
  - B. Make one SAR perspective plot containing
    1. Calculated time-averaged 1gSAR or 10gSAR
    2. FCC limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)
    3. Normalized time-averaged 1gSAR/1.6 or 10gSAR/4.0

6.2.1 Case 2 : Band Handover

The test configurations are:

2.4G CCK 5.5M 400s → 5G OFDM 6M 400s → 2.4G CCK 5.5M + 5G OFDM 6M 400s

2.4G Pmax of CCK5.5M = 22.5dBm

5G Pmax of OFDM6M = 22.5dBm

2.4G_P_Limit = 15.5dBm

5G_P_Limit = 14dBm

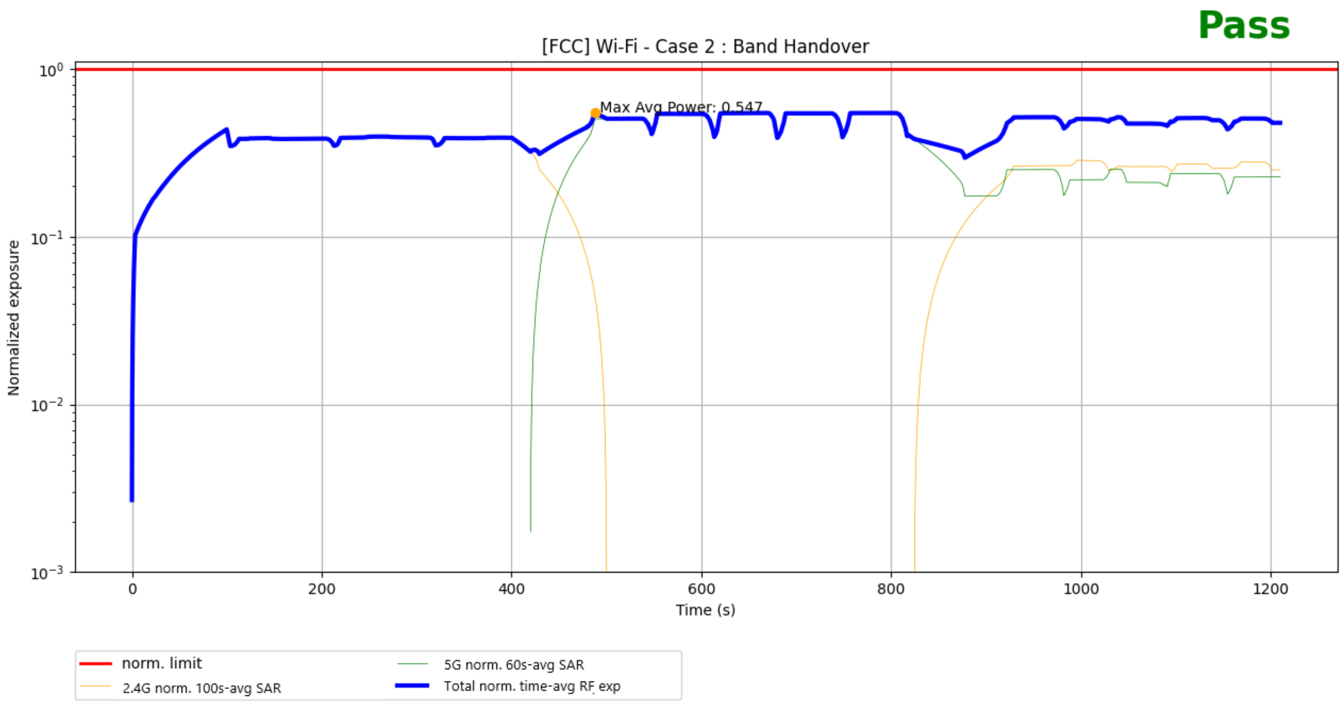
Spec SAR = 0.8 W/kg

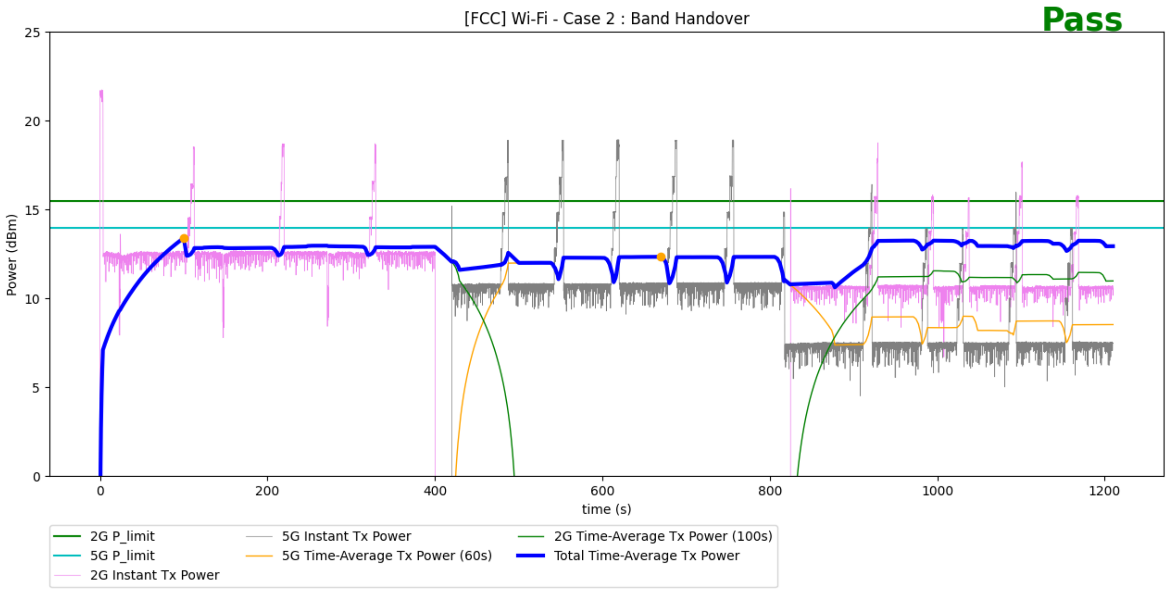
2G SAR:

Max TA Power:13.408(dBm)

5G SAR:

Max TA Power:12.347(dBm)




[FCC] Wi-Fi - Case 2 : Band Handover
Pass
Power (dBm)
time (s)
0
200
400
600
800
1000
1200
5
10
15
20
25
2G P_limit
5G P_limit
2G Instant Tx Power
5G Instant Tx Power
5G Time-Average Tx Power (60s)
2G Time-Average Tx Power (100s)
Total Time-Average Tx Power

6.3 Scenario 3: Antenna switching

Wi-Fi first selects an antenna to transmit packets then switches to another antenna within the same band. Note that ***PWF_SAR_limit*** may have a unique value for each Wi-Fi “band/antenna/exposure condition index” and time averaging window size also depends on frequencies. For any band supporting multiple TX antennas, select the one with the highest difference in ***PWF_SAR_limit*** among all supported antennas.

Select the band having the highest measured 1gSAR at ***P_WF_SAR_limit*** if multiple bands have the same ***P_WF_SAR_limit*** among supported antennas.
Antenna selection order
o Select the configuration with two antennas having ***P_WF_SAR_limit*** values less than P_WF_SAR_MAX.
o If the previous configuration does not exist, select the configuration with one antenna having ***P_WF_SAR_limit*** value less than P_WF_SAR_MAX.
o If the above two cannot be found, select one configuration with the two antennas having the least difference between their ***P_WF_SAR_limit*** and P_WF_SAR_MAX.

TX power is measured, recorded, and processed by the following steps.
Steps 1~4: Measure and record TX power versus time for test scenario 2.
Step 1: Start PWF_SAR_limit calibration mode and measure PWF_SAR_limit for both the selected antennas.
Step 2: Establish radio link with AP in the selected band and enable TA-SAR.

Step 3: Configure pre-defined TX power sequence to DUT and measure TX power versus time.

Step 4: Wi-Fi TX switches antennas.
Step 5: Convert the measured conducted TX power into SAR based on the formulas for scenario 1.
Step 6-1: Plot results. Make one power perspective plot containing

- Step 6-1-1. Instantaneous TX power
- Step 6-1-2. Requested power
- Step 6-1-3. Calculated time-averaged power
- Step 6-1-4. Calculated time-averaged power limits

Step 6-2: Make one SAR perspective plot containing

- Step 6-2-1. Calculated time-averaged 1gSAR or 10gSAR
- Step 6-2-2. FCC limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)
- Step 6-2-3. Normalized time-averaged 1gSAR/1.6 or 10gSAR/4.0

Note:
1.The correct power control is realized by TA-SAR algorithm when antenna switches from one to another.

2.The validation criteria are, at all times, the time-averaged 1gSAR or 10gSAR versus time shall not exceed FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR

6.3.1 Case 3 : Antenna Switching

Connect to one selected antenna: Configure pre-defined TX power sequence to DUT for selected band and selected antenna and then DUT transmits packets for 400s. Switch to another antenna: Wi-Fi TX switches to another selected antenna and DUT transmits packets for 400s.

The test configurations are:

2.4G/Ant0 CCK 5.5M 400s → 2.4G/Ant1 CCK 5.5M 400s

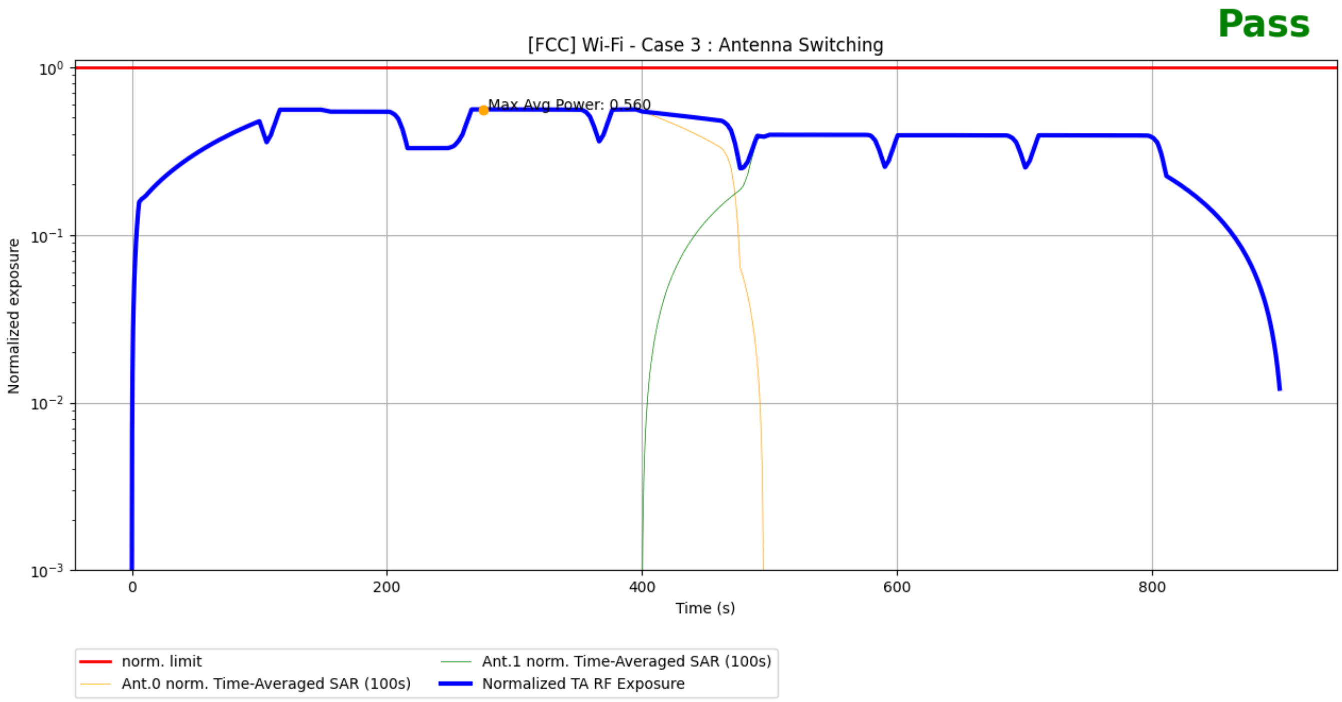
2.4G Pmax of CCK5.5M = 22.5dBm

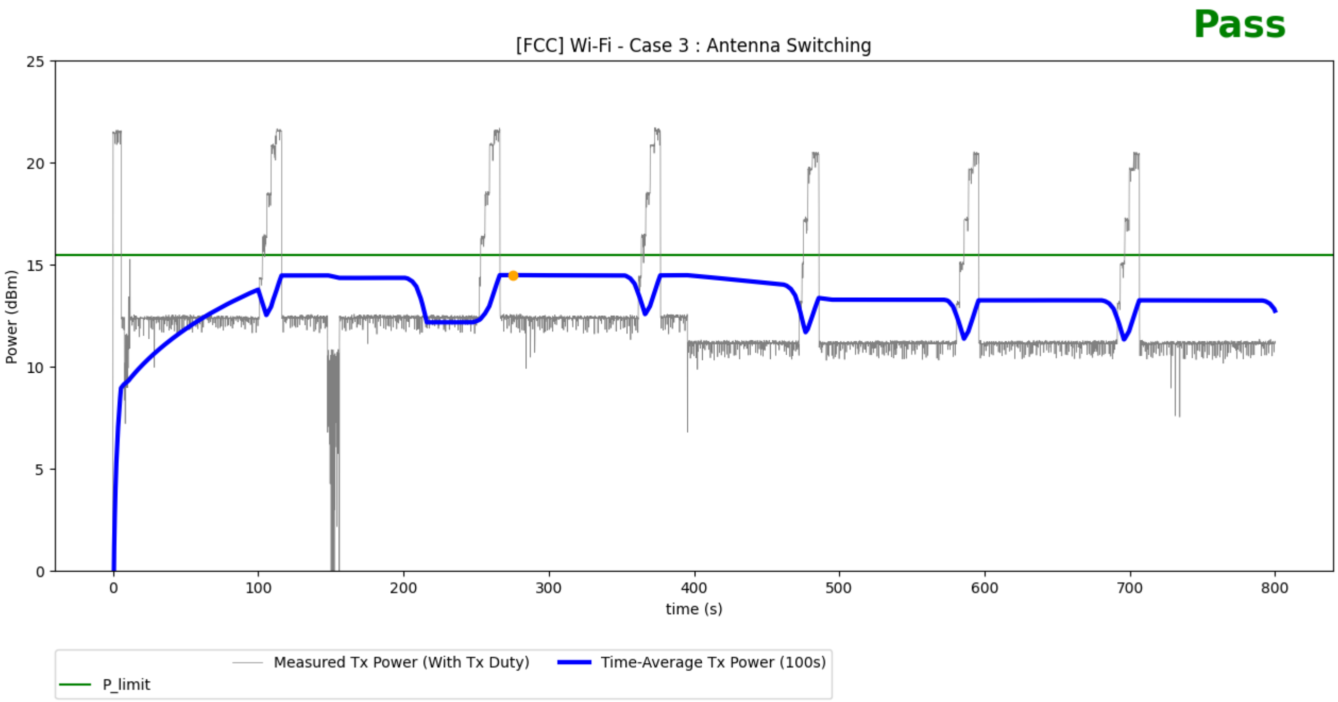
P_Limit = 15.5dBm

Spec SAR = 0.8 W/kg

SAR:

Max TA Power:14.502(dBm)




Pass
[FCC] Wi-Fi - Case 3 : Antenna Switching
Power (dBm)
time (s)
0
5
10
15
20
25
0
100
200
300
400
500
600
700
800
Measured Tx Power (With Tx Duty)
Time-Average Tx Power (100s)
P_limit

6.4 Scenario 4: Simultaneous SAR and PD via Conducted Power

The scenario is to test TER (total exposure ratio) under 2.4GHz band and 6GHz band simultaneous transmission. Since Wi-Fi 6GHz band needs to obey both SAR and PD exposure limits, the maximum of normalized TA-SAR and normalized TA-PD in 6GHz band should be used in TER calculation. The proposed algorithms can ensure TA-SAR/TA-PD control correctness by demonstrating that TER is less than or equal to 1 (FCC requirement).

- Select one channel of Wi-Fi 2.4GHz band with measured ***P_WF_SAR_limit*** less than ***P_WF_SAR_MAX*** and select one channel of Wi-Fi 6GHz band with measured ***P_WF_SAR_limit*** less than ***P_WF_SAR_MAX*** and with measured ***P_WF_PD_limit*** less than ***P_WF_PD_MAX***.

- Steps 1~4: Measure and record TX power versus time for test scenario 5.
  - Step 1: Start PWF_SAR_limit and PWF_PD_limit calibration mode, measure PWF_SAR_limit for the selected 2.4GHz band, and measure PWF_SAR_limit and PWF_PD_limit for the selected 6GHz band channel.
  - Step 2: Establish link with AP for the selected band and enable TA-SAR and TA-PD.
  - Step 3: Configure pre-defined TX power sequence to DUT and measure TX power versus time.
  - Step 4: Wi-Fi transmits packets at 2.4GHz band and 6GHz band.

- Step 5: Convert the measured conducted TX power into SAR, PD and calculate TER

For TA-SAR of each 2.4GHz, 5GHz, or 6GHz band

$$SAR_{n,normalized} = \frac{SAR_{n,avg}}{SAR_{n,limit}} = \frac{\frac{1}{T_{SAR_n}}\int_{t-T_{SAR_n}}^{t} SAR_n(\tau)d\tau}{SAR\_REG\_limit_n}$$

For TA-PD of each band at 6GHz band

$$PD_{m,normalized} = \frac{PD_{m,avg}}{PD_{m,limit}} = \frac{\frac{1}{T_{APD_m}}\int_{t-T_{APD_m}}^{t} PD_m(\tau)d\tau}{PD\_REG\_limit_m}$$

Instantaneous 1gSAR or 10gSAR versus time: $SAR(r)$, $PD(r)$

$$SAR(r) = \frac{conducted\_inst\_SAR\_TX\_power(r)}{P_{WF\_SAR\_limit}} \times WF\_SAR\_design\_limit$$

$$PD(r) = \frac{conducted\_inst\_PD\_TX\_power(r)}{P_{WF\_PD\_limit}} \times WF\_PD\_design\_limit$$

where PWF_SAR_limit is measured from step 1 and $WF\_SAR\_design\_limit$ is measured worst case SAR value at PWF_SAR_limit, PWF_PD_limit is measured from step 1 and $WF\_PD\_design\_limit$ is measured worst case PD value at PWF_PD_limit.

For simultaneous transmission, the sum of the normalized TA-SAR values in 2.4GHz and 5GHz bands together with the sum of the values of the maximum of normalized TA-SAR and normalized TA-PD in 6GHz band should meet TER requirement, as shown below.

$$TER = \sum_{n=1}^{M} \frac{SAR_{n,avg}}{SAR_{n,limit}} (2GHz/5GHz) + \sum_{m=M+1}^{N} \max\left[\frac{SAR_{m,avg}}{SAR_{m,limit}}, \frac{PD_{m,avg}}{PD_{m,limit}}\right](6GHz) \leq 1$$

- Step 6: Plot results

  A. Make one power perspective plot containing

     1. Instantaneous Tx power
     2. Requested power
     3. Calculated time-averaged power
     4. Calculated time-averaged power limits

  B. Make one SAR/PD perspective plot containing

     1. Calculated normalized time-averaged 1gSAR or 10gSAR for 2.4GHz band
     2. Calculated maximum of normalized time-averaged SAR (1gSAR or 10gSAR) and normalizedtime-averaged PD for 6GHz band
     3. Total Exposure Ratio (TER)
     4. FCC TER limit of 1

6.4.1 Case 5 : Simultaneous SAR and PD via Conducted Power

The test configurations are:
2G CCK 5.5M + 6G OFDM 6M 800s

2.4G Pmax of CCK5.5M = 22.5dBm

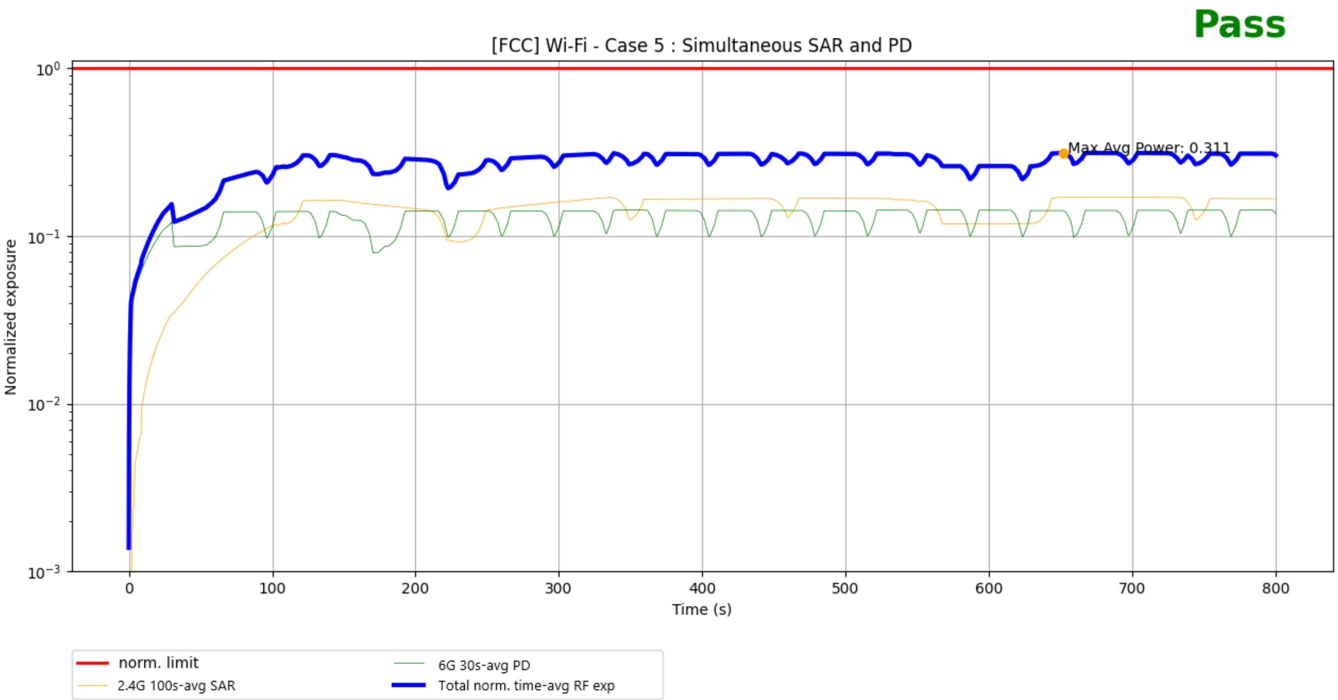
WLAN6G Pmax of OFDM 6M = 21.5 dBm

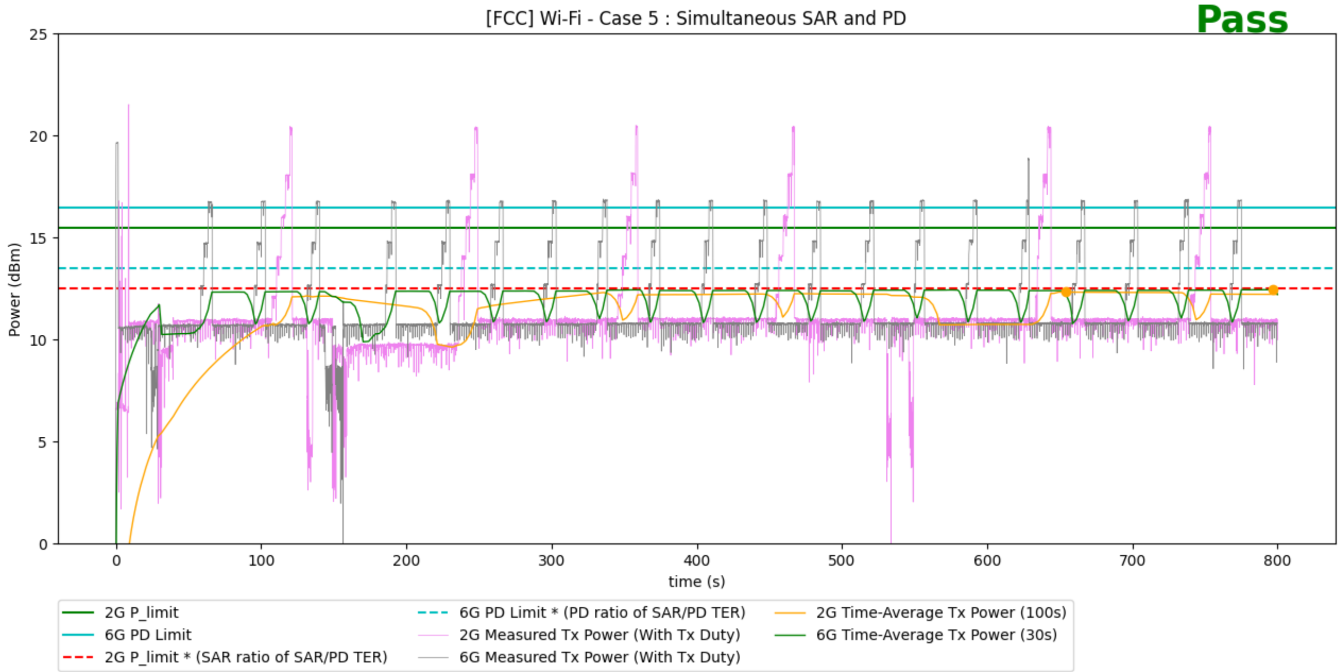
P_Limit_2G = 15.5dBm

P_Limit_6G = 16.5 dBm

Spec SAR = 0.8 W/kg

2G SAR:
Max TA Power:12.337(dBm)
6G PD:
Max TA Power:12.454(dBm)




[FCC] Wi-Fi - Case 5 : Simultaneous SAR and PD
Pass
Power (dBm)
time (s)
2G P_limit
6G PD Limit
2G P_limit * (SAR ratio of SAR/PD TER)
6G PD Limit * (PD ratio of SAR/PD TER)
2G Measured Tx Power (With Tx Duty)
6G Measured Tx Power (With Tx Duty)
2G Time-Average Tx Power (100s)
6G Time-Average Tx Power (30s)

7. SAR Test Results for Smart Transmit Validation

7.1 SAR Tissue Verification

The dielectric properties of the tissue simulating liquid have been measured within 24 hours before the SAR testing and within ±10 % of the target values. Liquid temperature during the SAR testing has kept within ±2 ℃.

Since the maximum deviation of dielectric properties of the tissue simulating liquid is within 5%, SAR correction is evaluated in the measurement uncertainty shown on section 6 of this report.

Frequency (MHz)	Liquid Temp. (℃)	Conductivity (σ)	Permittivity (εr)	Conductivity Target (σ)	Permittivity Target (εr)	σ Delta (%)	εr Delta (%)	Date
2450	21.6	1.83	39.9	1.8	39.2	1.67	1.79	Jan. 26, 2024
6500	22.1	6.12	32.7	6.07	34.5	0.82	-5.22	Jan. 26, 2024

7.2 Test System Validation

The SAR measurement system was validated according to procedures in KDB 865664 D01. The validation status in tabulated summary is as below.

Test Date	Probe S/N	Calibration Point	Conductivity (σ)	Permittivity (εr)	Validation for CW			Validation for Modulation		
					Sensitivity Range	Probe Linearity	Probe Isotropy	Modulation Type	Duty Factor	PAR
Jan. 26, 2024	7554	2450	1.83	39.9	Pass	Pass	Pass	OFDM	N/A	Pass
Jan. 26, 2024	7554	6500	6.12	32.7	Pass	Pass	Pass	OFDM	N/A	Pass

8. Calibration of Test Equipment

Equipment	Manufacturer	Model	SN	Cal. Date	Cal. Interval
System Validation Dipole	SPEAG	D2450V2	737	Feb. 20, 2023	1 Year
System Validation Dipole	SPEAG	D6.5GHzV2	1008	Sep. 21, 2023	1 Year
Dosimetric E-Field Probe	SPEAG	EX3DV4	7554	Sep. 19, 2023	1 Year
E-Field Probe	SPEAG	EUmmWV4	9615	Jul. 10, 2023	1 Year
Data Acquisition Electronics	SPEAG	DAE4	1431	Aug. 24, 2023	1 Year
Analong Signal Generator	R&S	SMA100B	104417	Oct. 23, 2023	1 Year
Mini-Circuits Wideband Amplifier	Mini-Circuits	ZVA-183-S+	434502031A	Jul. 07, 2023	1 Year
Universal Wireless Test Set	Anritsu	MT8870A	6262296569	Aug. 16, 2023	1 Year
Thermometer	YFE	YF-160A	120702365	Sep. 11, 2023	1 Year
Dielectric Assessment Kit	SPEAG	DAKS-3.5	1092	May 23, 2023	1 Year
Dielectric Assessment Kit	SPEAG	DAKS_VNA R140	0010917	May 22, 2023	1 Year
Powersource1	SPEAG	SE_UMS_160 BA	4010	Aug. 15, 2023	1 Year

9. Measurement Uncertainty

According to KDB 865664 D01, SAR measurement uncertainty analysis is required in SAR reports only when the highest measured SAR in a frequency band is ≥ 1.5 W/kg for 1-g SAR, and ≥ 3.75 W/kg for 10-g SAR. The procedures described in IEEE Std 1528-2013should be applied. The expanded SAR measurement uncertainty must be ≤ 30%,for a confidence interval of k = 2. When the highest measured SAR within a frequency band is < 1.5 W/kg for 1-g and < 3.75 W/kg for 10-g, the extensive SAR measurement uncertainty analysis described in IEEE Std 1528-2013 is not required in SAR reports submitted for equipment approval. Hence, the measurement uncertainty analysis is not required in this SAR report because the test result met the condition.

Source of Uncertainty	Uncertainty (± %)	Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (± %, 1g)	Standard Uncertainty (± %, 10g)	Vi
Measurement System								
Probe Calibration	6.0	Normal	1	1	1	6.0	6.0	∞
Axial Isotropy	4.7	Rectangular	√3	√0.5	√0.5	1.9	1.9	∞
Hemispherical Isotropy	9.6	Rectangular	√3	√0.5	√0.5	3.9	3.9	∞
Boundary Effect	1.0	Rectangular	√3	1	1	0.6	0.6	∞
Linearity	4.7	Rectangular	√3	1	1	2.7	2.7	∞
Detection Limits	0.25	Rectangular	√3	1	1	0.14	0.14	∞
Probe Modulation Response	4.8	Rectangular	√3	1	1	2.8	2.8	∞
Readout Electronics	0.3	Normal	1	1	1	0.3	0.3	∞
Response Time	0.0	Rectangular	√3	1	1	0.0	0.0	∞
Integration Time	1.7	Rectangular	√3	1	1	1.0	1.0	∞
RF Ambient Conditions – Noise	3.0	Rectangular	√3	1	1	1.7	1.7	∞
RF Ambient Conditions – Reflections	3.0	Rectangular	√3	1	1	1.7	1.7	∞
Probe Positioner Mechanical Tolerance	0.02	Rectangular	√3	1	1	0.01	0.01	∞
Probe Positioning with Respect to Phantom	0.4	Rectangular	√3	1	1	0.2	0.2	∞
Post-processing	2.0	Rectangular	√3	1	1	1.2	1.2	∞
Test Sample Related								
Test Sample Positioning	2.82 / 1.60	Normal	1	1	1	2.8	1.6	35
Device Holder Uncertainty	2.55 / 2.76	Normal	1	1	1	2.6	2.8	7
Power Drift of Measurement	5.0	Rectangular	√3	1	1	2.9	2.9	∞
PowerScaling	0.0	Rectangular	√3	1	1	0.0	0.0	∞
Phantom and Setup								
Phantom Uncertainty (Shape and Thickness Tolerances)	5.7	Rectangular	√3	1	1	3.3	3.3	∞
Liquid Conductivity (Temperature Uncertainty)	2.58	Rectangular	√3	0.78	0.71	1.2	1.1	∞
Liquid Conductivity (Measured)	2.95	Normal	1	0.78	0.71	2.3	2.1	61
Liquid Permittivity (Temperature Uncertainty)	1.97	Rectangular	√3	0.23	0.26	0.3	0.3	∞
Liquid Permittivity (Measured)	3.04	Normal	1	0.23	0.26	0.7	0.8	47
Combined Standard Uncertainty						± 10.9 %	± 10.7 %	
Expanded Uncertainty (K=2)						**± 21.8 %**	**± 21.4 %**	

Head SAR Uncertainty Budget for Frequency Range of 300 MHz to 3 GHz

Source of Uncertainty	Uncertainty (± %)	Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (± %, 1g)	Standard Uncertainty (± %, 10g)	Vi
Measurement System								
Probe Calibration	6.55	Normal	1	1	1	6.55	6.55	∞
Axial Isotropy	4.7	Rectangular	√3	0.7	0.7	1.9	1.9	∞
Hemispherical Isotropy	9.6	Rectangular	√3	0.7	0.7	3.9	3.9	∞
Boundary Effect	2.0	Rectangular	√3	1	1	1.2	1.2	∞
Linearity	4.7	Rectangular	√3	1	1	2.7	2.7	∞
Detection Limits	0.25	Rectangular	√3	1	1	0.14	0.14	∞
Probe Modulation Response	4.8	Rectangular	√3	1	1	2.8	2.8	∞
Readout Electronics	0.3	Normal	1	1	1	0.3	0.3	∞
Response Time	0.0	Rectangular	√3	1	1	0.0	0.0	∞
Integration Time	1.7	Rectangular	√3	1	1	1.0	1.0	∞
RF Ambient Conditions – Noise	3.0	Rectangular	√3	1	1	1.7	1.7	∞
RF Ambient Conditions – Reflections	3.0	Rectangular	√3	1	1	1.7	1.7	∞
Probe Positioner Mechanical Tolerance	0.04	Rectangular	√3	1	1	0.02	0.02	∞
Probe Positioning with Respect to Phantom	0.8	Rectangular	√3	1	1	0.5	0.5	∞
Post-processing	4.0	Rectangular	√3	1	1	2.3	2.3	∞
Test Sample Related								
Test Sample Positioning	2.82 / 1.60	Normal	1	1	1	2.8	1.6	35
Device Holder Uncertainty	2.55 / 2.76	Normal	1	1	1	2.6	2.8	7
Power Drift of Measurement	5.0	Rectangular	√3	1	1	2.9	2.9	∞
PowerScaling	0.0	Rectangular	√3	1	1	0.0	0.0	∞
Phantom and Setup								
Phantom Uncertainty (Shape and Thickness Tolerances)	6.2	Rectangular	√3	1	1	3.6	3.6	∞
Liquid Conductivity (Temperature Uncertainty)	2.58	Rectangular	√3	0.78	0.71	1.2	1.1	∞
Liquid Conductivity (Measured)	2.95	Normal	1	0.78	0.71	2.3	2.1	61
Liquid Permittivity (Temperature Uncertainty)	1.97	Rectangular	√3	0.23	0.26	0.3	0.3	∞
Liquid Permittivity (Measured)	3.04	Normal	1	0.23	0.26	0.7	0.8	47
Combined Standard Uncertainty						± 11.6 %	± 11.3 %	
Expanded Uncertainty (K=2)						**± 23.2 %**	**± 22.6 %**	

Head SAR Uncertainty Budget for Frequency Range of 3 GHz to 6 GHz

Source of Uncertainty	Uncertainty (± %)	Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (± %, 1g)	Standard Uncertainty (± %, 10g)	Vi
Measurement System								
Probe Calibration	6.0	Normal	1	1	1	6.0	6.0	∞
Axial Isotropy	4.7	Rectangular	√3	√0.5	√0.5	1.9	1.9	∞
Hemispherical Isotropy	9.6	Rectangular	√3	√0.5	√0.5	3.9	3.9	∞
Boundary Effect	1.0	Rectangular	√3	1	1	0.6	0.6	∞
Linearity	4.7	Rectangular	√3	1	1	2.7	2.7	∞
Detection Limits	0.25	Rectangular	√3	1	1	0.14	0.14	∞
Probe Modulation Response	4.8	Rectangular	√3	1	1	2.8	2.8	∞
Readout Electronics	0.3	Normal	1	1	1	0.3	0.3	∞
Response Time	0.0	Rectangular	√3	1	1	0.0	0.0	∞
Integration Time	1.7	Rectangular	√3	1	1	1.0	1.0	∞
RF Ambient Conditions – Noise	3.0	Rectangular	√3	1	1	1.7	1.7	∞
RF Ambient Conditions – Reflections	3.0	Rectangular	√3	1	1	1.7	1.7	∞
Probe Positioner Mechanical Tolerance	0.02	Rectangular	√3	1	1	0.01	0.01	∞
Probe Positioning with Respect to Phantom	0.4	Rectangular	√3	1	1	0.2	0.2	∞
Post-processing	2.0	Rectangular	√3	1	1	1.2	1.2	∞
Test Sample Related								
Test Sample Positioning	3.68 / 1.73	Normal	1	1	1	3.7	1.7	29
Device Holder Uncertainty	2.55 / 2.76	Normal	1	1	1	2.6	2.8	7
Power Drift of Measurement	5.0	Rectangular	√3	1	1	2.9	2.9	∞
PowerScaling	0.0	Rectangular	√3	1	1	0.0	0.0	∞
Phantom and Setup								
Phantom Uncertainty (Shape and Thickness Tolerances)	7.2	Rectangular	√3	1	1	4.2	4.2	∞
Liquid Conductivity (Temperature Uncertainty)	2.58	Rectangular	√3	0.78	0.71	1.2	1.1	∞
Liquid Conductivity (Measured)	2.95	Normal	1	0.78	0.71	2.3	2.1	61
Liquid Permittivity (Temperature Uncertainty)	1.97	Rectangular	√3	0.23	0.26	0.3	0.3	∞
Liquid Permittivity (Measured)	3.04	Normal	1	0.23	0.26	0.7	0.8	47
Combined Standard Uncertainty						± 11.5 %	± 11.0 %	
Expanded Uncertainty (K=2)						**± 23.0 %**	**± 22.0 %**	

Body SAR Uncertainty Budget for Frequency Range of 300 MHz to 3 GHz

Source of Uncertainty	Uncertainty (± %)	Probability Distribution	Divisor	Ci (1g)	Ci (10g)	Standard Uncertainty (± %, 1g)	Standard Uncertainty (± %, 10g)	Vi
Measurement System								
Probe Calibration	6.55	Normal	1	1	1	6.55	6.55	∞
Axial Isotropy	4.7	Rectangular	√3	0.7	0.7	1.9	1.9	∞
Hemispherical Isotropy	9.6	Rectangular	√3	0.7	0.7	3.9	3.9	∞
Boundary Effect	2.0	Rectangular	√3	1	1	1.2	1.2	∞
Linearity	4.7	Rectangular	√3	1	1	2.7	2.7	∞
Detection Limits	0.25	Rectangular	√3	1	1	0.14	0.14	∞
Probe Modulation Response	4.8	Rectangular	√3	1	1	2.8	2.8	∞
Readout Electronics	0.3	Normal	1	1	1	0.3	0.3	∞
Response Time	0.0	Rectangular	√3	1	1	0.0	0.0	∞
Integration Time	1.7	Rectangular	√3	1	1	1.0	1.0	∞
RF Ambient Conditions – Noise	3.0	Rectangular	√3	1	1	1.7	1.7	∞
RF Ambient Conditions – Reflections	3.0	Rectangular	√3	1	1	1.7	1.7	∞
Probe Positioner Mechanical Tolerance	0.04	Rectangular	√3	1	1	0.02	0.02	∞
Probe Positioning with Respect to Phantom	0.8	Rectangular	√3	1	1	0.5	0.5	∞
Post-processing	4.0	Rectangular	√3	1	1	2.3	2.3	∞
Test Sample Related								
Test Sample Positioning	3.68 / 1.73	Normal	1	1	1	3.7	1.7	29
Device Holder Uncertainty	2.55 / 2.76	Normal	1	1	1	2.6	2.8	7
Power Drift of Measurement	5.0	Rectangular	√3	1	1	2.9	2.9	∞
PowerScaling	0.0	Rectangular	√3	1	1	0.0	0.0	∞
Phantom and Setup								
Phantom Uncertainty (Shape and Thickness Tolerances)	7.6	Rectangular	√3	1	1	4.4	4.4	∞
Liquid Conductivity (Temperature Uncertainty)	2.58	Rectangular	√3	0.78	0.71	1.2	1.1	∞
Liquid Conductivity (Measured)	2.95	Normal	1	0.78	0.71	2.3	2.1	61
Liquid Permittivity (Temperature Uncertainty)	1.97	Rectangular	√3	0.23	0.26	0.3	0.3	∞
Liquid Permittivity (Measured)	3.04	Normal	1	0.23	0.26	0.7	0.8	47
Combined Standard Uncertainty						± 12.1 %	± 11.6 %	
Expanded Uncertainty (K=2)						**± 24.2 %**	**± 23.2 %**	

Body SAR Uncertainty Budget for Frequency Range of 3 GHz to 6 GHz

Source of Uncertainty	Uncertainty (± dB)	Probability Distribution	Divisor	Ci	Standard Uncertainty (± dB)	Vi
Measurement System						
Probe Calibration	0.49	Normal	1	1	0.49	∞
Hemispherical Isotropy	0.50	Rectangular	√3	1	0.29	∞
Linearity	0.20	Rectangular	√3	1	0.12	∞
System Detection Limits	0.04	Rectangular	√3	1	0.02	∞
Modulation Response	0.40	Rectangular	√3	1	0.23	∞
Readout Electronics	0.03	Normal	1	1	0.03	∞
Response Time	0.00	Rectangular	√3	1	0.00	∞
Integration Time	0.00	Rectangular	√3	1	0.00	∞
RF Ambient Conditions – Noise	0.20	Rectangular	√3	1	0.12	∞
RF Ambient Conditions – Reflections	0.20	Rectangular	√3	1	0.12	∞
Probe Positioner Mechanical Tolerance	0.04	Rectangular	√3	1	0.02	∞
Probe Positioning with Respect to Phantom	0.30	Rectangular	√3	1	0.17	∞
S_{avg} Reconstruction	2.00	Rectangular	√3	1	1.15	∞
Test Sample Related						
Power Drift of Measurement	0.20	Rectangular	√3	1	0.12	∞
Input Power	0.00	Normal	1	1	0.00	∞
Combined Standard Uncertainty					± 1.34	
Expanded Uncertainty (K=2)					**± 2.68**	

Uncertainty Budget for Power Density Measurement for Frequency Range of 6 GHz to 10 GHz

10. Information of the Testing Laboratories

We, Bureau Veritas Consumer Products Services (H.K.) Ltd., Taoyuan Branch, were founded in 1988 to provide our best service in EMC, Radio, Telecom and Safety consultation. Our laboratories are accredited and approved according to ISO/IEC 17025.

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The road map of all our labs can be found in our web site also.

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