

FCC TAS validation – Part 2:

Tests under dynamic transmit power scenarios

The following samples were submitted and identified on behalf of the client as:

Product Name	Mobile Phone
Brand Name	OPPO
Model No.	CPH2797
Applicant	Guangdong OPPO Mobile Telecommunications Corp.,Ltd. NO.18 HaiBin Road, Wusha Village, Chang'an Town, DongGuan City, Guangdong Province, P.R. China
FCC ID	R9C-OP24203
Date of EUT Receipt	Aug. 28, 2025
Date of Test(s)	Aug. 29, 2025 ~ Sep. 09, 2025
Date of Issue	Sep. 18, 2025

Approved By /

John Teh

John Yeh

In the configuration tested, the EUT complied with the standards specified above.

Remarks:

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Revision History

Report Number	Revision	Description	Issue Date	Revised By	Remark
TESA2508000598ES	00	Initial creation of document	Sep. 18, 2025	Kimmy Chiou	

Note:

1. The mark " * " is the revised version of the report due to comments submitted by the certification.

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1 GENERAL INFORMATION

1.1 Test Facility

Laboratory	Test Site Address	Test Site Name	Test Engineer	PM	FCC Designation number	IC CAB identifier
SGS Taiwan Ltd. Central RF Lab. (TAF code 3702)	1F, No. 8, Alley 15, Lane 120, Sec. 1, NeiHu Road, Neihu District, Taipei City, 11493, Taiwan	SAR 2	-	-	TW0029/ 150169	TW3702
		SAR 6	Jiash Yeh	Kiki Lin		
		SAR 8	-	-		
	No. 2, Keji 1st Rd., Guishan Township, Taoyuan County, 33383, Taiwan	SAR 1	-	-	TW0028/ 200037	
		SAR 4	-	-		
	No.134, Wu Kung Road, New Taipei Industrial Park, Wuku District, New Taipei City, Taiwan	SAR 3	-	-	TW0027/ 891563	
		SAR 7	-	-		

Note: Test site name is remarked on a bolded mark as an indication where measurements occurred in specific test site and address.

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1.2 Overview

FCC regulation allows time-averaged RF exposure to demonstrate compliance to safety limits. Because RF exposure is correlated to transmission power (TX power), the TX power can be controlled to meet FCC RF exposure limits defined as the specific absorption rate (SAR) limit for transmit frequencies < 6GHz and power density (PD) 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 at all times the time-averaged RF exposure is compliant with the FCC regulation. For PD limit, the proposed Time-Averaged Power Density (TA-PD) algorithm controls TX power to ensure that at all times the time-averaged RF exposure is compliant with the FCC PD requirement. For Wi-Fi and BT 6GHz band, the proposed TA-SAR algorithm and the proposed TA-PD algorithm ensure that at all times the time-averaged RF exposure is compliant with the FCC SAR requirement, PD requirement, and total exposure ratio (TER) limit. In the FCC regulation, the averaging window of SAR is 100 seconds for transmit frequencies less than 3 GHz and 60 seconds for transmit frequencies between 3GHz and 6GHz. As a result, for Wi-Fi and BT 2.4GHz band, the time window is 100 seconds and for Wi-Fi 5/6GHz band, the time window is 60 seconds. For Wi-Fi and BT 6GHz band, the averaging window of PD is 30 seconds.

This document proposes the test plan, test procedures, and measurement setup for the validation of the proposed

- Wi-Fi TA-SAR (time-averaged specific absorption rate) and TA-PD (time-averaged absorbed power density) algorithm,
- Bluetooth (BT) TA-SAR algorithm,
- Joint Wi-Fi and BT TA-SAR/TA-PD algorithm for Wi-Fi and BT simultaneous transmission with dynamic RF exposure budget allocation.

The measurement results are also provided to show that the requirements defined by FCC can be all met. The scope of the test proposal is for standalone Wi-Fi TA-SAR/TA-PD algorithm, standalone BT TA-SAR algorithm, and joint Wi-Fi and BT TA-SAR/TA-PD algorithm, while the cellular TA-SAR/TA-PD is not within the scope of this test proposal. The joint Wi-Fi and BT TA-SAR/TA-PD algorithm can guarantee that the normalized exposure budgets for Wi-Fi TA-SAR/TA-PD and BT TA-SAR/TA-PD can be determined jointly and dynamically while at the same time guaranteeing that TER is less than or equal to 1.

The rest of the document is organized as follows. The TA-SAR/TA-PD algorithm details are described in chapter 2. The overview of test proposal is given in chapter 3. The test scenarios and test procedures for Wi-Fi TA-SAR conducted power are described in chapter 4. The test scenarios and test procedures for Wi-Fi TA-PD are described in Chapter 5. The test scenarios and test procedures for BT TA-SAR are described in Chapter 6. The test scenarios and test procedures for BT TA-PD are described in Chapter 7. Wi-Fi and BT simultaneous transmission TA-SAR test scenarios and test procedures are described in Chapter 8. For Wi-Fi TA-SAR validation, the measurement setup and results for conducted power are included in Chapter 9, while the SAR measurements are included in Chapter 14. For Wi-Fi TA-PD validation, the measurement setup and results for conducted power are included in Chapter 10, while the PD measurements are included in Chapter 15. For BT TA-SAR validation, the measurement setup and results for conducted power are included in chapter 11, while the SAR measurements are included in

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Chapter 16. For the validation of joint Wi-Fi and BT TA-SAR algorithm for Wi-Fi and BT simultaneous transmission, the measurement setup and results for conducted power are included in Chapter 13. It is concluded in Chapter 18 that the proposed TA-SAR/TA-PD algorithm can dynamically control transmission power to ensure FCC compliance in real-time.

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2 WI-FI AND BT TA-SAR/TA-PD ALGORITHM CONCEPT

Mediatek developed TA-SAR and TA-PD algorithms to control instantaneous TX power for transmit frequencies less and larger than 6GHz respectively, so that the total time-averaged RF exposures (i.e., SAR, PD, and SAR+PD exposure) are less than FCC requirements.

2.1 Algorithm Description

The proposed TA-SAR and TA-PD algorithms use TX power control to accomplish RF exposure compliance for **Wi-Fi and BT** system. The basic concept of both algorithms is the same, if time-averaged TX power approaches a predefined TX power limit which is mapped from SAR or PD limit, the instantaneous TX power will be constrained to ensure that the time-averaged TX power is less than the predefined TX limit at all times. The parameters of the Wi-Fi TA-SAR algorithm are listed in Table 2-1 and the parameters of the Wi-Fi TA-PD algorithm are listed in Table 2-2. The parameters of the BT TA-SAR algorithm are listed in Table 2-3.

The current time-averaged TX power is guaranteed to be lower than the predefined TX power limit P_{SAR_limit} or P_{PD_limit} , which is mapped from SAR or PD limit. As in traditional SAR testing, we measure the power P_{SAR_limit} (mW) and its corresponding maximum 1g or 10g peak spatial-averaged SAR (SAR_REG_limit), similarly, P_{PD_limit} (mW) and its corresponding maximum 4cm² averaged PD (PD_REG_limit). For example, $P_{SAR_limit} = 70.79\text{mW} = 18.5\text{dBm}$ maps to SAR_REG_limit = 1.6W/kg. If device total uncertainty is considered for more conservative assessment, WF_SAR_design_limit (or BT_SAR_design_limit) which is SAR_REG_limit minus the device total uncertainties is used for TX power mapping, similarly, WF_PD_design_limit which is PD_REG_limit minus the device total uncertainties is used for TX power mapping. The TX power limit $P_{WF_SAR_limit}$ (or $P_{BT_SAR_limit}$) is the power mapped from WF_SAR_design_limit (or BT_SAR_design_limit), similarly, the TX power limit $P_{WF_PD_limit}$ is the power mapped from WF_PD_design_limit. For example, if the device total uncertainty is 0.5dB, $P_{WF_SAR_limit} = 63.09\text{mW} = 18\text{dBm}$ maps to WF_SAR_design_limit = 1.43W/kg.

- If the predicted time-averaged TX power tends to be larger than P_{SAR_limit} or P_{PD_limit} , TA-SAR/TA-PD algorithm enables TX constraint to limit instantaneous TX power. The constraint power is dynamically adjusted based on predicted power and duty cycle of the next time period.
- At any time period, TA-SAR algorithm satisfies the following equation:

$$\frac{1}{T_{SAR}} \int_{t-T_{SAR}}^t inst_TX_power(\tau) d\tau \leq P_{SAR_limit}$$

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where $inst_TX_power(\tau)$ denotes the instantaneous TX power at time τ and T_{SAR} is the time averaging window defined by FCC for assessing time-averaged SAR. P_{SAR_limit} is the predefined TX power limit which is mapped from SAR exposure limit.

- At any time period, TA-PD algorithm satisfies the following equation:

$$\frac{1}{T_{PD}} \int_{t-T_{PD}}^t inst_TX_power(\tau) d\tau \leq P_{PD_limit}$$

where $inst_TX_power(\tau)$ denotes the instantaneous TX power at time τ and T_{PD} is the time averaging window defined by FCC for assessing time-averaged PD. P_{PD_limit} is the predefined TX power limit which is mapped from PD exposure limit.

According to "987594 D04 UN6GHZ Pre-Approval Guidance Checklist v02" published on August 7, 2023, for simultaneous transmissions, the corresponding total exposure ratio (TER) for all devices with multiple antennas or multiple transmitters is expressed as:

$$TER = \sum_{k=1}^{N_s} \left[\frac{SAR_k}{SAR_{k,limit}} \right] + \sum_{k=1}^{N_f} \left[\frac{MPE_{field,k}}{MPE_{field,limit}} \right]^2 + \sum_{k=1}^{N_{PD}} \left[\frac{MPE_{PD,k}}{MPE_{PD,limit}} \right]$$

with N_s , N_f , and N_{PD} referring to sources requiring SAR, field-MPE, or PD-MPE, respectively, k referring to measured or estimated values for the source k , and "limit" to the corresponding applicable compliance limit. Simultaneous transmission evaluations and test exemption analyses may use SPLSR per KDB Publication 447458.

Compliance condition for all applicable simultaneous transmission conditions is $TER \leq 1$.

The scope of this document is for Wi-Fi TA-SAR/TA-PD and BT TAR-SAR/TA-PD compliance assessment only, therefore only the values of SAR_k and $MPE_{PD,k}$ related to Wi-Fi and BT in the above equation are considered in our assessment. If other transmitters exist together with Wi-Fi and BT transmitters, it can be requested that $TER(\text{for Wi-Fi and BT only}) \leq a \leq 1$, where a is a fixed budget of the total TER for Wi-Fi TA-SAR/TA-PD and BT TAR-SAR/TA-PD components only. Since only the parameters of Mediatek's TA-SAR/TA-PD algorithms need to be scaled according to the value a without any change to the Mediatek's algorithms themselves, the demonstration of Wi-Fi TA-SAR/TA-PD and BT TAR-SAR/TA-PD compliance is provided within the scope of this document with $TER(\text{for Wi-Fi and BT only}) \leq 1$.

The normalized TA-SAR of each 2.4GHz, 5GHz or 6GHz band for Wi-Fi or BT is calculated by the following equations,

$$SAR_{n_WF,normalized} = \frac{SAR_{n_WF,avg}}{SAR_{n_WF,limit}} = \frac{\frac{1}{T_{SAR_{n_WF}}} \int_{t-T_{SAR_{n_WF}}}^t SAR_{n_WF}(\tau) d\tau}{SAR_REG_WF_limit_n}$$

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$$SAR_{n,BT,normalized} = \frac{SAR_{n,BT,avg}}{SAR_{n,BT,limit}} = \frac{\frac{1}{T_{SAR_{n,BT}}} \int_{t-T_{SAR_{n,BT}}}^t SAR_{n,BT}(\tau) d\tau}{SAR_{REG_BT_limit_n}}$$

where $SAR_{n,limit}$ ($SAR_{n_{WF},limit}$ or $SAR_{n_{BT},limit}$) is the basic restriction limit that is applicable to the n -th transmitter/test frequency.

The notation PD is used interchangeably with MPE_{PD} in this document. The normalized TA-PD of each 6GHz band for Wi-Fi or BT is calculated by the following equations,

$$PD_{m_{WF},normalized} = \frac{PD_{m_{WF},avg}}{PD_{m_{WF},limit}} = \frac{\frac{1}{T_{PD_{m_{WF}}}} \int_{t-T_{PD_{m_{WF}}}}^t PD_{m_{WF}}(\tau) d\tau}{PD_{REG_WF_limit_m}}$$

where $PD_{m,limit}$ ($PD_{m_{WF},limit}$) is the reference level limit that is applicable for the m -th transmitter/test frequency.

Since Wi-Fi or BT 6GHz band needs to obey both SAR and PD exposure limits, the maximum of normalized TA-SAR and normalized TA-PD in 6GHz band is adopted in TER calculation within the scope of this document, i.e.,

$$\frac{MPE_{PD,k}}{MPE_{PD,limit}} \text{ is replaced by } \begin{cases} \max \left[\frac{SAR_m}{SAR_{m,limit}}, \frac{PD_m}{PD_{m,limit}} \right], & 6GHz < f_m \leq 10GHz \\ \frac{PD_m}{PD_{m,limit}}, & 10GHz < f_m \end{cases}$$

in the TER formula.

In summary, 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.

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$$TER = \sum_{n_{WF}=1}^{M1} \frac{SAR_{n_{WF},avg}}{SAR_{n_{WF},limit}} (Wi - Fi \text{ 2GHz/5GHz}) + \sum_{n_{BT}=1}^{M2} \frac{SAR_{n_{BT},avg}}{SAR_{n_{BT},limit}} (BT \text{ 2GHz/5GHz})$$

$$+ \sum_{m_{WF}=M1+1}^{N1} \max \left[\frac{SAR_{m_{WF},avg}}{SAR_{m_{WF},limit}}, \frac{PD_{m_{WF},avg}}{PD_{m_{WF},limit}} \right] (Wi - Fi \text{ 6GHz}) \leq 1$$

The output power can be converted to SAR or PD by the following equations.
In particular, for Wi-Fi SAR,

$$\frac{1}{T_{SAR}} \int_{t-T_{SAR}}^t SAR_{WF}(\tau) d\tau = \frac{\frac{1}{T_{SAR}} \int_{t-T_{SAR}}^t inst_{WF_SAR_TX_power}(\tau) d\tau}{P_{WF_SAR_limit}} \times WF_SAR_design_limit$$

for Wi-Fi PD,

$$\frac{1}{T_{PD}} \int_{t-T_{PD}}^t PD_{WF}(\tau) d\tau = \frac{\frac{1}{T_{PD}} \int_{t-T_{PD}}^t inst_{PD_TX_power}(\tau) d\tau}{P_{WF_PD_limit}} \times WF_PD_design_limit$$

for BT SAR,

$$\frac{1}{T_{SAR}} \int_{t-T_{SAR}}^t SAR_{BT}(\tau) d\tau = \frac{\frac{1}{T_{SAR}} \int_{t-T_{SAR}}^t inst_{BT_SAR_TX_power}(\tau) d\tau}{P_{BT_SAR_limit}} \times BT_SAR_design_limit$$

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where $inst_WF_SAR_TX_power(\tau)$, $inst_WF_PD_TX_power(\tau)$, $inst_BT_SAR_TX_power(\tau)$ and $inst_BT_PD_TX_power(\tau)$ denote the instantaneous TX power at time τ for SAR and PD respectively. T_{SAR} and T_{PD} are the time averaging windows defined by FCC for assessing time-averaged SAR and PD. The meanings of $P_{WF_SAR_limit}$, $WF_SAR_design_limit$, and SAR_REG_limit are described in Table 2-1, the meaning of $P_{WF_PD_limit}$, $WF_PD_design_limit$, and PD_REG_limit are described in Table 2-2, the meanings of $P_{BT_SAR_limit}$, $BT_SAR_design_limit$, and SAR_REG_limit are described in Table 2-3.

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2.2 Operating Parameters for Algorithm Validation

Table 2-1 Wi-Fi TA-SAR algorithm parameters

Algorithm parameters	Description
$P_{WF_SAR_limit}$ $(P_{WF_SAR_limit})$	<p>The time-averaged maximum power level limit corresponding to WF_SAR_design_limit.</p> <ul style="list-style-type: none"> For FCC, SAR_REG_limit: 1.6 W/kg (1g-SAR), 4 W/kg (10g-SAR). WF_SAR_design_limit is SAR_REG_limit minus device total uncertainty for more conservative assessment. P_WF_SAR_limit has the unique value for each Wi-Fi band/antenna/exposure condition index.
$P_{WF_SAR_MAX_limit}$ $(P_{WF_SAR_MAX_limit})$	<p>Wi-Fi TA-SAR maximum instantaneous TX power limit, which is less than or equal to maximum TX power $P_{WF_SAR_MAX}$ ($P_{WF_SAR_MAX}$) that can be possibly transmitted in Wi-Fi. The power limit is dynamically adjusted based on Wi-Fi TA-SAR algorithm.</p>

Table 2-2 Wi-Fi TA-PD algorithm parameters

Algorithm parameters	Description
$P_{WF_PD_limit}$ $(P_{WF_PD_limit})$	<p>The time-averaged maximum power level limit corresponding to WF_PD_design_limit.</p> <ul style="list-style-type: none"> For FCC, PD_REG_limit: 10 W/m² (4cm² PD) WF_PD_design_limit is PD_REG_limit minus device total uncertainty for more conservative assessment. P_WF_PD_limit has the unique value for each Wi-Fi band/antenna/exposure condition index.
$P_{WF_PD_MAX_limit}$ $(P_{WF_PD_MAX_limit})$	<p>Wi-Fi TA-PD maximum instantaneous PD TX power limit, which is less than or equal to maximum TX power $P_{WF_PD_MAX}$ ($P_{WF_PD_MAX}$) that can be possibly transmitted in Wi-Fi. The power limit is dynamically adjusted based on Wi-Fi TA-PD algorithm.</p>

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Table 2-3 BT TA-SAR algorithm parameters

Algorithm parameters	Description
$P_{BT_SAR_limit}$ $(P_{BT_SAR_limit})$	<p>The time-averaged maximum power level limit corresponding to BT_SAR_design_limit.</p> <ul style="list-style-type: none"> For FCC, SAR_REG_limit: 1.6 W/kg (1g-SAR), 4 W/kg (10g-SAR). BT_SAR_design_limit is SAR_REG_limit minus device total uncertainty for more conservative assessment. <p>$P_{BT_SAR_limit}$ has the unique value for each BT antenna/exposure condition index.</p>
$P_{BT_SAR_MAX_limit}$ $(P_{BT_SAR_MAX_limit})$	<p>BT TA-SAR maximum instantaneous SAR TX power limit, which is less than or equal to maximum TX power $P_{BT_SAR_MAX}$ ($P_{BT_SAR_MAX}$) that can be possibly transmitted in BT. The power limit is dynamically adjusted based on BT TA-SAR algorithm.</p>

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3 OVERVIEW OF WI-FI AND BT TA-SAR/TA-PD TEST PROPOSAL

For the completeness of verifying that the proposed TA-SAR/TA-PD algorithm can realize FCC compliance regarding RF exposure, several test scenarios for Wi-Fi system are constructed as below:

- **Wi-Fi test scenario 1:** Test TX mode change between normal mode and sleep mode to verify algorithm and SAR compliance.
- **Wi-Fi test scenario 2:** Test band handover to ensure algorithm control continuity and correctness.
- **Wi-Fi test scenario 3:** Test different transmission antennas to ensure algorithm control works correctly during antenna switch from one antenna to another.
- **Wi-Fi test scenario 4:** Test different ECI (Exposure Condition Index) to ensure algorithm control behaves as expected during ECI switch from one ECI to another. (ex., head→ body worn)
- **Wi-Fi test scenario 5:** Test TER under 2.4GHz band and 6GHz band simultaneous transmission. Since both SAR and PD are required in Wi-Fi 6GHz band, the maximum of normalized TA-SAR and normalized TA-PD in 6GHz band should be used in TER calculation. The proposed algorithm can ensure TA-SAR/TA-PD control correctness and prove the normalized total RF exposure is less than or equal to 1 (FCC requirement).

Table 3-1 shows the test scenario list for Wi-Fi TA-SAR/TA-PD validation. For Wi-Fi TA-SAR 2.4GHz and 5GHz bands validation, scenarios 1 to 4 are proposed to demonstrate FCC compliance. For Wi-Fi 7 MLO SAR and PD switch, scenario 5 is proposed. For Wi-Fi TA-PD 6GHz band validation, scenario 1 is proposed.

Table 3-1 Test scenario list for Wi-Fi TA-SAR/TA-PD validation

Test scenario		Description	Wi-Fi TA-SAR 2.4/5GHz	Wi-Fi TA-SAR 6GHz	Wi-Fi TA-PD 6GHz
1	TX mode change between normal mode and sleep mode	Test normal mode and sleep mode switch	✓	✓	✓
2	Band handover	Test 2.4G/5GHz band change	✓		
3	Antenna switching	Change antenna index	✓		
4	ECI (Exposure Condition Index) change	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	✓	✓	✓

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For BT TA-SAR/TA-PD validation, the following test scenario is constructed.

- **BT test scenario 1:** BT TX transmits maximum power with varying duty.

Table 3-2 shows the test scenario list for BT TA-SAR validation.

Table 3-2 Test scenario list for BT TA-SAR/TA-PD validation

Test scenario		Description	BT TA-SAR 2.4/5GHz	BT TA-SAR 6GHz	BT TA-PD 6GHz
1	TX with varying duty	BT TX transmits maximum power with varying duty	✓		

Wi-Fi and BT simultaneous transmission test scenario is constructed as below:

- **Wi-Fi and BT simultaneous transmission test scenario 1:** Wi-Fi and BT are assigned dynamic RF exposure budget individually with the sum of the total exposure budget ≤ 1 . Wi-Fi TA-SAR algorithm and BT TA-SAR algorithm operate interactively. Wi-Fi and BT are requested to transmit at individual maximum power levels. This scenario tests that the proposed TA-SAR algorithms can ensure compliance during Wi-Fi and BT simultaneous transmission.

Table 3-3 shows the test scenario list for the TA-SAR validation under Wi-Fi and BT simultaneous transmission.

Table 3-3 Test scenario list for Wi-Fi and BT simultaneous transmission TA-SAR validation

Test scenario		Description	Wi-Fi TA-SAR 5GHz	BT TA-SAR 2.4GHz
1	Wi-Fi and BT simultaneous TX	Wi-Fi and BT both transmit under max power requests	✓	✓

For the chipsets that will be used by Mediatek's customers, there are two(2) or three(3) antennas for different products. For ease of discussion, definitions of operational bands are as follows

- G-band: 2.4GHz band,
- A-band: one of the 5GHz band or 6GHz band.

Each antenna allows G-band transmission, A-band transmission, or simultaneous G-band + A-band transmission. For two-antenna chipsets, the maximum supported features are dual band dual concurrent (DBDC) G-band + A-band, in which case, there can be two spatial streams in G-band (out of two antennas) and two spatial streams in A-band (out of two antennas) simultaneously. For three-antenna chipsets, the maximum supported features are tri-bands, namely, 1 G-band + 2 A-bands, in which case, there can be two spatial streams in G-band (out of two antennas), two spatial streams in one A-band (out of two antennas), and one spatial stream in another A-band (out of one antenna) simultaneously.

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Wi-Fi operational conditions and antenna configurations are summarized in the following two tables, in which SISO means single-input single output and MIMO means multiple-input multiple output.

The table 3-4 summarizes all applicable Wi-Fi operational conditions for two-antenna chipsets, where representative antenna states are shown. For example, in G-band SISO, the table shows that Ant0 is active in G-band and Ant1 is off, while it can also be true that Ant0 is off and Ant1 is active in G-band.

Table 3-4 Wi-Fi operational conditions and antenna configurations

Operational conditions	Ant0	Ant1
G-band SISO	G-band	Off
G-band MIMO	G-band	G-band
A-band SISO	A-band	Off
A-band MIMO	A-band	A-band
G-band SISO + A-band SISO	G-band	A-band
G-band SISO + A-band MIMO	G-band + A-band	A-band
G-band MIMO + A-band SISO	G-band + A-band	G-band
G-band MIMO + A-band MIMO	G-band + A-band	G-band + A-band

The table 3-5 summarizes all applicable Wi-Fi operational conditions for three-antenna chipsets. The Ant2 is active only under tri-band transmission.

Table 3-5 Wi-Fi operational conditions and antenna configurations

Operational conditions	Ant0	Ant1	Ant2
G-band SISO	G-band	off	Off
G-band MIMO	G-band	G-band	Off
A-band SISO	A-band	off	Off
A-band MIMO	A-band	A-band	Off
G-band SISO + A-band SISO	G-band	A-band	Off
G-band SISO + A-band MIMO	G-band + A-band	A-band	Off
G-band MIMO + A-band SISO	G-band + A-band	G-band	Off
G-band MIMO + A-band MIMO	G-band + A-band	G-band + A-band	Off
G-band SISO + A-band SISO + another A-band SISO	G-band	A-band	Another A-band
G-band SISO + A-band MIMO + another A-band SISO	G-band + A-band	A-band	Another A-band
G-band MIMO + A-band SISO + another A-band SISO	G-band + A-band	G-band	Another A-band
G-band MIMO + A-band MIMO + another A-band SISO	G-band + A-band	G-band + A-band	Another A-band

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Regarding Wi-Fi + BT operations, the following options are available.

1. ANT0: Wi-Fi G-band + BT G-band (Wi-Fi and BT must be time-division multiplexed)
2. ANT0: Wi-Fi A-band + BT G-band
3. ANT1: Wi-Fi G-band + BT G-band (Wi-Fi and BT must be time-division multiplexed)
4. ANT1: Wi-Fi A-band + BT G-band

From the RF exposure perspective, (ANT0: Wi-Fi A-band + BT G-band) is worse than (ANT0: Wi-Fi G-band + BT G-band), similarly, (ANT1: Wi-Fi A-band + BT G-band) is worse than (ANT1: Wi-Fi G-band + BT G-band).

For each applicable operation condition, the algorithm parameters, such as $P_{WF_SAR_limit}$, time averaging window size, etc., can be adjusted accordingly to guarantee RF regulatory compliance. All applicable operation conditions have been considered in algorithm design and proposed test scenarios.

For Wi-Fi TA-SAR validation, description of the conducted power measurement test procedures is included in Sections 4.2~4.6, and description of the SAR measurement test procedures is included in Section 4.7. For Wi-Fi TA-PD validation, description of the conducted power measurement test procedures is included in Section 5.2, and description of the PD measurement test procedures is included in Section 5.3. For BT TA-SAR validation, description of the conducted power measurement test procedures is included in Section 6.2, and description of the SAR measurement test procedures is included in Section 6.3. For Wi-Fi and BT simultaneous transmission TA-SAR validation, description of the conducted power measurement test procedures is included in Section 8.2.

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4 WI-FI TA-SAR TEST SCENARIOS AND TEST PROCEDURES

In order to demonstrate that Wi-Fi TA-SAR algorithm performs as expected under various operating scenarios, Table 4-1 lists the test scenarios and test sequences to validate Wi-Fi TA-SAR algorithm. The test sequences are defined in Section 4.1. The details of each test procedures via conducted power and SAR measurements are described in Sections 4.2~4.6 and Section 4.7, respectively.

Table 4-1 Wi-Fi TA-SAR test scenario and test sequence list

Test scenario		Test sequence	Description	Device requirement
1	TX mode change between normal mode and sleep mode	Defined in Section 4.1	Test normal mode and sleep mode switch	
2	Band handover	Defined in Section 4.1	Test 2.4GHz/5GHz band change	Supports DBDC
3	Antenna switching	Defined in Section 4.1	Change antenna index	
4	ECI (Exposure Condition Index) change	Defined in Section 4.1	Test under ECI transition (e.g., head → body worn)	
5	Simultaneous SAR and PD	Defined in Section 4.1	TER of 2.4GHz TA-SAR and 6GHz TA-SAR/TA-PD	Supports WiFi DBDC or MLO

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4.1 Test Sequences for All Scenarios

The test sequence is predefined for Wi-Fi TA-SAR:

- **Wi-Fi TA-SAR test sequence:** Wi-Fi is requested to transmit static and maximum power with high duty cycle.

The test sequence is illustrated in Figure 4-1. The waveform of the test sequence is listed in Table 4-2.

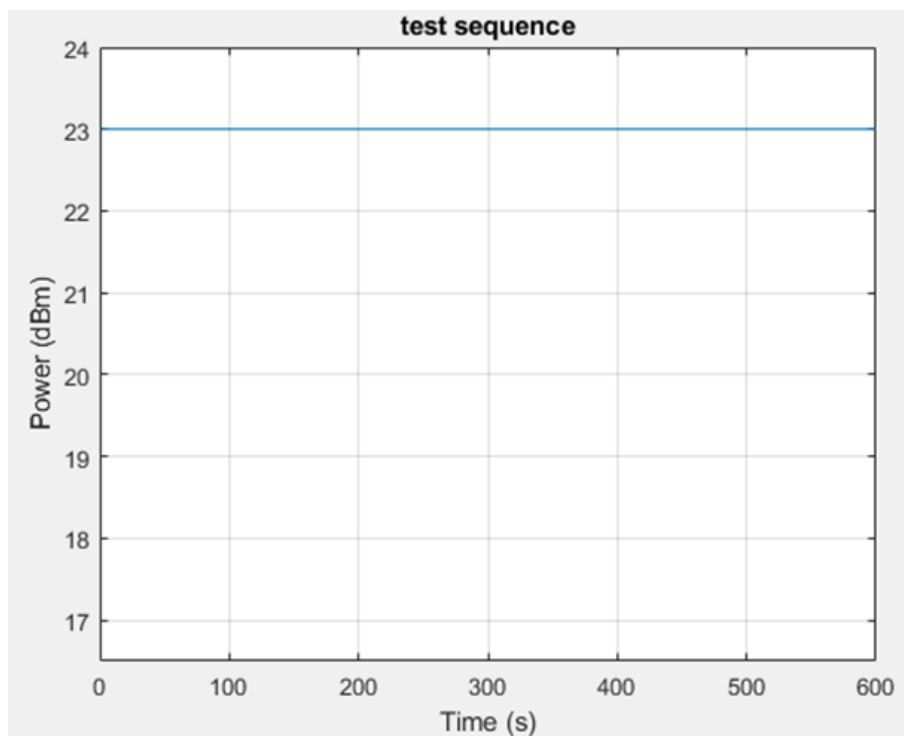


Figure 4-1 Wi-Fi TA-SAR test sequence

Table 4-2 Wi-Fi TA-SAR test sequence

Time (s)	Duration (s)	Power (dBm)	Note
0	600	23	Wi-Fi TX maximum power (P_WF_SAR_MAX)

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4.2 Test Configuration and Procedure for Wi-Fi TA-SAR Test Scenario 1: TX Mode Change between Normal Mode and Sleep Mode via Conducted Power Measurements

4.2.1 Configuration

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:

- 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.

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4.2.2 Procedure

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 $P_{WF_SAR_limit}$ calibration mode and measure $P_{WF_SAR_limit}$ 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.
 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: $SAR(\tau)$

$$SAR(\tau) = \frac{\text{conducted_inst_SAR_TX_power}(\tau)}{P_{WF_SAR_limit}} \times WF_SAR_design_limit$$

where $P_{WF_SAR_limit}$ is measured from step 1 and $WF_SAR_design_limit$ is measured worst case SAR value at $P_{WF_SAR_limit}$.

Time average SAR versus time: $Time_avg_SAR(t)$

$$Time_avg_SAR(t) = \frac{1}{T_{SAR}} \int_{t-T_{SAR}}^t SAR(\tau) d\tau$$

- Step 6: Plot results
 - A. Make one power perspective plot containing
 1. Instantaneous TX power
 2. Requested power (test sequence)
 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)

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4.3 Test Configuration and Procedure for Scenario 2: Band Handover via Conducted Power Measurements

4.3.1 Configuration

The scenario tests Wi-Fi 2.4GHz and 5GHz band handover and DBDC mode. The test configuration switches from 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 with the 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 $P_{WF_SAR_limit}$.

4.3.2 Procedure

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.

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- 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: $SAR_1(\tau)$ (band1), $SAR_2(\tau)$ (band2)

$$SAR_1(\tau) = \frac{conducted_inst_SAR_TX_power_1(\tau)}{P_{WF_SAR_limit_1}} \times WF_SAR_design_limit_1$$

$$SAR_2(\tau) = \frac{conducted_inst_SAR_TX_power_2(\tau)}{P_{WF_SAR_limit_2}} \times WF_SAR_design_limit_2$$

where $P_{WF_SAR_limit_1}$ and $P_{WF_SAR_limit_2}$ are measured from step 1,
 $WF_SAR_design_limit_1$ and $WF_SAR_design_limit_2$ are measured worst case SAR values at $P_{WF_SAR_limit_1}$ and $P_{WF_SAR_limit_2}$, respectively.

Time average SAR versus time: $Time_avg_SAR(t)$

$$Time_avg_SAR(t) = \frac{1}{T_{SAR}} \left[\frac{\int_{t-T_{SAR}}^t SAR_1(\tau) d\tau}{WF_SAR_REG_limit_1} + \frac{\int_{t-T_{SAR}}^t SAR_2(\tau) d\tau}{WF_SAR_REG_limit_2} \right]$$

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

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4.4 Test Configuration and Procedure for Wi-Fi TA-SAR Test Scenario 3: Antenna Switching via Conducted Power Measurements

4.4.1 Configuration

Wi-Fi first selects an antenna to transmit packets then switches to another antenna within the same band. For any band supporting multiple TX antennas, select the one with the highest difference in $P_{WF_SAR_limit}$ among all supported antennas.

- Select the band having the highest measured 1gSAR at $P_{WF_SAR_limit}$ if multiple bands having the same $P_{WF_SAR_limit}$ among supported antennas.
- Antenna selection order
 - Select the configuration with two antennas having $P_{WF_SAR_limit}$ values less than $P_{WF_SAR_MAX}$.
 - If the previous configuration does not exist, select the configuration with one antenna having $P_{WF_SAR_limit}$ value less than $P_{WF_SAR_MAX}$.
 - 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 $P_{WF_SAR_MAX}$.

4.4.2 Procedure

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

- Steps 1~4: Measure and record TX power versus time for test scenario 3.
 - Step 1: Start $P_{WF_SAR_limit}$ calibration mode and measure $P_{WF_SAR_limit}$ 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.
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.
- Step 5: Convert the measured conducted TX power into SAR based on the formulas for scenario 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 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

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It is noted that the following operations are done as well for this scenario:

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

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4.5 Test Configuration and Procedure for Wi-Fi TA-SAR Test Scenario 4: Exposure Condition Index (ECI) Change via Conducted Power Measurements

4.5.1 Configuration

The scenario tests the time-averaged TX power is less than the predefined TX limit at all times when exposure condition index changes which means $P_{WF_SAR_limit}$ changes in the test. This scenario selects any one band having two different $P_{WF_SAR_limit}$ values less than $P_{WF_SAR_MAX}$ in the two ECI groups. One test is sufficient as the feature operation is independent of technology and band.

4.5.2 Procedure

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

- Steps 1~4: Measure and record TX power versus time for test scenario 4.
 - Step 1: Start $P_{WF_SAR_limit}$ calibration mode and measure $P_{WF_SAR_limit}$ for the selected band/channel.
 - 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 ECI changes.
Connect to selected band with initial $P_{WF_SAR_limit}$ in one ECI group index:
Configure pre-defined TX power sequence to DUT for selected band and then DUT transmits packets for 400s.
Change $P_{WF_SAR_limit}$ value to another ECI group index: Set the command to change $P_{WF_SAR_limit}$ for 400s
- Step 5: Convert the measured conducted TX power into SAR based on the formulas for scenario 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 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

It is noted that the following operations are done as well for this scenario:

- The correct power control is controlled by TA_SAR when ECI switches from one to another.
- 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.

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4.6 Test Configuration and Procedure for Wi-Fi TA-SAR Test Scenario 5: Simultaneous SAR and PD via Conducted Power Measurements

4.6.1 Configuration

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 $P_{WF_PD_MAX}$.

4.6.2 Procedure

- Steps 1~4: Measure and record TX power versus time for test scenario 5.
 - Step 1: Start $P_{WF_SAR_limit}$ and $P_{WF_PD_limit}$ calibration mode, measure $P_{WF_SAR_limit}$ for the selected 2.4GHz band, and measure $P_{WF_SAR_limit}$ and $P_{WF_PD_limit}$ 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

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

For TA-PD of each band at 6GHz band

$$PD_{m,normalized} = \frac{PD_{m,avg}}{PD_{m,limit}} = \frac{\frac{1}{T_{APDm}} \int_{t-T_{APDm}}^t PD_m(\tau) d\tau}{PD_REG_limit_m}$$

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

$$SAR(\tau) = \frac{\text{conducted_inst_SAR_TX_power}(\tau)}{P_{WF_SAR_limit}} \times WF_SAR_design_limit$$

$$PD(\tau) = \frac{\text{conducted_inst_PD_TX_power}(\tau)}{P_{WF_PD_limit}} \times WF_PD_design_limit$$

where $P_{WF_SAR_limit}$ is measured from step 1 and $WF_SAR_design_limit$ is measured worst case SAR value at $P_{WF_SAR_limit}$, $P_{WF_PD_limit}$ is measured from step 1 and $WF_PD_design_limit$ is measured worst case PD value at $P_{WF_PD_limit}$.

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 normalized time-averaged PD for 6GHz band
 3. Total Exposure Ratio (TER)
 4. FCC TER limit of 1

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4.7 Test Configuration and Procedure for Wi-Fi TA-SAR Test Scenario 1: TX Mode Change between Normal Mode and Sleep Mode via SAR Measurements

4.7.1 Configuration

The test procedures in the previous sections (Sections 4.2 ~ 4.6) mainly focus on measuring conducted TX power, in this section test via SAR measurement is performed. The validation can be provided by performing one test scenario from the previous section.

In this test via SAR measurement, the test configuration of test scenario 1 in Section 4.2.1 is used.

4.7.2 Procedure

SAR is measured and recorded by the following steps:

- Steps 1~3: Measure and record TA-SAR versus time for test scenario 1.
 - Step 1: Start $\text{meas_SAR_}P_{WF_SAR_limit}$ calibration mode for the selected band/channel. Measure meas_SAR at peak location of the area scan where $\text{meas_SAR_}P_{WF_SAR_limit}$ corresponds to this meas_SAR value at $P_{WF_SAR_limit}$.
 - 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 instantaneous SAR versus time.

- Step 4: Convert the measured SAR into time-averaged SAR.

Convert the instantaneous measured SAR from step 3 into 1gSAR or 10gSAR value.

Perform the running time average to 1gSAR or 10g SAR to determine the time-averaged value versus time by the following equations.

Instantaneous 1gSAR or 10gSAR versus time: $SAR(\tau)$

$$SAR(\tau) = \frac{\text{meas_SAR}(\tau)}{\text{meas_SAR_}P_{WF_SAR_limit}} \times WF_SAR_design_limit$$

where $\text{meas_SAR_}P_{WF_SAR_limit}$ is measured from step 1, $\text{meas_SAR}(\tau)$ is the instantaneous SAR measured in step 3, and $WF_SAR_design_limit$ is the measured worse-case SAR value at $P_{WF_SAR_limit}$.

$$Time_avg_SAR(t) = \frac{1}{T_{SAR}} \int_{t-T_{SAR}}^t SAR(\tau) d\tau$$

- Step 5: Plot results
 - A. Calculated time-averaged 1gSAR or 10gSAR
 - B. FCC limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)

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5 WI-FI TA-PD TEST SCENARIOS AND TEST PROCEDURES

In order to demonstrate that TA-PD algorithm performs as expected under various operating scenarios, Table 5-1 lists the test scenarios and test sequences to validate TA-PD algorithm. The details of test procedures via conducted power and PD measurements are described in Sections 5.2 and 5.3

Table 5-1 Test scenario and test sequence list for Wi-Fi TA-PD validation

Test scenario		Test sequence	Description	Device requirement
1	TX mode change between normal mode and sleep mode	Defined in Section 5.1	Test normal mode and sleep mode switch	Supports 6GHz band

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5.1 Wi-Fi TA-PD Test Sequences

The test sequence is predefined for Wi-Fi TA-PD:

- **Wi-Fi TA-PD test sequence:** Wi-Fi TX is requested to transmit static and maximum power with high duty.

The test sequence is illustrated in Figure 5-1. The waveform of the test sequence is listed in Table 5-2.

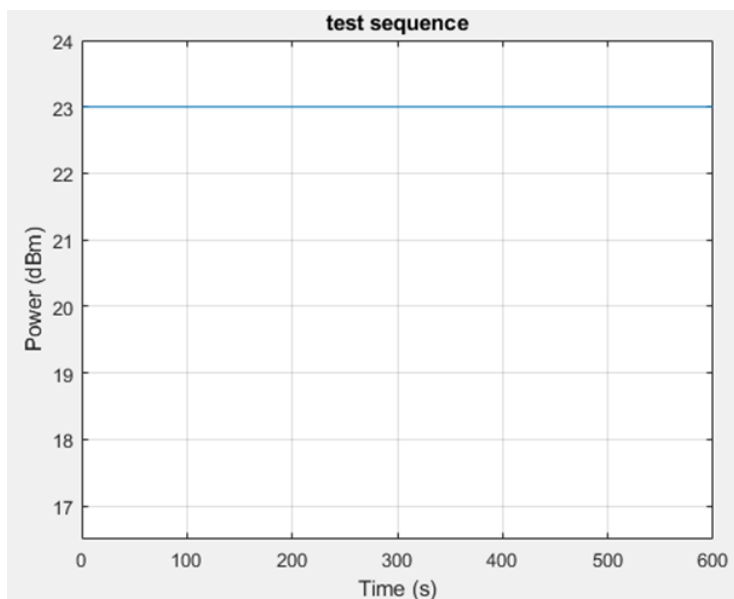


Figure 5-1 Wi-Fi TA-PD test sequence

Table 5-2 Wi-Fi TA-PD test sequence

Time (s)	Duration (s)	Power (dBm)	Note
0	600	23	Wi-Fi TX maximum power (P_WF_PD_MAX)

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5.2 Test Configuration and Procedure for Wi-Fi TA-PD Test Scenario 1: TX Mode Change between Normal Mode and Sleep Mode via Conducted Power Measurements

5.2.1 Configuration

The scenario tests Wi-Fi TX mode switching from normal throughput mode to sleep mode. Since Mediatek's TA-PD 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 $P_{WF_PD_limit}$ values (corresponding to $WF_PD_design_limit$) and are described as below:

- Select one band with least $P_{WF_PD_limit}$ among the ones whose $P_{WF_PD_limit}$ values are below $P_{WF_PD_MAX}$.
 - Only one band needs to be tested if all the bands have same $P_{WF_PD_limit}$.
 - Only one band needs to be tested if only one band has $P_{WF_PD_limit}$ below $P_{WF_PD_MAX}$.
 - If the same least $P_{WF_PD_limit}$ applies to multiple bands, select the band with the highest measured PD at $P_{WF_PD_limit}$.
 - If $P_{WF_PD_limit}$ values of all bands are over $P_{WF_PD_MAX}$, there is no need to test these bands.

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5.2.2 Procedure

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 $P_{WF_PD_limit}$ calibration mode and measure $P_{WF_PD_limit}$ for the selected band.
 - Step 2: Establish radio link with AP in the selected band and enable TA-PD.
 - 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 for 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 PD.

Convert the measured conducted TX power from Step 4 into spatial-averaged PD value using the following equation. Perform the running time average to power and spatial-averaged PD value to determine time-averaged value versus time as follows.

Instantaneous PD versus time: $PD(\tau)$

$$PD(\tau) = \frac{\text{conducted_inst_PD_TX_power}(\tau)}{P_{WF_PD_limit}} \times WF_PD_design_limit$$

where $P_{WF_PD_limit}$ is measured from step 1 and $WF_PD_design_limit$ is measured worst case PD value at $P_{WF_PD_limit}$.

Time-averaged PD versus time: $Time_avg_PD(\tau)$

$$Time_avg_PD(t) = \frac{1}{T_{PD}} \int_{t-T_{PD}}^t PD(\tau) d\tau$$

- 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 PD
 2. FCC limit of 10W/m² (PD)

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5.3 Test Configuration and Procedure for Wi-Fi TA-PD Test Scenario 1: TX Mode Change between Normal Mode and Sleep Mode via PD Measurements

5.3.1 Configuration

The test procedure in the previous section (Section 5.2) mainly focuses on measuring conducted TX power, in this section test via PD measurement is performed. The validation can be provided by performing test scenario 1.

5.3.2 Procedure

PD is measured and recorded by the following steps:

- Steps 1~3: measure and record TA-PD versus time for test scenario 1.
 - Step 1: Start $meas_PD_{P_{WF_PD_limit}}$ calibration mode for the selected band/channel. Measure $meas_PD$ at peak location of the area scan and the $meas_PD_{P_{WF_PD_limit}}$ corresponds to this $meas_PD$ value at $P_{WF_PD_limit}$.
 - Step 2: Establish radio link with AP in the selected band and enable TA-PD.
 - Step 3: Configure pre-defined TX power sequence to DUT and measure instantaneous PD versus time.
- Step 4: Convert the measured PD into time-averaged PD.
Convert the instantaneous measured PD from step 3 into spatial-averaged PD value. Perform the running time average to spatial-averaged PD value to determine time-averaged value versus time by following equations.
Instantaneous PD versus time: $PD(\tau)$

$$PD(\tau) = \frac{meas_PD(\tau)}{meas_PD_{P_{WF_PD_limit}}} \times WF_PD_design_limit$$

where $meas_PD_{P_{WF_PD_limit}}$ is measured from step 1, $meas_PD(\tau)$ is the instantaneous measured PD measured in step 3, and $WF_PD_design_limit$ is the measured worse-case PD value at $P_{WF_PD_limit}$.

$$Time_avg_PD(\tau) = \frac{1}{T_{PD}} \int_{t-T_{PD}}^t PD(\tau) d\tau$$

- Step 5: Plot results
 - A. Calculated time-averaged PD
 - B. FCC limit of 10W/m² (PD)

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6 BT TA-SAR TEST SCENARIOS AND TEST PROCEDURES

In order to demonstrate that BT TA-SAR algorithm performs as expected under various operating scenarios, Table 6-1 lists the test scenarios and test sequences to validate TA-SAR algorithm. The test sequences are defined in Section 6.1. The details of test procedures via conducted power and SAR measurements are described in Section 6.2 and Section 6.3.

Table 6-1 Test scenario and test sequence list for BT TA-SAR validation

Test scenario		Test sequence	Description
1	TX with varying duty	Defined in Section 6.1	BT TX transmits maximum power with varying duty

6.1 BT TA-SAR Test Sequences

The test sequence is predefined for BT TA-SAR:

- **BT TA-SAR test sequence:** BT TX is requested to transmit static and maximum power with varying duty cycles.

The maximum power of the test sequence is listed in Table 6-2. The duty cycles of the test sequence are illustrated in Figure 6-1, while the power of the test sequence under maximum power with the given varying duty cycles is illustrated in Figure 6-2.

Table 6-2 Test sequence

Start Time (s)	Duration (s)	Power (dBm)	Note
0	1000	18	BT TX maximum power (P_BT_SAR_MAX)

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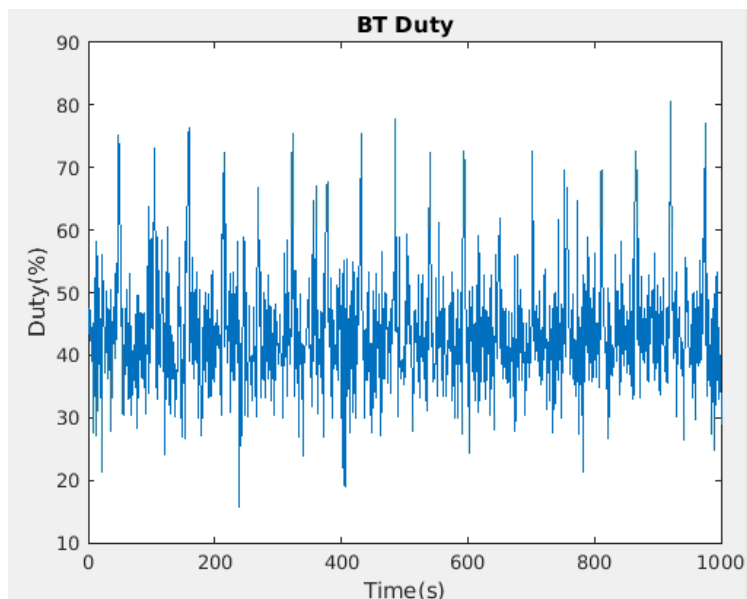


Figure 6-1 The duty cycles of BT TA-SAR test sequence

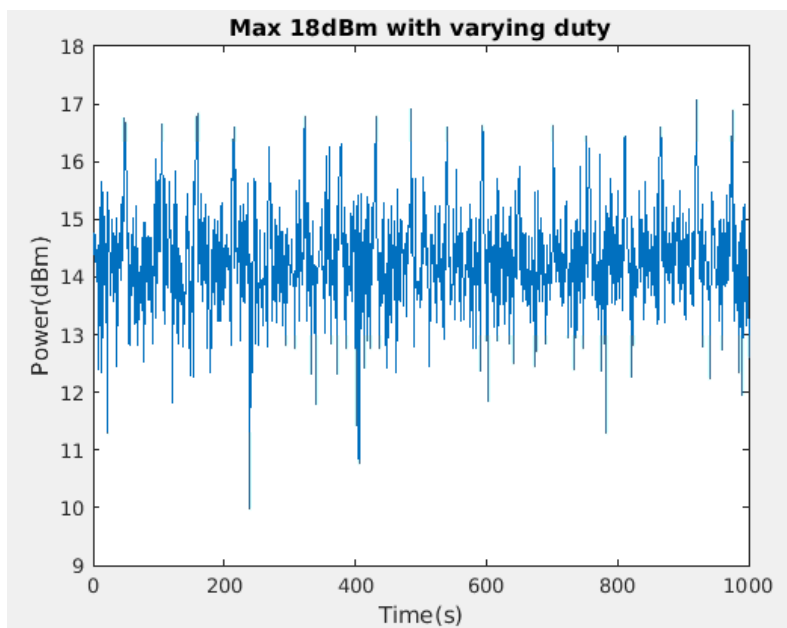


Figure 6-2 The actual power of BT TA-SAR test sequence corresponding to max power with varying duty cycles shown in Figure 6-2

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6.2 Test Configuration and Procedure for BT TA-SAR Test Scenario 1: TX with Varying Duty via Conducted Power Measurements

6.2.1 Configuration

The scenario tests BT TX with varying duty at 2.4GHz band. For the varying BT duty defined in the test sequence, select the $P_{BT_SAR_limit}$ value which is lower than the average BT TX power ($P_{BT_SAR_MAX}$ with duty pattern) of the test sequence. If the $P_{BT_SAR_limit}$ value is larger than the average BT TX power of the test sequence, a scaling ratio which is less than 1 can be defined and used to scale down the $P_{BT_SAR_limit}$ to test BT TA-SAR algorithm.

6.2.2 Procedure

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

- Steps 1~3: Measure and record TX power versus time for test scenario 1.
 - Step 1: Start $P_{BT_SAR_limit}$ calibration mode and measure $P_{BT_SAR_limit}$ 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: Convert the measured conducted TX power into SAR.
Convert the measured conducted TX power from Step 3 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: $SAR(\tau)$

$$SAR(\tau) = \frac{conducted_inst_SAR_TX_power(\tau)}{P_{BT_SAR_limit}} \times BT_SAR_design_limit$$

where $P_{BT_SAR_limit}$ is measured from step 1 and SAR_design_limit is measured worst case SAR value at $P_{BT_SAR_limit}$.

Time average SAR versus time: $Time_avg_SAR(t)$

$$Time_avg_SAR(t) = \frac{1}{T_{SAR}} \int_{t-T_{SAR}}^t SAR(\tau) d\tau$$

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- Step 5: Plot results
 - A. Make one power perspective plot containing
 1. Instantaneous TX power
 2. Requested power (test sequence)
 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)

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6.3 Test Configuration and Procedure for BT TA-SAR Test Scenario 1: TX with Varying Duty via SAR Measurements

6.3.1 Configuration

The test procedure in the previous section (Section 6.2) mainly focuses on measuring conducted TX power, in this section test via SAR measurements is performed. The validation can be provided by performing test scenario 1.

6.3.2 Procedure

SAR is measured and recorded by the following steps:

- Steps 1~3: Measure and record TA-SAR versus time for test scenario 1.
 - Step 1: Start $meas_SAR_{P_{BT_SAR_limit}}$ calibration mode for the selected band/channel. Measure $meas_SAR$ at peak location of the area scan where $meas_SAR_{P_{BT_SAR_limit}}$ corresponds to this $meas_SAR$ value at $P_{BT_SAR_limit}$.
 - 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 instantaneous SAR versus time.

- Step 4: Convert the measured SAR into time-averaged SAR.

Convert the instantaneous measured SAR from step 3 into 1gSAR or 10gSAR value.

Perform the running time average to 1gSAR or 10g SAR to determine the time-averaged value versus time by the following equations.

Instantaneous 1gSAR or 10gSAR versus time: $SAR(\tau)$

$$SAR(\tau) = \frac{meas_SAR(\tau)}{meas_SAR_{P_{BT_SAR_limit}}} \times BT_SAR_design_limit$$

where $meas_SAR_{P_{BT_SAR_limit}}$ is measured from step1, $meas_SAR(\tau)$ is the instantaneous measured SAR measured in step 3, and $BT_SAR_design_limit$ is measured worse-case SAR value at $P_{BT_SAR_limit}$.

$$Time_{avg_SAR}(t) = \frac{1}{T_{SAR}} \int_{t-T_{SAR}}^t SAR(\tau) d\tau$$

- Step 5: Plot results
 - A. Calculated time-averaged 1gSAR or 10gSAR
 - B. FCC limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)

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7 WI-FI AND BT SIMULTANEOUS TRANSMISSION TA-SAR TEST SCENARIOS AND TEST PROCEDURES

In order to demonstrate that Wi-Fi and BT simultaneous transmission TA-SAR algorithms perform as expected under various operating scenarios, Table 7-1 lists the test scenarios and test sequences to validate Wi-Fi and BT simultaneous transmission TA-SAR algorithms.

The purpose of system level Wi-Fi and BT simultaneous transmission is to demonstrate the compliance continuity in the following scenarios:

1. Across Wi-Fi and BT technology switch
2. Total exposure ratio of Wi-Fi and BT simultaneous transmission

Table 7-1 Test scenario and test sequence list for Wi-Fi and BT simultaneous transmission TA-SAR validation

Test scenario		Test sequence	Description
1	Wi-Fi and BT Simultaneous TX	Wi-Fi test sequence 1 defined in Section 4.1 and BT test sequence 1 defined in Section 6.1	Wi-Fi and BT both transmit under max power requests

7.1 Wi-Fi and BT simultaneous transmission TA-SAR Test Sequences

To validate Wi-Fi and BT simultaneous transmission TA-SAR algorithms, both Wi-Fi test sequence 1 defined in Section 4.1 and BT test sequence 1 defined in Section 6.1 are used.

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7.2 Test Configuration and Procedure for Wi-Fi and BT Simultaneous Transmission

Test Scenario 1: Wi-Fi and BT Simultaneous TX via Conducted Power Measurements

7.2.1 Configuration

The test flow of the system level compliance test is shown in figure 8-1. The test contains 4 sections and 3 transitions: Start with Wi-Fi and BT simultaneous transmission (Section A), drop off BT radio and transition to Wi-Fi only transmission (Section B), then transition to Wi-Fi and BT simultaneous transmission (Section C), and finally transition to BT only transmission (Section D).



Figure 8-1 Wi-Fi and BT simultaneous transmission scenario

The configuration contains both Wi-Fi configuration and BT configuration.

- For Wi-Fi, select one channel of Wi-Fi 2.4GHz/5GHz band with measured $P_{WF_SAR_limit}$ less than $P_{WF_SAR_MAX}$. Pre-allocate a TER budget x , to obtain the Wi-Fi budgeted limit $x \cdot P_{WF_SAR_limit}$.
- For BT, select one channel of BT 2.4GHz/5GHz band with measured $P_{BT_SAR_limit}$ value lower than the average BT TX power ($P_{BT_SAR_MAX}$ with duty pattern) of the test sequence. Pre-allocate a TER budget y , to obtain the BT budgeted limit $y \cdot P_{BT_SAR_limit}$.
- The dynamic exposure budget allocation mechanism assigns different budgets for Wi-Fi and BT based on each radio power and duty requirement, which means x and y are varying over time.
- The constraint on the TER budgets is $x + y \leq 1$.

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7.2.2 Procedure

For Wi-Fi and BT, TX power is measured, recorded, and processed by the following steps:

- Steps 1~4: Measure and record TX power versus time.
 - Step 1: Start $P_{WF_SAR_limit}$ and $P_{WF_BT_limit}$ calibration mode, measure $P_{WF_SAR_limit}$ and $P_{WF_BT_limit}$ for the selected band.
 - Step 2: Establish link with AP for the selected band and enable TA-SAR and TA-BT.
 - Step 3: Configure pre-defined TX power sequences of Wi-Fi and BT to DUT and measure TX power versus time.
 - Step 4: Set DUT to the Wi-Fi and BT test scenario as depicted in Figure 8-1.
 - ◆ Section A: Connect with Wi-Fi and BT to have simultaneous transmission. Request Wi-Fi and BT to transmit at maximum power and maximum duty for at least 200s.
 - ◆ Section B: Drop BT connection and request Wi-Fi only to transmit at maximum power and maximum duty for at least 100s.
 - ◆ Section C: Request Wi-Fi and BT to transmit at maximum power and maximum duty for at least 200s.
 - ◆ Section D: Drop Wi-Fi connection and request BT only to transmit at maximum power and maximum duty.
- Step 5: Convert the measured Wi-Fi conducted TX power into SAR based on the formulas for Wi-Fi test scenario 1 and convert the measured BT conducted TX power into SAR based on the formulas for BT test scenario 1.
- Step 6: Plot results
 - A. Make one Wi-Fi power perspective plot containing
 1. Wi-Fi instantaneous TX power
 2. Wi-Fi calculated time-averaged power
 3. Wi-Fi budgeted power limit $x \cdot P_{WF_SAR_limit}$
 - B. Make one BT power perspective plot containing
 1. BT instantaneous TX power
 2. BT calculated time-averaged power
 3. BT budgeted power limit $y \cdot P_{BT_SAR_limit}$
 - C. Make one SAR perspective plot containing
 1. Normalized Wi-Fi 1g SAR or 10g SAR
 2. Normalized BT 1g SAR or 10g SAR
 3. Normalized total time-averaged 1g SAR or 10g SAR over time
 4. Normalized FCC limit of 1.6 W/kg (1g SAR) or 4.0 W/kg (10g SAR)

The validation criteria are

1. At all times, Wi-Fi time-averaged power is below $x \cdot P_{WF_SAR_limit}$ and BT time-averaged power is below $y \cdot P_{BT_SAR_limit}$; or
2. At all times, the time-averaged total 1g SAR or 10g SAR versus time shall not exceed FCC limit of 1.6 W/kg for 1g SAR or 4.0 W/kg for 10g SAR.

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8 WI-FI TA-SAR VALIDATION VIA CONDUCTED POWER MEASUREMENTS

For conducted power measurements, TA-SAR algorithm is implemented in firmware in a phone and a notebook. The exact measurement setup diagrams for Android DUT and Windows DUT are shown in Section 8.1.

8.1 Measurement Setup

The general measurement setup for Android DUT is shown in Figure 8-1. There is a control PC which controls DUT and peer devices that act as soft-AP or STA. The WLAN traffic is established between peer devices and DUT, e.g., an engineering model of smart phone. The traffic from DUT TX is UDP and controlled by control PC. For Windows DUT, the general measurement setup is shown in Figure 8-2. Different from Android DUT, the TA-SAR control program is executed in Windows DUT.

The test sequence and scenarios are controlled by PC command. The transmitter power is measured with spectrum analyzers. There are two peer devices and two spectrum analyzers to support test scenarios with multiple operation frequencies. Furthermore, the moving average of each measured power is calculated to ensure the conductive time-averaging power is always below the power limit threshold.

The test measurement setup for test scenarios 1 and 4 is illustrated in Figure 8-3. The test measurement setup for test scenarios 2 and 5 is illustrated in Figure 8-4. The test measurement setup for test scenario 3 is illustrated in Figure 8-5. Note that for test scenario 3, an RF attenuator is added to the conductive path to provide proper attenuation from DUT to AP and DUT to spectrum analyzer.

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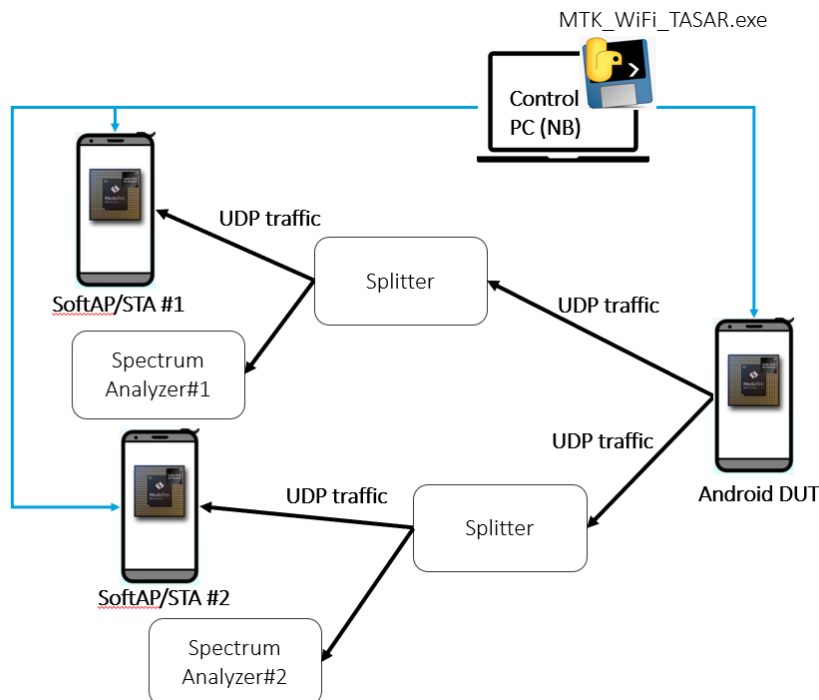


Figure 8-1. General setup for Wi-Fi TA-SAR conducted power measurement for Android DUT

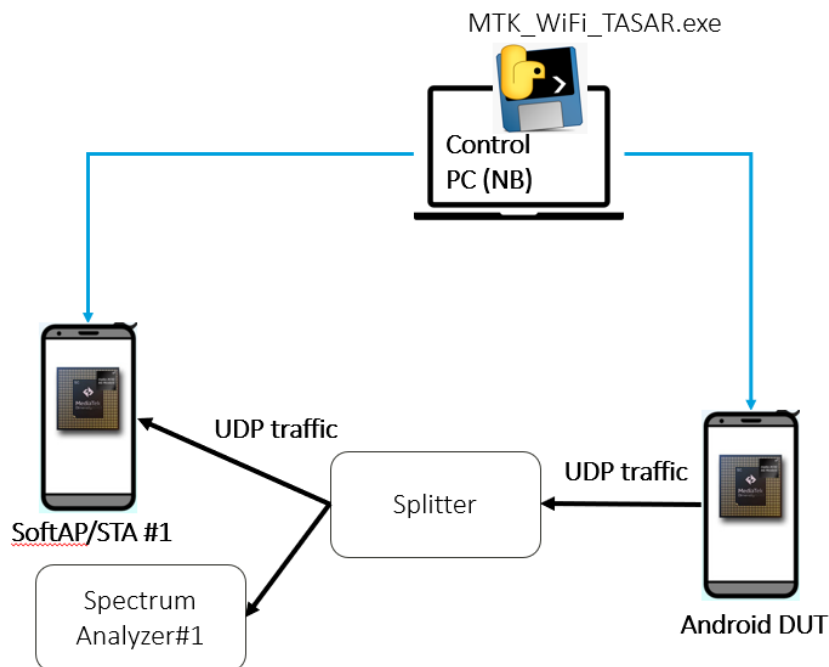


Figure 8-2. Wi-Fi TA-SAR conducted power test setup for test scenarios 1 and 4 with Android DUT

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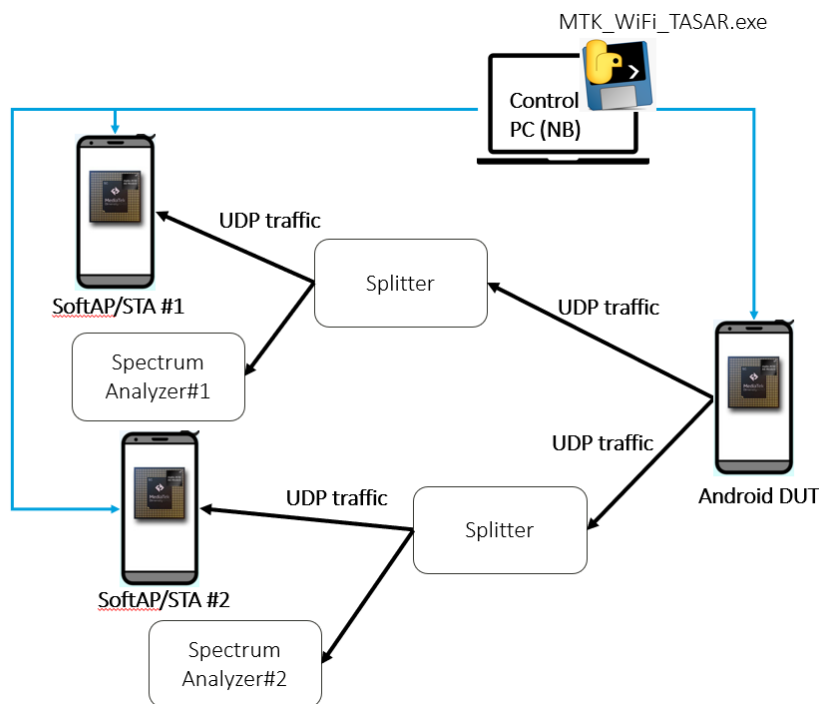


Figure 8-3. Wi-Fi TA-SAR conducted power test setup for test scenarios 2 and 5 with Android DUT

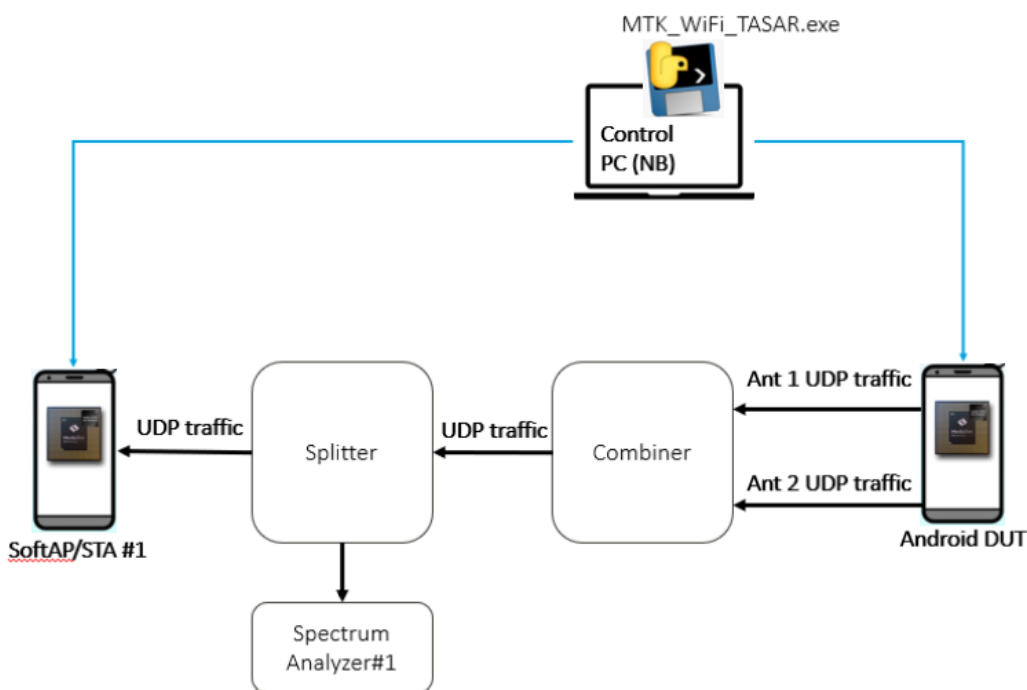


Figure 8-4. Wi-Fi TA-SAR conducted power test setup for test scenario 3 with Android DUT

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Spectral analyzer utilizing zero-span mode is used for monitoring the time-domain conductive power of the DUT. This spectral analyzer may be replaced by a power probe or other time-domain power logging instrument as well. The detailed setup of the spectral analyzer is shown as follow:

Center frequency:= WLAN channel frequency
 Span: Zero span
 RBW: Spectral analyzer's maximum capability (8MHz for Keysight PXA N9030A)
 VBW: =RBW
 Sweep Time: 1400s
 Sweep Point: =10 times of sweep time + 1 = 14001
 Detector mode: RMS
 Trace mode: Single hold (clear write)

Since the WLAN data bandwidth (ex. 20MHz) is larger than the max resolution bandwidth of spectral analyzer, a power correlation method is essential to determine the actual conductive channel power (per data bandwidth occupied) from the readout of the spectral analyzer (in terms of power density dBm/RBW).

The correlation term that accounts for the conductive power to spectral analyzer readout and RF cable loss is obtained with the following steps:

1. Setup the TA-SAR conductive measurement as shown in Figure 10-1 to Figure 10-4.
2. Configure DUT to MTK engineering mode and set DUT to continuous packet TX mode (duty cycle $\geq 98\%$) with TX information such as WLAN channel, rate, and TX power.
3. Determine the power correlation term as

$$Corr. = DUT\ TX\ power - measured\ power\ of\ the\ spectral\ analyzer$$

The readout of the spectral analyzer is thus correlated to the actual conductive channel power at the DUT output port by arithmetically adding *Corr.* to the raw data in mW domain.

In control PC, an executable file named MTK_WiFi_TASAR.exe controls the test of TA-SAR/TA-PD according to different test scenarios. It controls the connections between DUT and peer devices, controls test sequence according to the selected test scenario, starts the UDP traffic from DUT, and pulls the logs from DUT.

Logs	2022/7/18 上午 12:28
_bz2.pyd	2022/6/4 下午 11:39
_decimal.pyd	2022/6/4 下午 11:39
_hashlib.pyd	2022/6/4 下午 11:39
_lzma.pyd	2022/6/4 下午 11:39
_socket.pyd	2022/6/4 下午 11:39
base_library.zip	2022/7/18 上午 12:28
libcrypto-1_1.dll	2022/6/4 下午 11:39
MTK_WiFi_TASAR.exe	2022/7/18 上午 12:28
python310.dll	2022/6/4 下午 11:39
select.pyd	2022/6/4 下午 11:39
unicodedata.pyd	2022/6/4 下午 11:39
VCRUNTIME140.dll	2022/6/4 下午 11:39

Figure 8-5. Control scripts executed in control PC

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8.2 Conducted Power Measurement Results for Wi-Fi TA-SAR Test Scenario 1: TX Mode Change between Normal Mode and Sleep Mode

This test is the conducted power measurement for Wi-Fi 2.4GHz band and 6GHz band TX mode change. The detailed setting is listed in Table 8-1 and Table 8-2. Figure 8-6 demonstrates the DUT's instantaneous conducted TX power, the time-averaged conducted TX power behavior over time, and the power limit for test scenario 1-1 and test scenario 1-2. Figure 8-7 illustrate the corresponding time-averaged SAR over time converted from the TX time-averaged power by using the equation listed in Section 4.2.2. As seen in this figure, the time-averaged SAR does not exceed the FCC limit.

Table 8-1 TA-SAR parameters setting for test scenario 1-1

Test band	$P_{WF_SAR_MAX}$	$P_{WF_SAR_limit}$
2.4GHz	22 dBm	13 dBm

Table 8-2 TA-SAR parameters setting for test scenario 1-2

Test band	$P_{WF_SAR_MAX}$	$P_{WF_SAR_limit}$
6GHz	14 dBm	5 dBm

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Pass

[FCC] Wi-Fi - Case 1-1 : 2G SAR TX Mode Change between Normal Mode and Sleep Mode

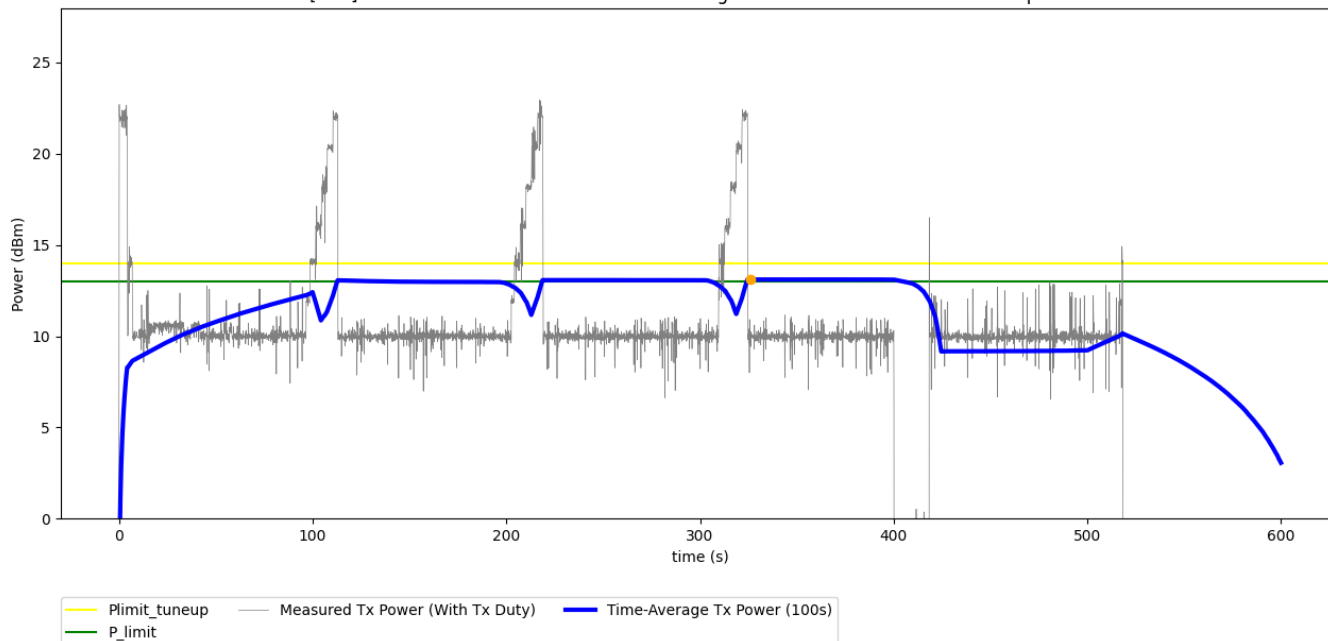


Figure 8-6 Time-averaged conducted TX power over time for test scenario 1-1

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[FCC] Wi-Fi - Case 1-2-2 : 6G SAR TX Mode Change between Normal Mode and Sleep Mode

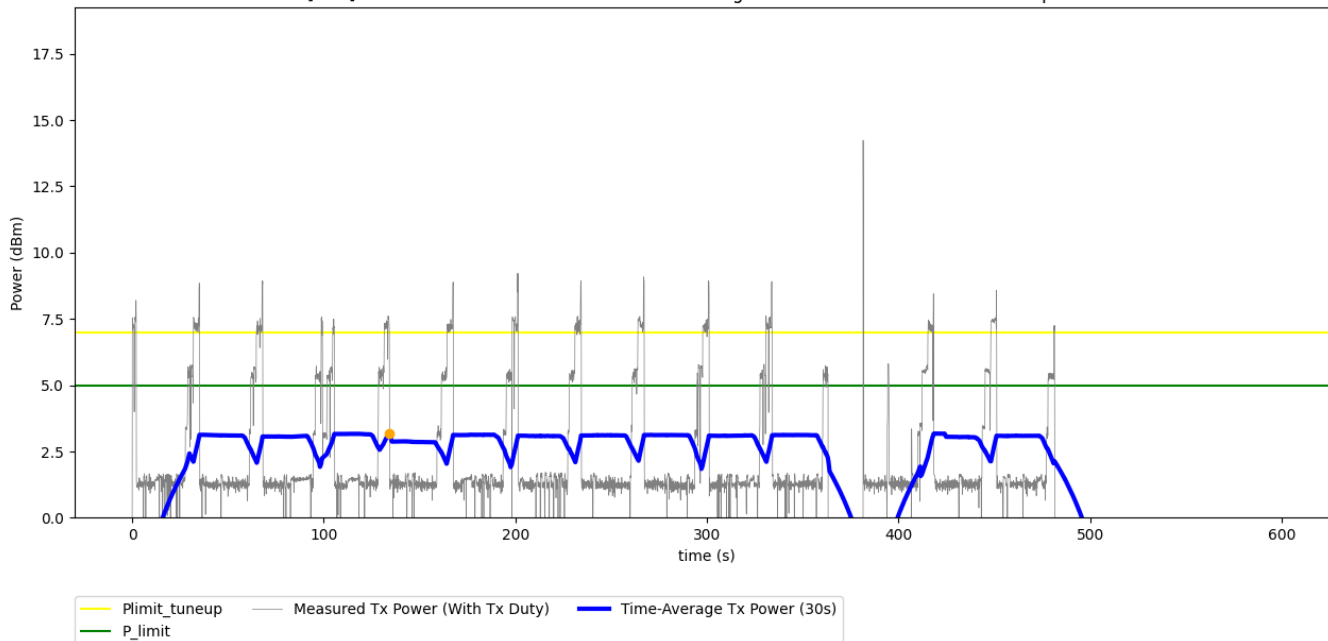


Figure 8-7 Time-averaged conducted TX power over time for test scenario 1-2

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8.3 Conducted Power Measurement Results for Wi-Fi TA-SAR Test Scenario 2: Band Handover

This test is the conducted power measurement for Wi-Fi 2.4GHz/5GHz band handover. The detailed setting is listed in Table 8-3. Figure 8-8 demonstrates the DUT's instantaneous conducted TX power, the time-averaged conducted TX power behavior over time, and the power limit. Figure 8-9 illustrates the corresponding time-averaged SAR over time converted from the TX time-averaged power by using the equation listed in Section 4.3.2. As seen in this figure, the normalized time-averaged SAR does not exceed the FCC limit.

Table 8-3 TA-SAR parameters setting for test scenario 2

Test band	Switch time	$P_{WF_SAR_MAX}$	$P_{WF_SAR_limit}$
2.4GHz	0~400s	22 dBm	13 dBm
5GHz	400s~800s	18 dBm	9.5 dBm

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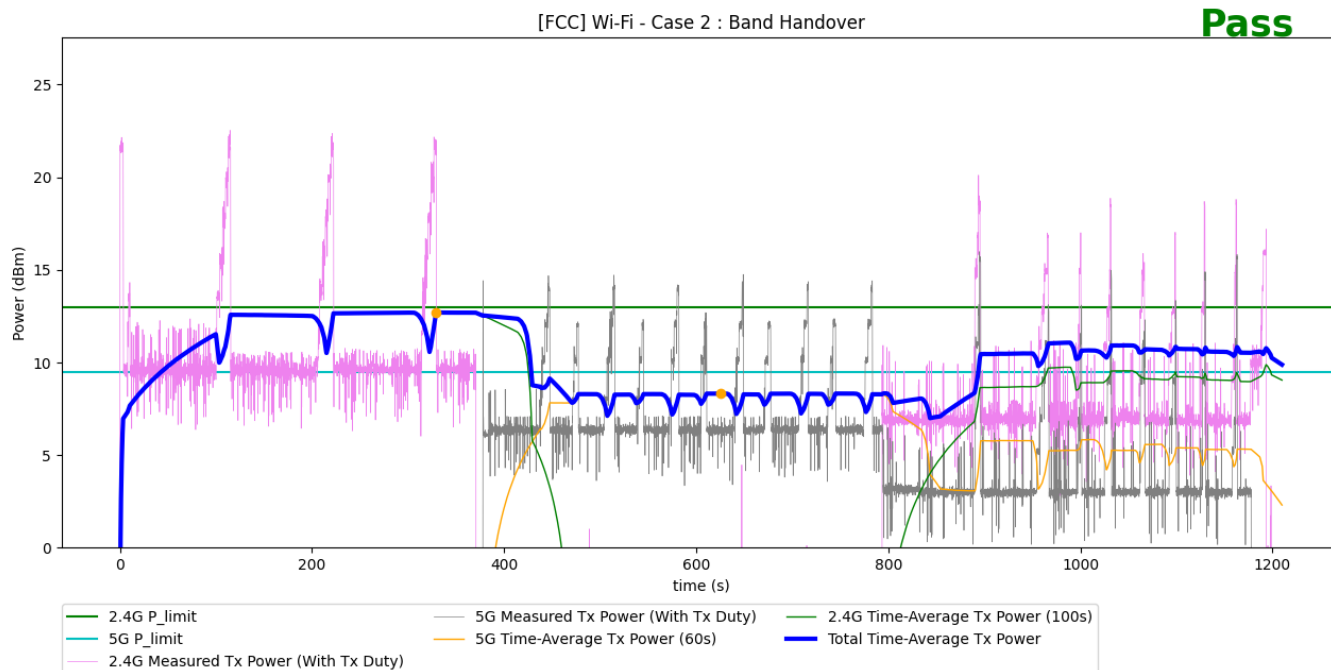


Figure 8-8 Time-averaged conducted TX power over time for Wi-Fi TA-SAR test scenario 2

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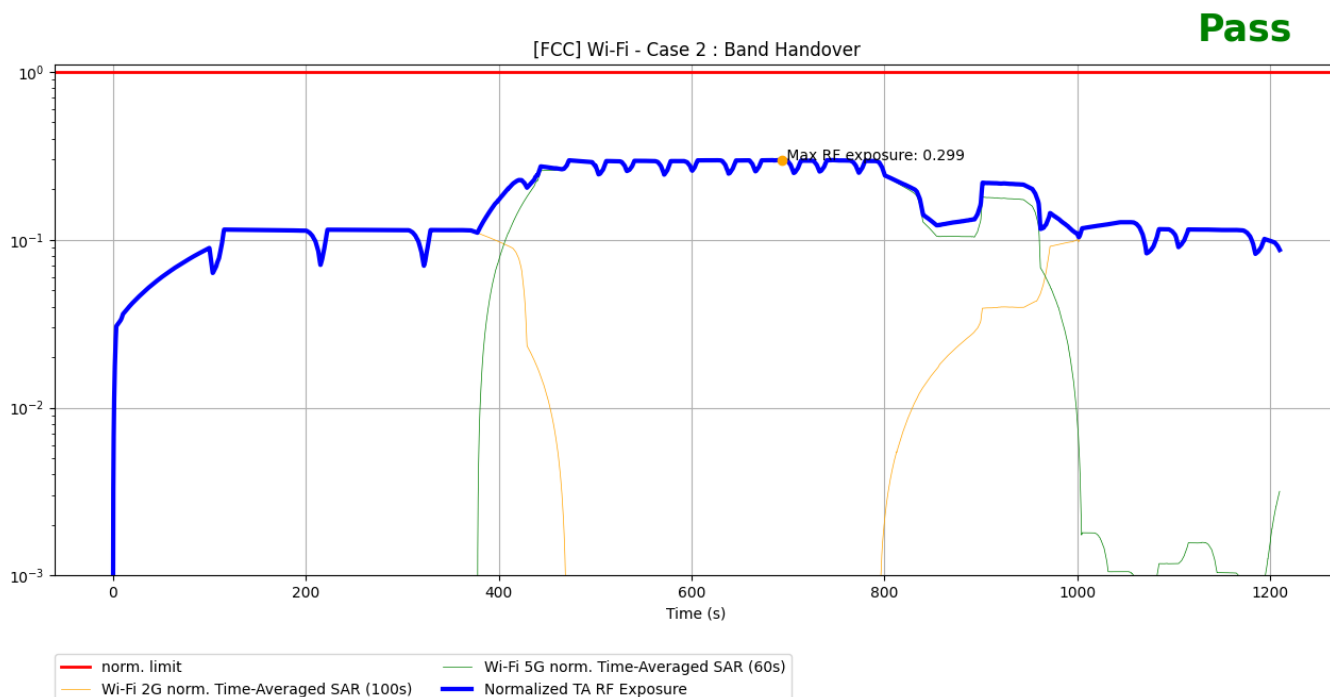


Figure 8-9 Normalized time-averaged SAR over time for Wi-Fi TA-SAR test scenario 2

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8.4 Conducted Power Measurement Results for Wi-Fi TA-SAR Test Scenario 3: Antenna Switching

This test is the conducted power measurement for Wi-Fi antenna switching. The detailed setting is listed in Table 8-4. Figure 8-10 demonstrates the DUT's instantaneous conducted TX power, the time-averaged conducted TX power behavior over time, and the power limit. Figure 8-11 illustrates the corresponding time-averaged SAR over time converted from the TX time-averaged power by using the equation listed in Section 4.4.2. As seen in this figure, the normalized time-averaged SAR does not exceed the FCC limit.

Table 8-4 TA-SAR parameters setting for test scenario 3

Test band	Antenna	Switch time	$P_{WF_SAR_MAX}$	$P_{WF_SAR_limit}$
2.4GHz	0	0~400s	22 dBm	13 dBm
2.4GHz	1	400s~800s	22 dBm	13 dBm

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[FCC] Wi-Fi - Case 3 : 2G Antenna Switching

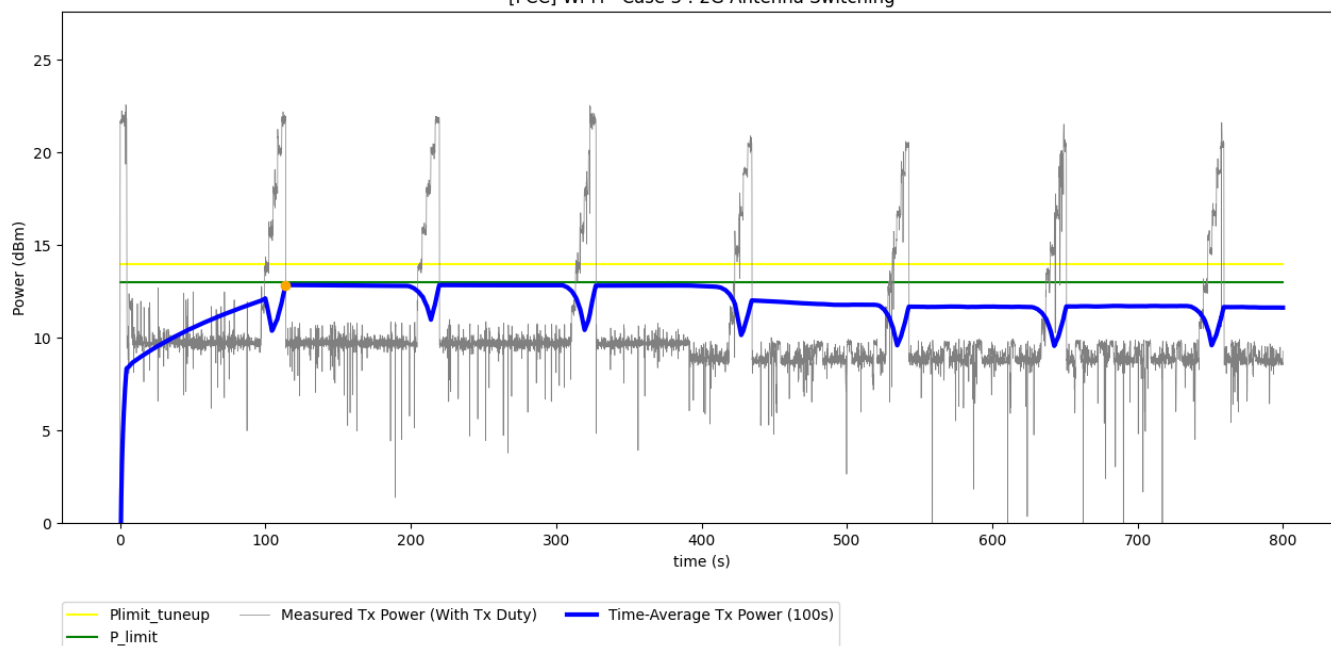


Figure 8-10 Time-averaged conducted TX power over time for test scenario 3

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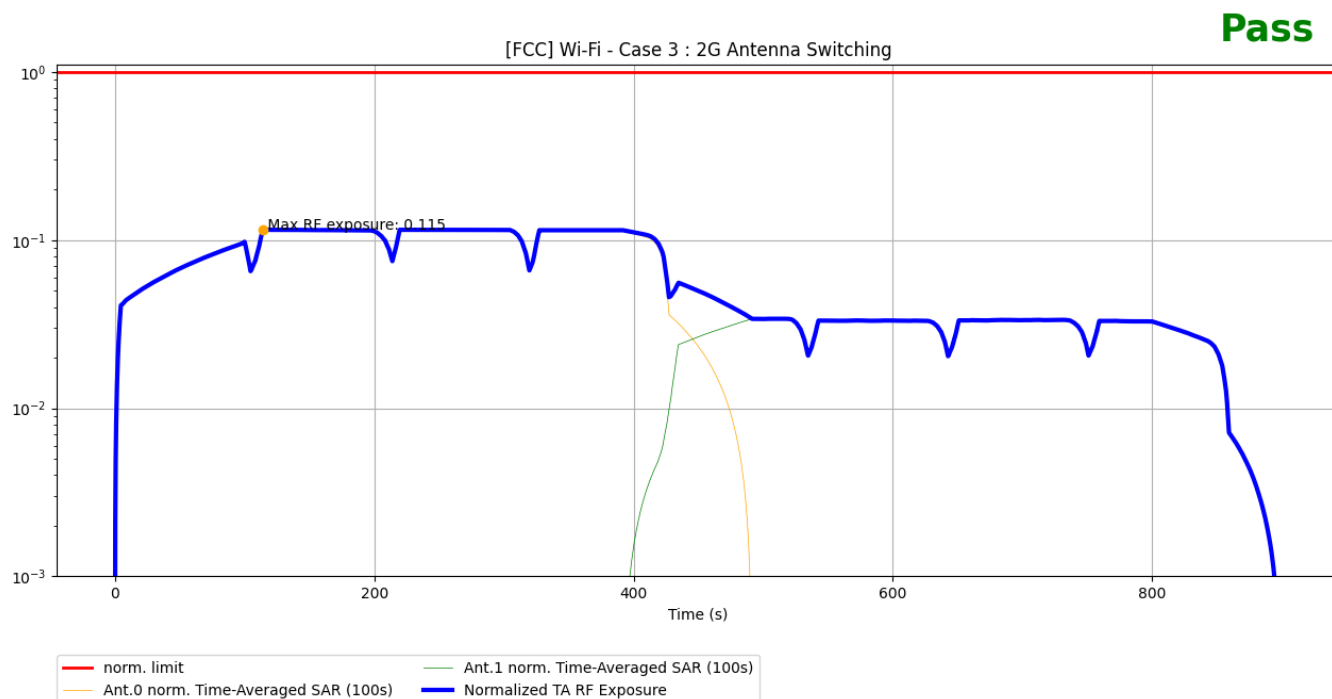


Figure 8-11 Normalized time-averaged SAR over time for test scenario 3

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8.5 Conducted Power Measurement Results for Wi-Fi TA-SAR Test Scenario 4: ECI Change

This test is the conducted power measurement for Wi-Fi ECI change. The detailed setting is listed in Table 8-5. Figure 8-12 demonstrates the DUT's instantaneous conducted TX power, the time-averaged conducted TX power behavior over time, and the power limit. Figure 8-13 illustrates the corresponding time-averaged SAR over time converted from the TX time-averaged power by using the equation listed in Section 4.5.2. As seen in this figure, the normalized time-averaged SAR does not exceed the FCC limit.

Table 8-5 TA-SAR parameters setting for test scenario 4

Test band	Switch time	ECI	$P_{WF_SAR_MAX}$	$P_{WF_SAR_limit}$
2.4GHz	0~400s	1	22 dBm	13 dBm
2.4GHz	400s~800s	2	22 dBm	11 dBm

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[FCC] Wi-Fi - Case 4 : 2G ECI change

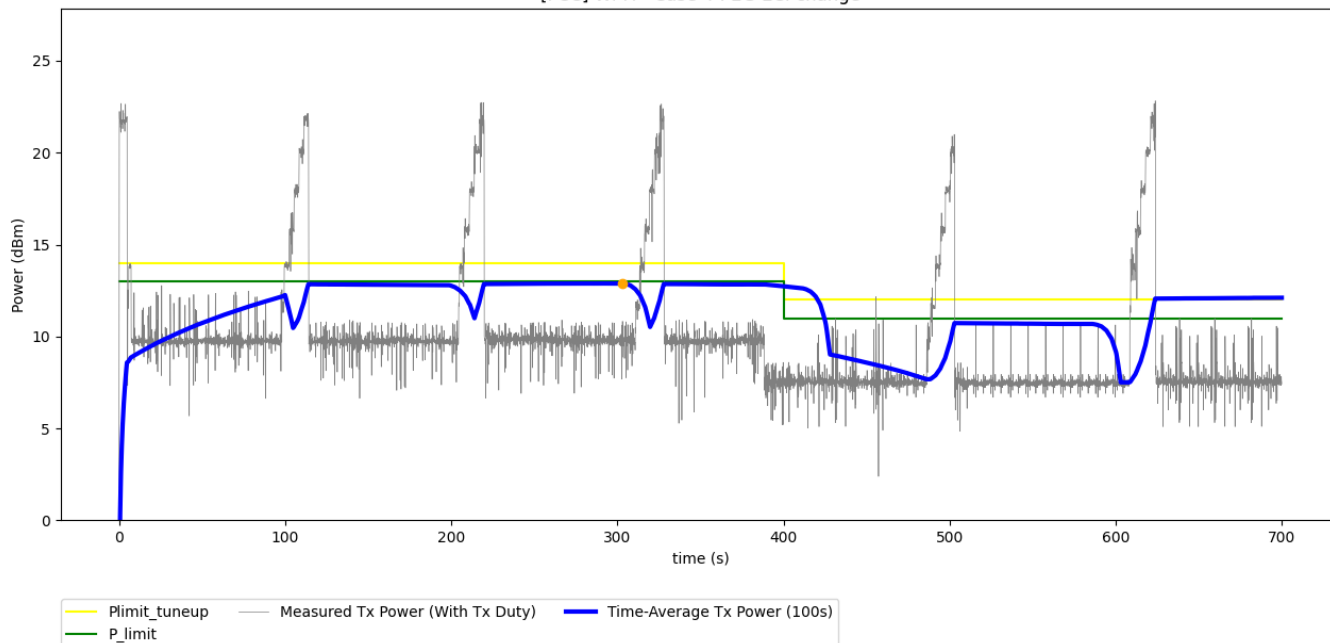


Figure 8-12 Time-averaged conducted TX power over time for Wi-Fi TA-SAR test scenario 4

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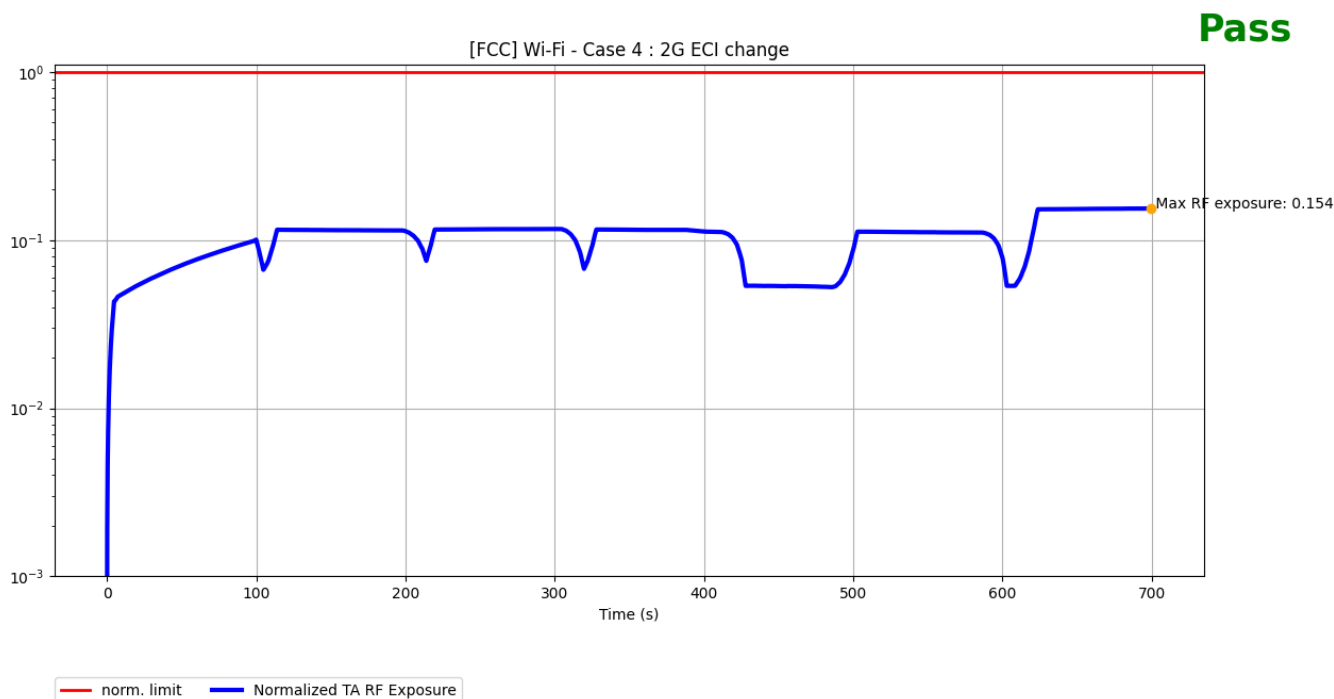


Figure 8-13 Time-averaged SAR over time for Wi-Fi TA-SAR test scenario 4

NOTE: The instantaneous TX power should be compared with P_WF_SAR_limit of the corresponding configuration, i.e., 13 dBm for ECI 1 and 11dBm for ECI 2, then transformed and averaged in SAR perspective to check compliance. Therefore, even though the time-averaged TX power seems to exceed P_WF_SAR_limit after ECI changes at 400s, the time-averaged SAR meets regulation as a matter of fact.

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8.6 Conducted Power Measurement Results for Wi-Fi TA-SAR Test Scenario 5: Simultaneous SAR and PD

This test is the conducted power measurement for Wi-Fi SAR and PD TER. The detailed setting is listed in Table 8-6. As mentioned in Section 4.6, Wi-Fi 6GHz band needs to obey both SAR and PD exposure limits, therefore the maximum of normalized TA-SAR and normalized TA-PD in 6GHz band should be used in TER calculation. For our simulation in 6GHz band, normalized TA-PD is larger than normalized TA-SAR, therefore normalized TA-PD is used in TER calculation. Figure 8-14 shows the conducted power measurement result for 2.4GHz TA-SAR and 6GHz TA-PD. The conducted power result of SAR/PD exposure is converted into normalized time-averaged SAR/PD. Figure 8-15 shows the total normalized time-averaged RF exposure is always below the normalized FCC requirement of 1.

Table 8-6 TA-SAR/TA-PD parameters setting for test scenario 5

TER	Test band	Switch time	$P_{WF_SAR_MAX}$	$P_{WF_SAR_limit}$ or $P_{WF_PD_limit}$
SAR	2.4GHz	0~800s	22	11
SAR	6GHz	0~800s	14	5
PD	6GHz	0~800s	14	5

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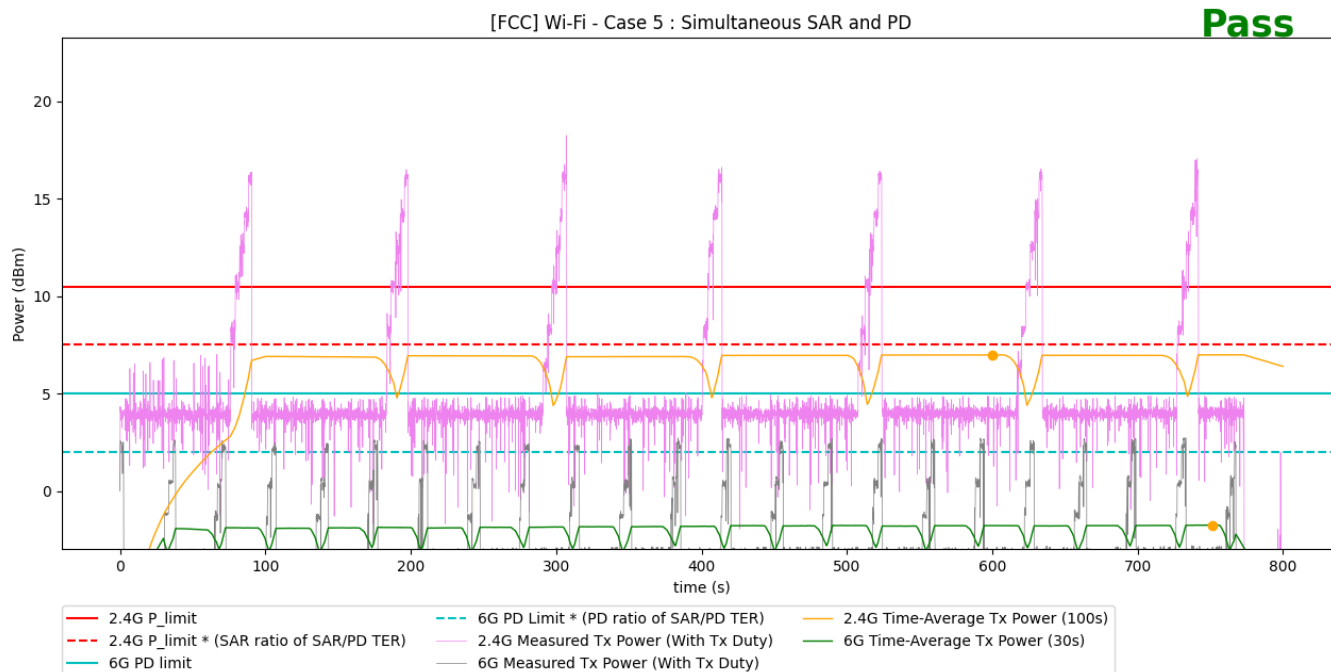


Figure 8-14 Time-averaged conducted TX power over time for Wi-Fi TA-SAR test scenario 5

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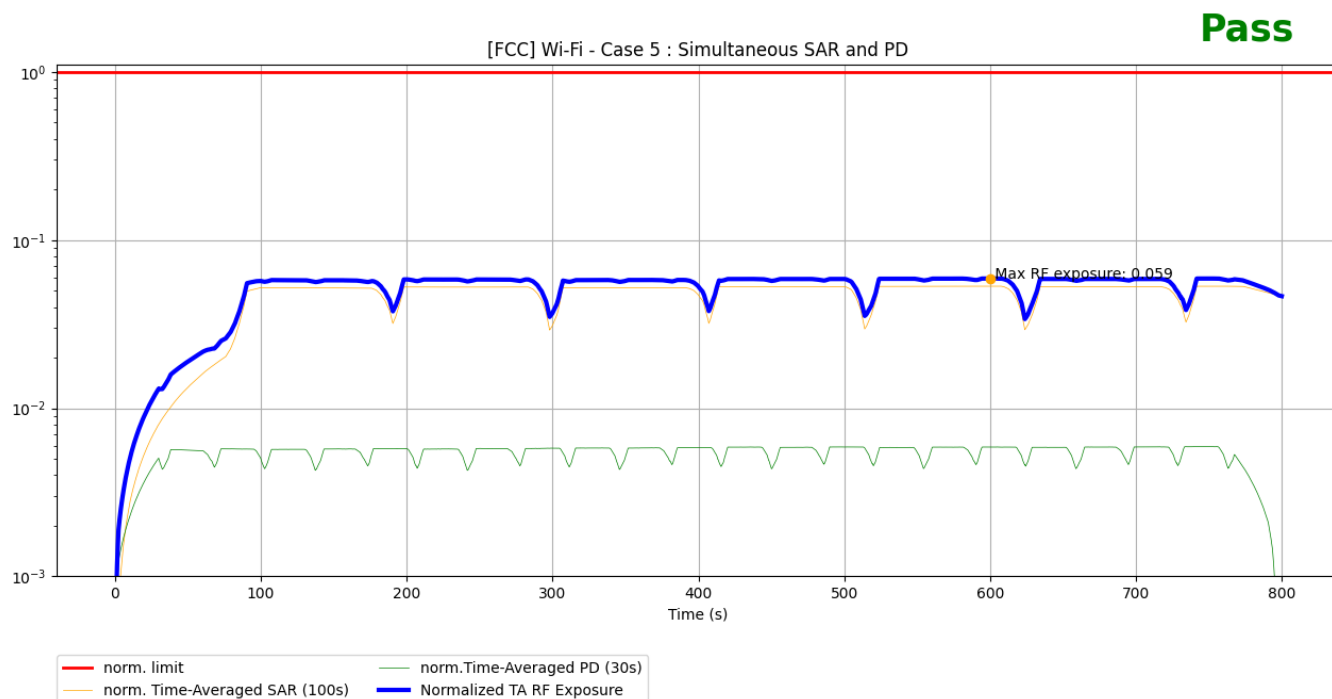


Figure 8-15 Normalized time-averaged SAR over time for Wi-Fi TA-SAR test scenario 5

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9 WI-FI TA-PD VALIDATION VIA CONDUCTED POWER MEASUREMENTS

For conducted power measurements, TA-PD algorithm is implemented in firmware in a phone and a notebook

9.1 Measurement Setup

The exact measurement setup diagrams for Android DUT and Windows DUT are shown in Section 9.1.

9.2 Conducted Power Measurement Results for Wi-Fi TA-PD Test Scenario 1: TX Mode Change between Normal Mode and Sleep Mode

This test is the conducted power measurement for Wi-Fi PD 6GHz band TX mode change. The test measurement setup is illustrated in Section 9. The detailed setting is listed in Table 9-1. Figure 9-1 demonstrates the DUT's instantaneous conducted TX power, the time-averaged conducted TX power behavior over time, the time-averaged PD does not exceed the FCC limit.

Table 9-1 TA-PD parameters setting for test scenario 1

Test band	$P_{WF\ PD\ MAX}$	$P_{WF\ PD\ limit}$
6GHz	14 dBm	5 dBm

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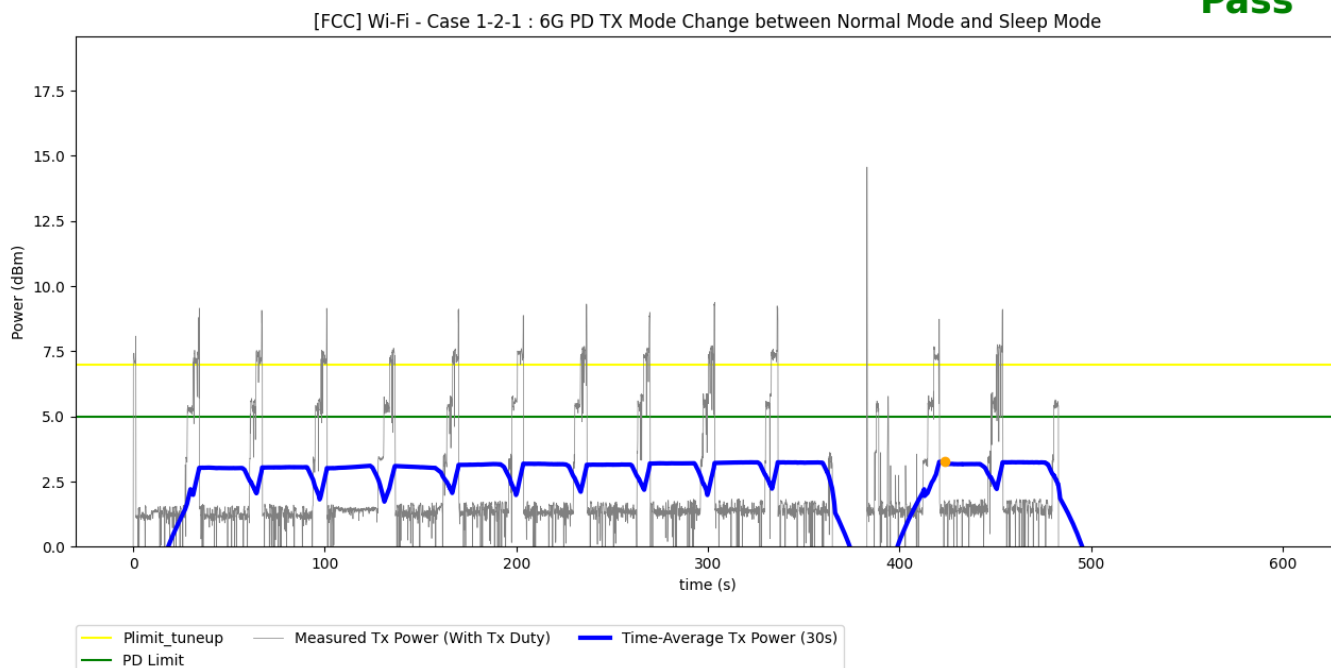


Figure 9-1 Time-averaged conducted TX power over time for Wi-Fi TA-PD test scenario 1

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10 BT TA-SAR VALIDATION VIA CONDUCTED POWER MEASUREMENTS

10.1 Measurement Setup

The general measurement setup for BT DUT is shown in Figure 10-1. There is a control PC which controls the DUT and a companion device to allow the DUT to create a connection to a BT companion device (remotely or manually) and use the test sequence specified in Section 6.1. The transmitter power is measured with a spectrum analyzer. The moving average of each measured power is calculated to ensure the conducted time-averaging power is always below the power limit.

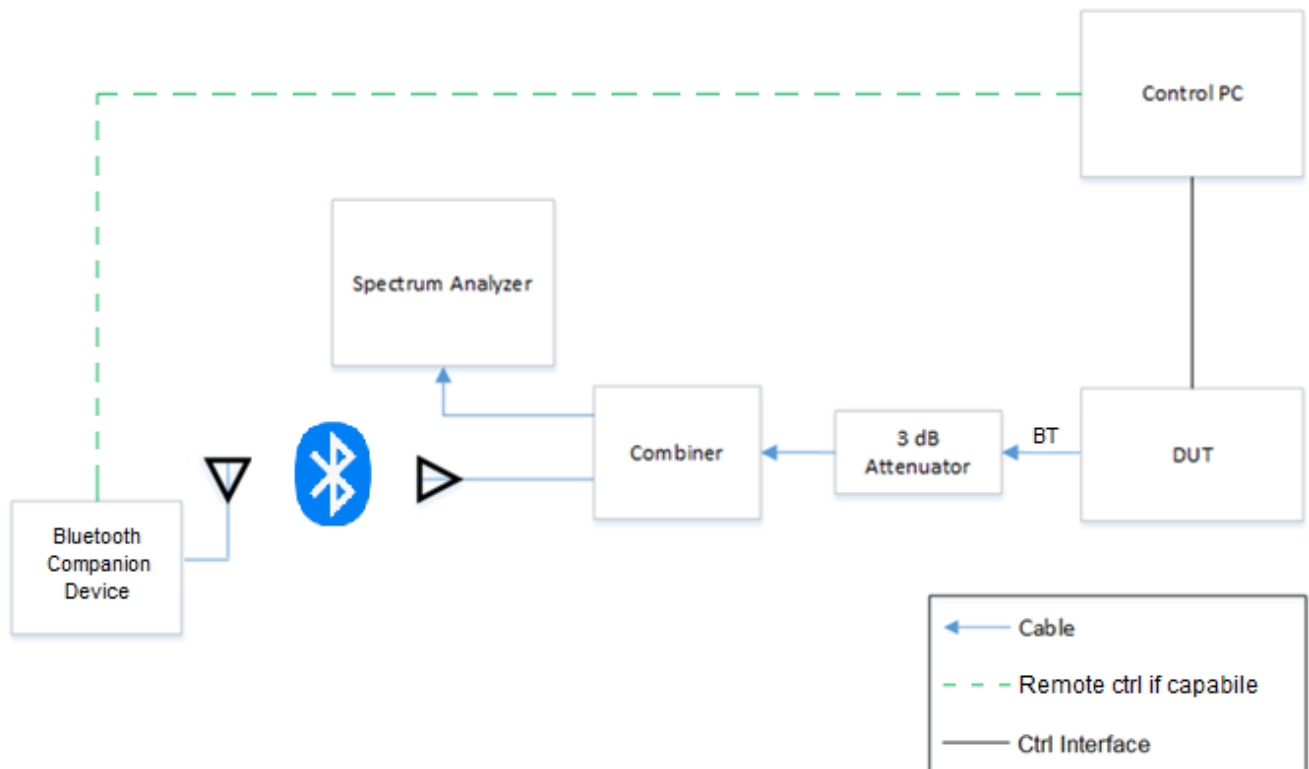


Figure 10-1. General setup for BT TA-SAR conducted power measurement for BT DUT

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10.2 Conducted Power Measurement Results for BT TA-SAR Test Scenario 1: TX with Varying Duty

This test is the conducted power measurement for BT under the test sequence specified in Section 6.1. The detailed setting is listed in Table 10-1. Figure 10-2 shows the time-averaged conducted TX power is always below the power limit.

Table 10-1 TA-SAR parameters setting for test scenario 1

Test band	$P_{BT\ SAR\ MAX}$	$P_{BT\ SAR\ limit}$
2.4GHz	18 dBm	15 dBm

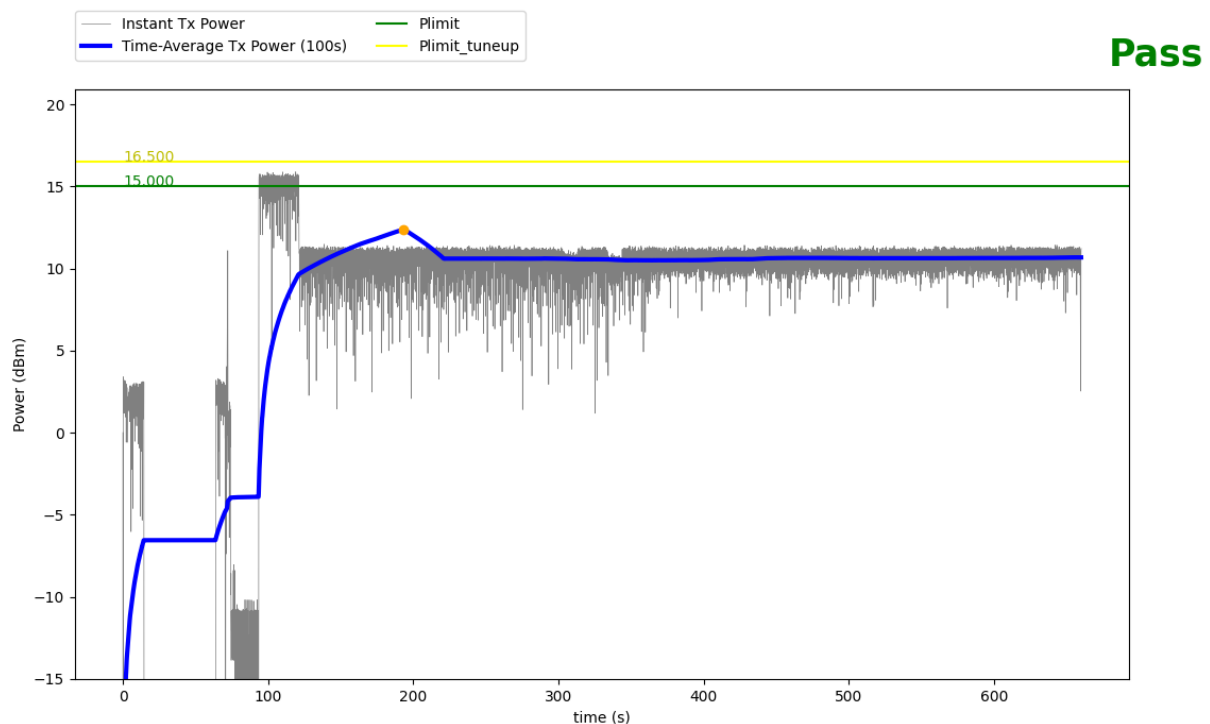


Figure 10-2 Time-averaged conducted TX power over time for BT TA-SAR test scenario 1

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11 WI-FI AND BT SIMULTANEOUS TRANSMISSION TA-SAR VALIDATION VIA CONDUCTED POWER MEASUREMENTS

11.1 Measurement Setup

Wi-Fi and BT TA-SAR simultaneous transmission conducted power test setup is shown in Figure 11-1.

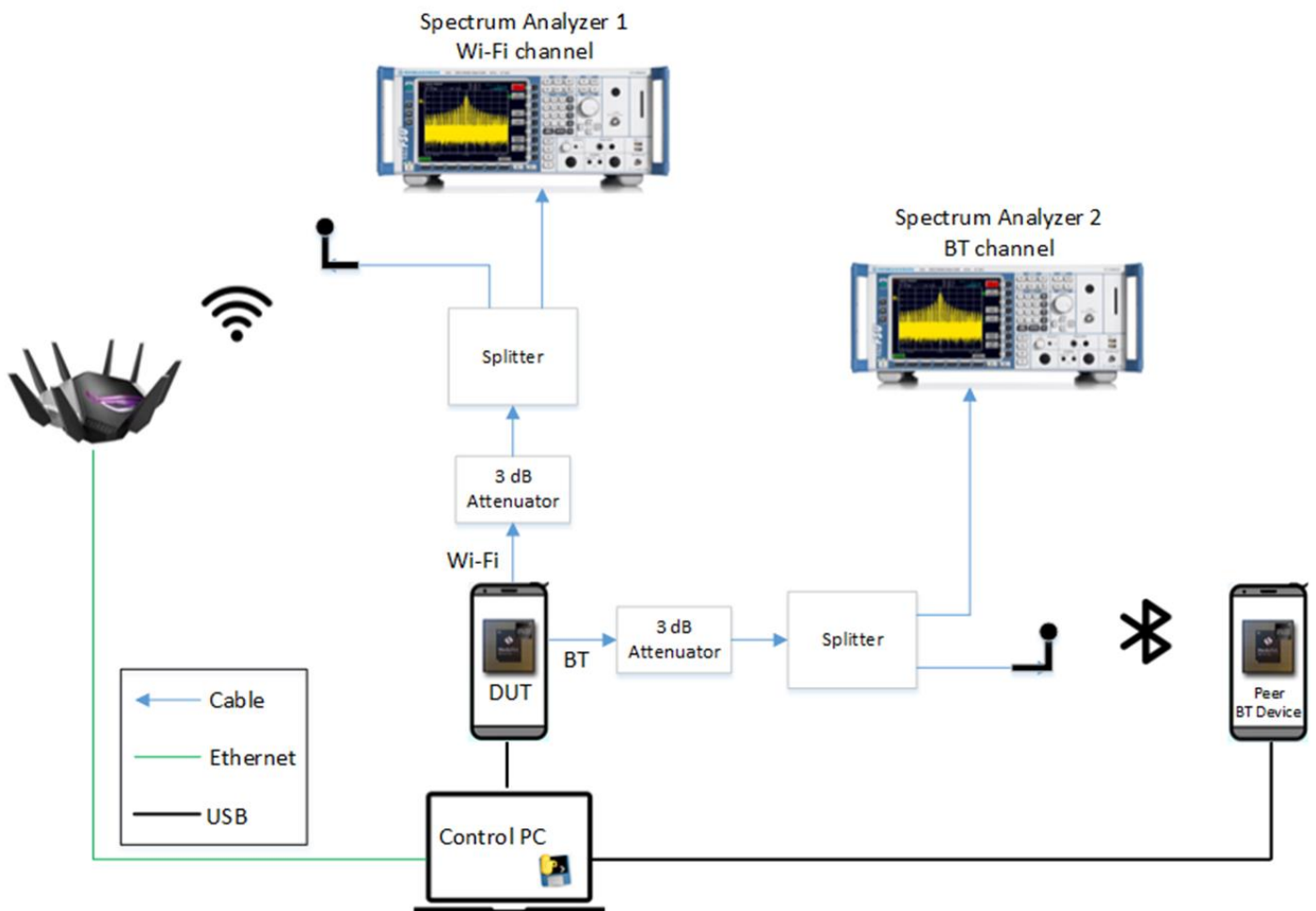


Figure 11-1. TA-SAR conducted power test setup for Wi-Fi and BT simultaneous transmission test scenario 1 with Android DUT

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11.2 Conducted Power Measurement Results for Wi-Fi and BT Simultaneous Transmission Test Scenario 1: Wi-Fi and BT Simultaneous TX

Figure 11-2 shows that the total time-averaged RF exposure of Wi-Fi and BT simultaneous transmission is always below normalized limit of 1.0. The test result validates the total RF exposure compliance in system level test scenario.

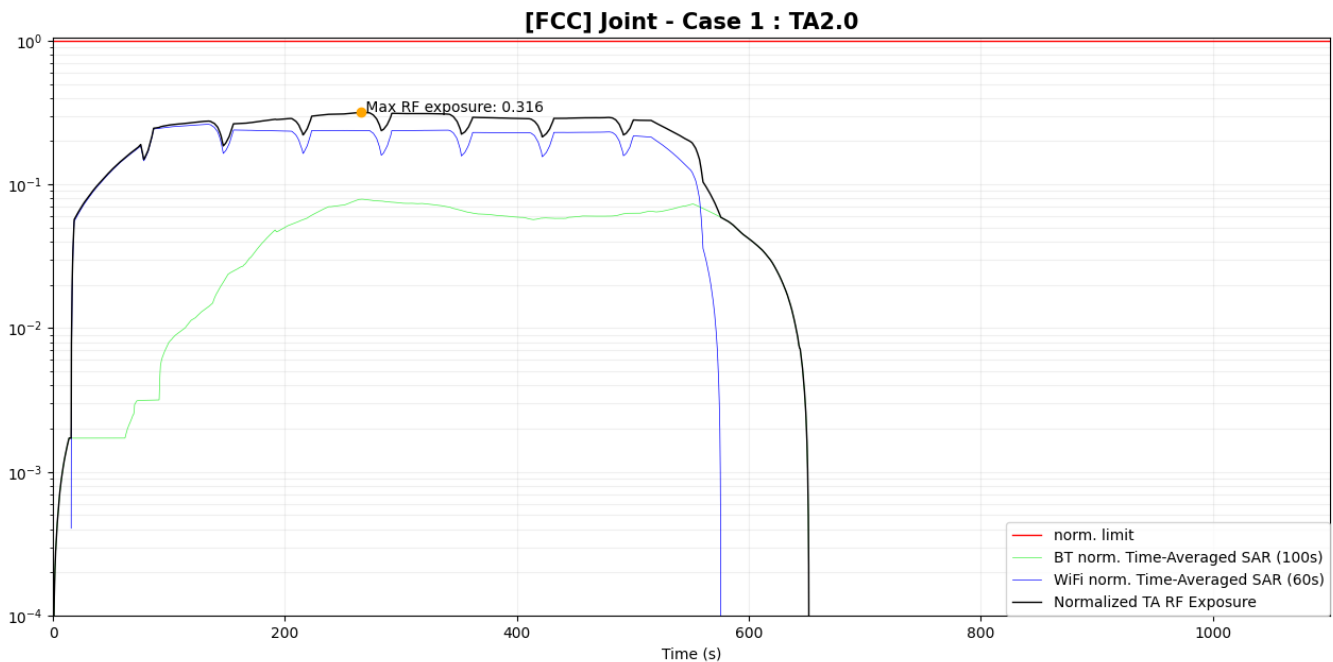
Pass

Figure 11-2 Total normalized Time-averaged RF exposure for Wi-Fi and BT simultaneous transmission test scenario 1

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12 WI-FI TA-SAR VALIDATION VIA SAR MEASUREMENTS

For SAR measurements, TA-SAR algorithm is implemented in firmware in a phone and a notebook. The exact setup photographs are shown in Section 12.1.

12.1 Measurement Setup

The lab SAR measurement setup photos are shown in Figure 12-1



Figure 12-1 DASY6 TA-SAR test environment

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12.2 SAR Measurement Results for Wi-Fi TA-SAR Test Scenario 1: TX Mode Change between Normal Mode and Sleep Mode

Mediatek's TA-SAR algorithm is tested in SPORTON (an FCC certified lab) by using DASY6. The detailed setting is listed in Table 12-1 and Table 12-2. Figure 12-2 demonstrates test scenario 1-1 of 2.4GHz band TA-SAR measurement result and Figure 12-3 demonstrates test scenario 1-2 of 6GHz band TA-SAR measurement result.

Table 12-1 TA-SAR parameters setting for test scenario 1-1

Test band	$P_{WF\ SAR\ MAX}$	$P_{WF\ SAR\ limit}$
2.4GHz	22 dBm	13 dBm

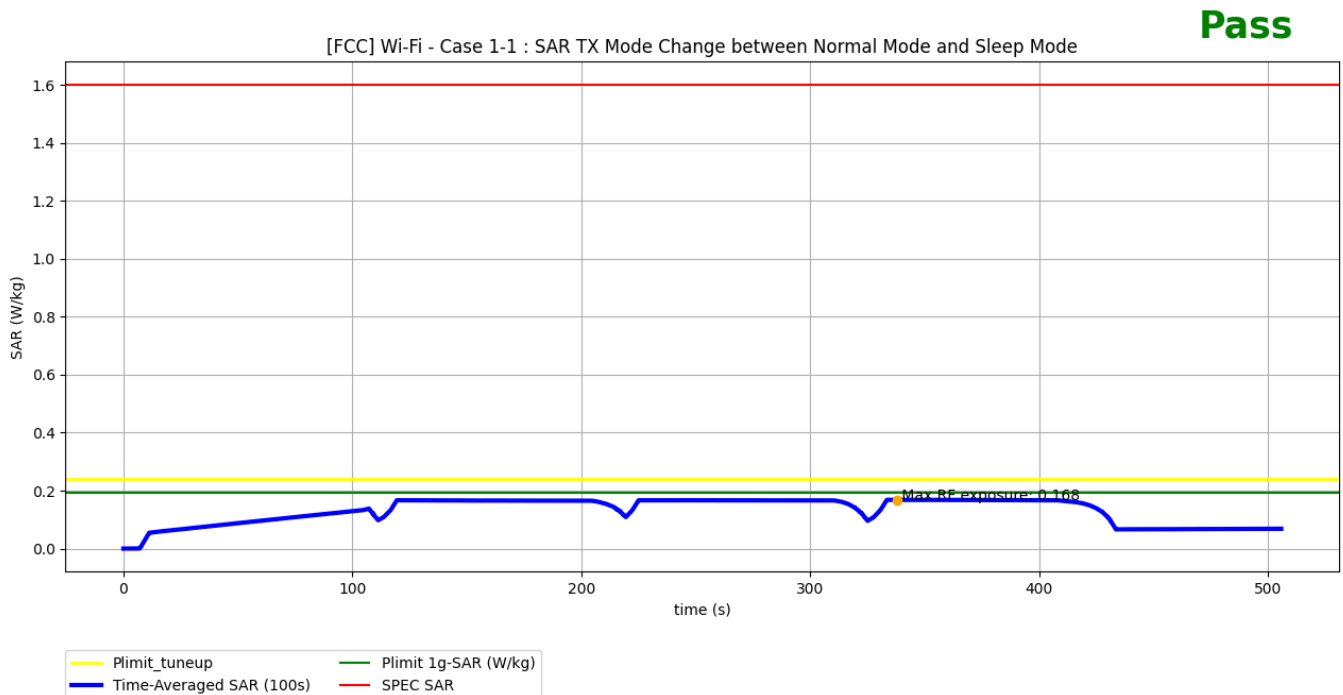


Figure 12-2 Time-averaged SAR measurement for Wi-Fi TA-SAR test scenario 1-1

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.168 W/kg
Validation result: pass	

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Table 12-2 TA-SAR parameters setting for test scenario 1-2

Test band	Max power	$P_{WF\ SAR\ limit}$
6GHz	14 dBm	5 dBm

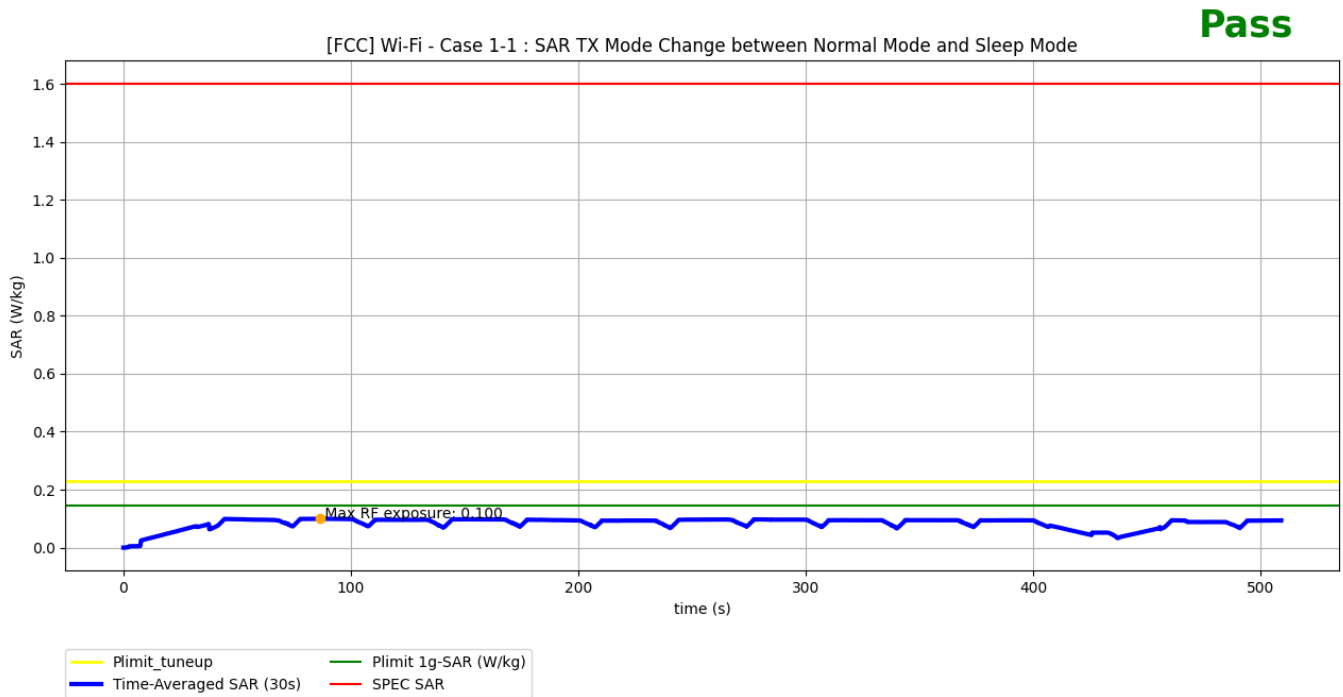


Figure 12-3 Time-averaged SAR measurement for Wi-Fi TA-SAR test scenario 1-2

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.1 W/kg
Validation result: pass	

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13 WI-FI TA-PD VALIDATION VIA PD MEASUREMENTS

For PD measurements, TA-PD algorithm is implemented in firmware in a phone and a notebook.

13.1 Measurement Setup

The lab PD measurement setup photos are similar to those shown Section 13.1.

13.2 PD Measurement Results for Wi-Fi TA-PD Test Scenario 1: TX Mode Change between Normal Mode and Sleep Mode

Mediatek's TA-PD algorithm is tested in SPORTON (an FCC certified lab). The detailed setting is listed in Table 13-1. Figure 13-1 demonstrates test scenario 1 of 6GHz band TA-PD measurement result.

Table 13-1 TA-PD parameters setting for test scenario 1

Test band	$P_{WF\ PD\ MAX}$	$P_{WF\ PD\ limit}$
6GHz	14 dBm	5 dBm

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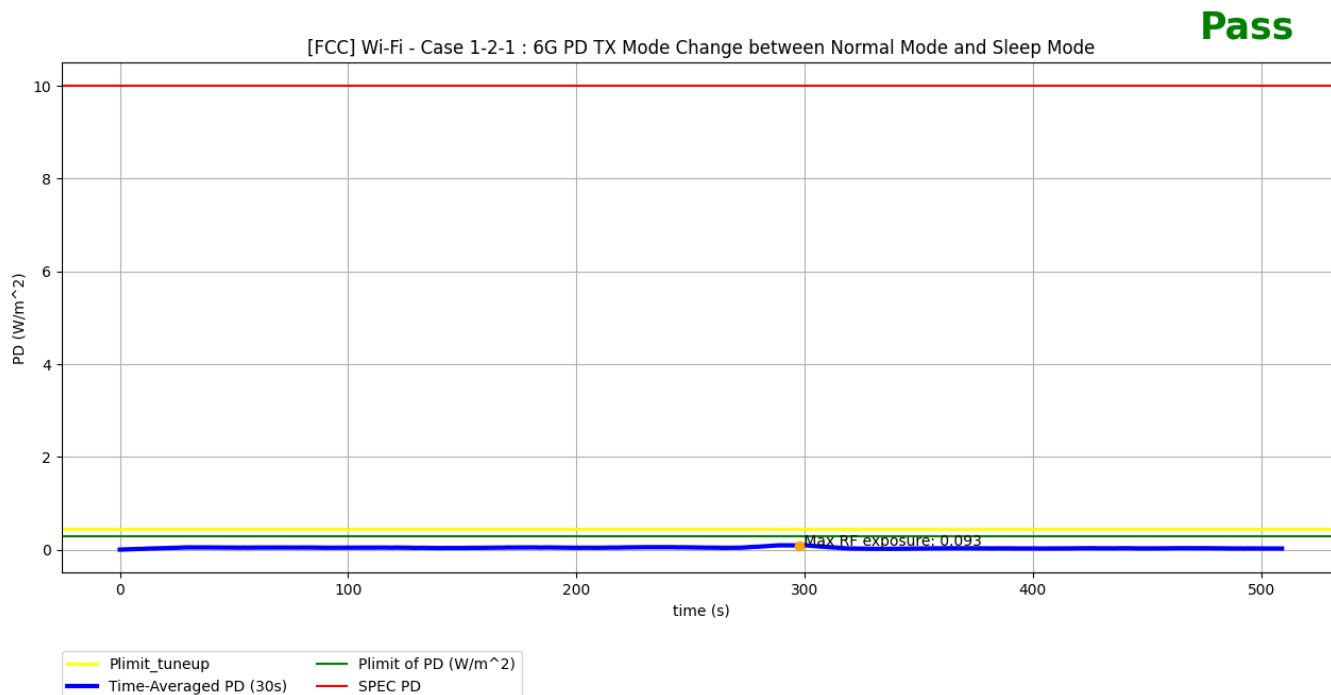


Figure 13-1 Time-averaged PD measurement result for Wi-Fi TA-PD test scenario 1

FCC PD limit	10 W/m ²
Max 30s-time averaged PD	0.093 W/ m ²
Validation result: pass	

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14 BT TA-SAR VALIDATION VIA SAR MEASUREMENTS

For SAR measurements, TA-SAR algorithm is implemented in firmware in a phone and a notebook.

14.1 Measurement Setup

The lab SAR measurement setup photos are similar to those shown Section 14.1.

14.2 SAR Measurement Results for BT TA-SAR Test Scenario 1: TX with varying duty

Mediatek's TA-SAR algorithm is tested in an FCC certified lab by using DASY6. The detailed setting is listed in Table 14-1. Figure 14-1 demonstrates test scenario 1 of 2.4GHz band TA-SAR measurement result.

Table 14-1 TA-SAR parameters setting for test scenario 1

Test band	$P_{BT_SAR_MAX}$	$P_{BT_SAR_limit}$
2.4GHz	18 dBm	15 dBm

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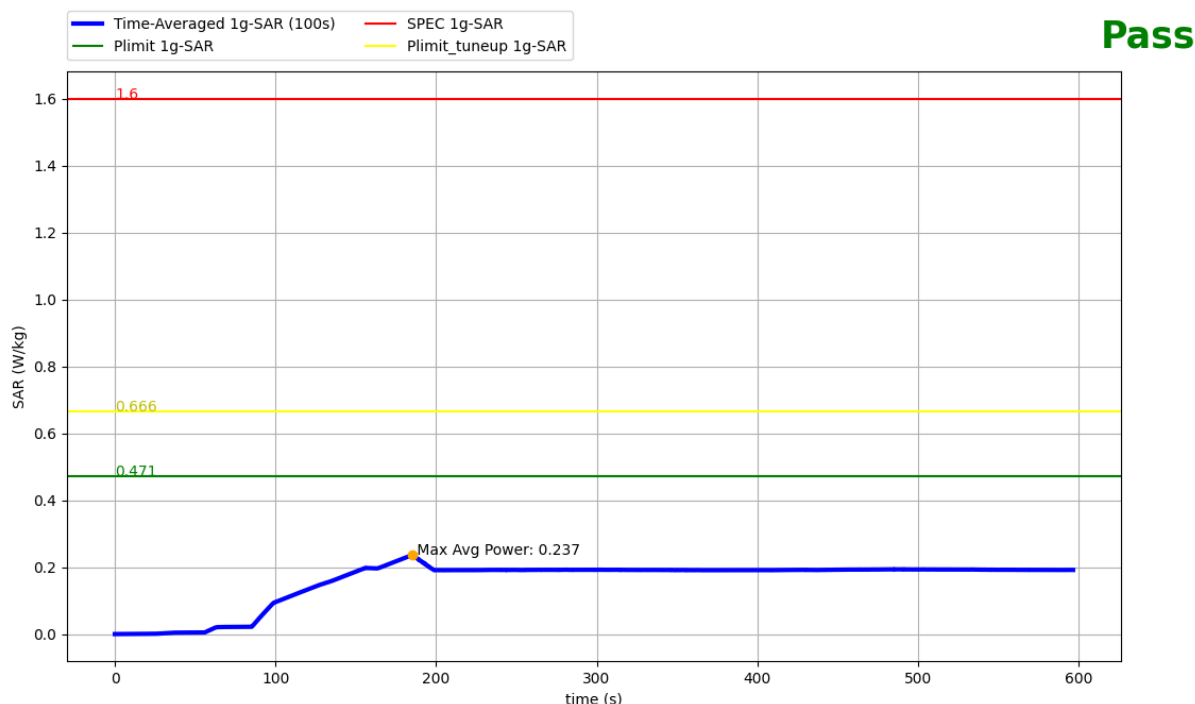


Figure 14-1 Time-averaged SAR measurement for BT TA-SAR test scenario 1-1

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.237 W/kg
Validation result: pass	

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15 CONCLUSIONS

This document proposes Wi-Fi/BT TA-SAR/TA-PD test scenarios and procedures for Mediatek's Wi-Fi/BT TA-SAR/TA-PD algorithms. The conducted power measurement results in Chapter 9 and 10 show that Mediatek's Wi-Fi TA-SAR/TA-PD algorithms can maintain SAR and PD over time below the FCC regulatory limits. The conducted power measurement results in Chapter 11 show that Mediatek's BT TA-SAR algorithms can maintain SAR over time below the FCC regulatory limits. The conducted power measurement results in Chapter 13 show that Mediatek's Wi-Fi/BT TA-SAR algorithms under Wi-Fi and BT simultaneous transmission can maintain SAR over time below the FCC regulatory limits.

Furthermore, the near-field measurements are also done in a certified lab (i.e., SGS) to further validate Mediatek's Wi-Fi/BT TA-SAR algorithms. The SAR measurement results in Chapter 14 and PD measurement results in Chapter 15 demonstrate that Mediatek's Wi-Fi TA-SAR/TA-PD algorithms can maintain SAR and PD over time below the FCC regulatory limits. The SAR measurement results in Chapter 16 demonstrate that Mediatek's BT TA-SAR algorithms can maintain SAR and PD over time below the FCC regulatory limits. It is concluded that Mediatek's Wi-Fi TA-SAR/TA-PD algorithms and BT TA-SAR algorithms can be validated for FCC compliance by the proposed test methodology.

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APPENDIX A. CDASY6 SYSTEM VERIFICATION

EX3DV4 E-Field Probe

Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Calibration	Basic Broad Band Calibration in air Conversion Factors (CF) for HSL 2450/5850/6500 MHz Additional CF for other liquids and frequencies upon request	
Frequency	10 MHz to > 6 GHz	
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)	
Dynamic Range	10 µW/g to > 100 mW/g Linearity: ± 0.2 dB (noise: typically < 1 µW/g)	
Dimensions	Tip diameter: 2.5 mm	
Application	High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.	

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Phantom

Model	Twin SAM	
Construction	<p>The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209.</p> <p>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 manually teaching three points with the robot.</p>	
Shell Thickness	2 ± 0.2 mm	
Filling Volume	Approx. 25 liters	
Dimensions	Height: 850 mm; Length: 1000 mm; Width: 500 mm	

DEVICE HOLDER

Construction	<p>In combination with the Twin SAM Phantom V4.0/V4.0C or Twin SAM, the Mounting Device (made from POM) enables the rotation of the mounted transmitter in spherical coordinates, whereby the rotation point is the ear opening. The devices can be easily and accurately positioned according to IEC, IEEE, CENELEC, CE or other specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).</p>	 <p>Device Holder</p>
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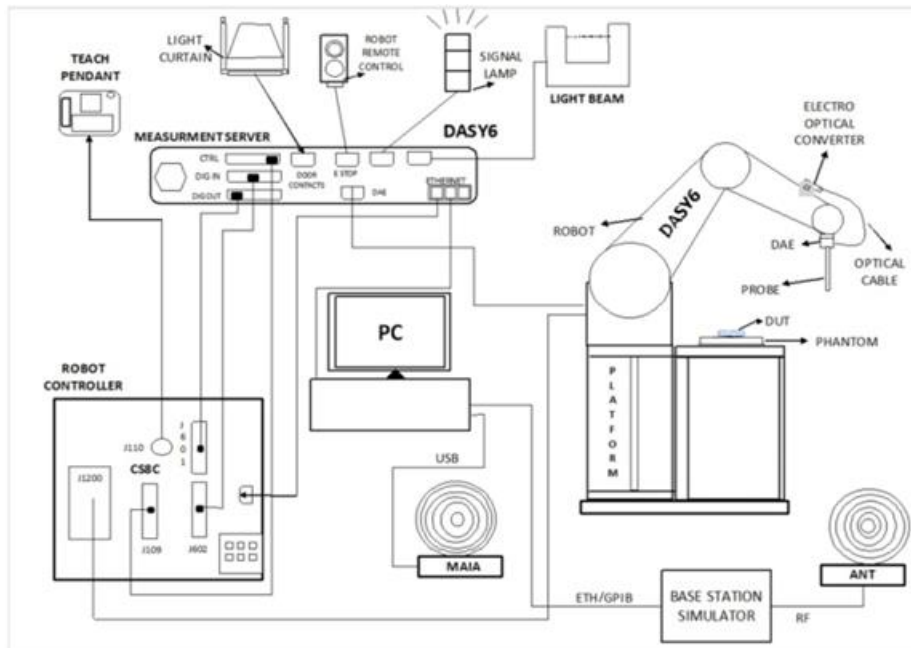
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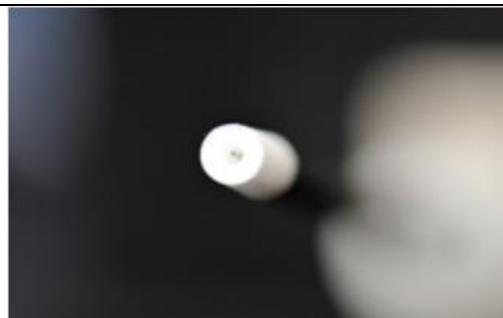
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PD system**Block Diagram (DASY6)**

Power density measurements for mmWave frequencies were performed using SPEAG DASY6 with cDASY6 5G module. The DASY6 included a high precision robotics system (Staubli), robot controller, desktop computer, near-field probe, probe alignment sensor, and the 5G phantom cover.

**EUmmWVx probe**

The EUmmWVx probe is based on the pseudo-vector probe design, which not only measures the field magnitude but also derives its polarization ellipse. The design entails two small 0.8mm dipole sensors mechanically protected by high-density foam, printed on both sides of a 0.9mm wide and 0.12mm thick glass substrate. The body of the probe is specifically constructed to minimize distortion by the scattered fields. The probe consist of two sensors with different angles (1 and 2) 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. The probe design allows measurements at distances as small as 2mm 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.



Two dipoles optimally arranged to obtain pseudo-vector information. Minimum 3 measurements/ point, 120° rotated around probe axis.

Sensors (0.8mm 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

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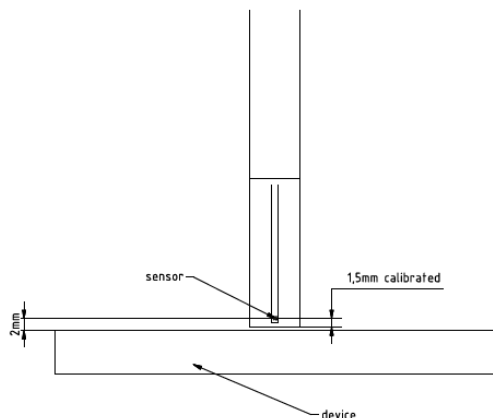
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Dynamic Range	< 20 V/m – 10,000 V/m with PRE-10 (min < 50 V/m - 3000 V/m)
Position Precision	< 0.2 mm (DASY6)
Dimensions	Overall length: 337 mm (tip: 20 mm) Tip diameter: encapsulation 8 mm (internal sensor < 1mm) Distance from probe tip to dipole centers: < 2 mm. Sensor displacement to probe's calibration point: < 0.3 mm
Applications	E-field measurements of 5G devices and other mm-wave transmitters operating above 10GHz in < 2 mm distance from device (free-space). Power density, H-field and far-field analysis using total field reconstruction (cDASY6 5G module required)
Compatibility	cDASY6 + 5G-Module SW1.0 and higher



mmWave Phantom

The mmWave Phantom approximates free-space conditions, allowing for the evaluation of the antenna side of the device and the front (screen) side or any opposite-radiating side of wireless devices operating above 10 GHz without distorting the RF field. It consists of a 40mm thick Rohacell plate used as a test bed, which has a loss tangent ($\tan \delta$) ≤ 0.05 and a relative permittivity (ϵ_r) ≤ 1.2 . High-performance RF absorbers are placed below the foam.

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APPENDIX B. INSTRUMENTS LIST

Equipment List					
Manufacturer	Device	Type	Serial number	Date of last calibration	Date of next calibration
SPEAG	Data acquisition Electronics	DAE4	856	Apr/17/2025	Apr/16/2026
SPEAG	Dosimetric E-Field Probe	EX3DV4	7466	Jan/28/2025	Jan/27/2026
SPEAG	E-field Probe for Near Field Application	EUmmWV4	9616	Mar/14/2025	Mar/13/2026
SPEAG	System Validation Dipole	D2450V2	727	Apr/15/2025	Apr/14/2026
SPEAG	System Validation Dipole	D5GHzV2	1349	Mar/19/2024	Mar/18/2027
SPEAG	System Validation Dipole	D6.5GHzV2	1029	Jun/12/2025	Jun/11/2026
SPEAG	5G Verification Source 10GHz	5G-Veri10	1021	Jan/16/2025	Jan/15/2026
SPEAG	Dielectric Assessment Kit	DAKS-3.5	1053	Feb/17/2025	Feb/16/2026
Agilent	MXG Analog Signal Generator	N5181A	MY50144143	Apr/24/2025	Apr/23/2026
Keysight	EXA Signal Analyzer	N9010B	MY63440390	Feb/13/2025	Feb/12/2026
Keysight	EXA Signal Analyzer	N9010B	MY59071573	Jun/03/2025	Jun/02/2026
R&S	MXG Analog Signal Generator	SMB100A03	182012	Aug/09/2025	Aug/08/2026
Agilent	Dual-directional coupler	772D	MY52180142	Oct/30/2024	Oct/29/2025
Agilent	Dual-directional coupler	778D	MY52180302	Nov/06/2024	Nov/05/2025
EMCI	Amplifier	ZHL-42	980189	Calibration not required	Calibration not required
EMCI	Amplifier	ZVE-8G	980190	Calibration not required	Calibration not required
EMCI	Amplifier	EMC 2830P	980156	Calibration not required	Calibration not required
R&S	Power Sensor	NRP18S	101973	Feb/21/2025	Feb/20/2026
R&S	Power Meter	NRX	102191	Feb/21/2025	Feb/20/2026
R&S	Power Sensor	NRP18S	101974	Nov/11/2024	Nov/10/2025
SPEAG	Software	DASY 6 V16.0.2.136	N/A	Calibration not required	Calibration not required
SPEAG	Software	DASY 52 V52.10.4	N/A	Calibration not required	Calibration not required
SPEAG	Software	DASY 6 mmWave V2.4.2.62	N/A	Calibration not required	Calibration not required
SPEAG	Phantom	SAM	N/A	Calibration not required	Calibration not required
SPEAG	Phantom	mmWave Phantom	N/A	Calibration not required	Calibration not required
TECEP	Digital thermometer	HTC-1	EC23010602	Dec/30/2024	Dec/29/2025

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APPENDIX C. SAR SYSTEM VERIFICATION

Tissue Simulating Liquid

For the measurement of the field distribution inside the SAM phantom with DASY, the phantom must be filled with homogeneous tissue simulating liquid. For head SAR testing, the liquid height from the ear rint (ERP) of the phantom to the liquid top surface is larger than 15cm. For body SAR testing, the liquid height from reference point to the center of the flat phantom to the liquid top surface is larger than 15cm.

Tissue Simulant Liquid measurement

The dielectric properties for this Head-simulant fluid were measured by using the SPEAG Dielectric Assessment Kit (DAKS-3.5)

All dielectric parameters of tissue simulates were measured within 24 hours of SAR measurements. The measured conductivity and permittivity are all within $\pm 5\%$ of the target values.

Measurement results of Tissue Simulant Liquid

Measured Frequency (MHz)	Target Dielectric Constant, ϵ_r	Target Conductivity, σ (S/m)	Measured Dielectric Constant, ϵ_r	Measured Conductivity, σ (S/m)	% dev ϵ_r	% dev σ	Limit	Measurement Date
2442	39.214	1.793	40.211	1.836	2.54%	2.40%	$\pm 5\%$	Sep. 08, 2025
2450	39.200	1.800	40.195	1.848	2.54%	2.67%	$\pm 5\%$	
5825	35.275	5.296	36.266	5.411	2.81%	2.17%	$\pm 5\%$	
5850	35.250	5.323	36.223	5.435	2.76%	2.10%	$\pm 5\%$	
6135	34.938	5.639	35.883	5.779	2.70%	2.48%	$\pm 5\%$	
6500	34.500	6.070	35.464	6.237	2.79%	2.75%	$\pm 5\%$	

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The composition of the tissue simulating liquid:

Simulating Liquids for 600 MHz -10 GHz, Manufactured by SPEAG:

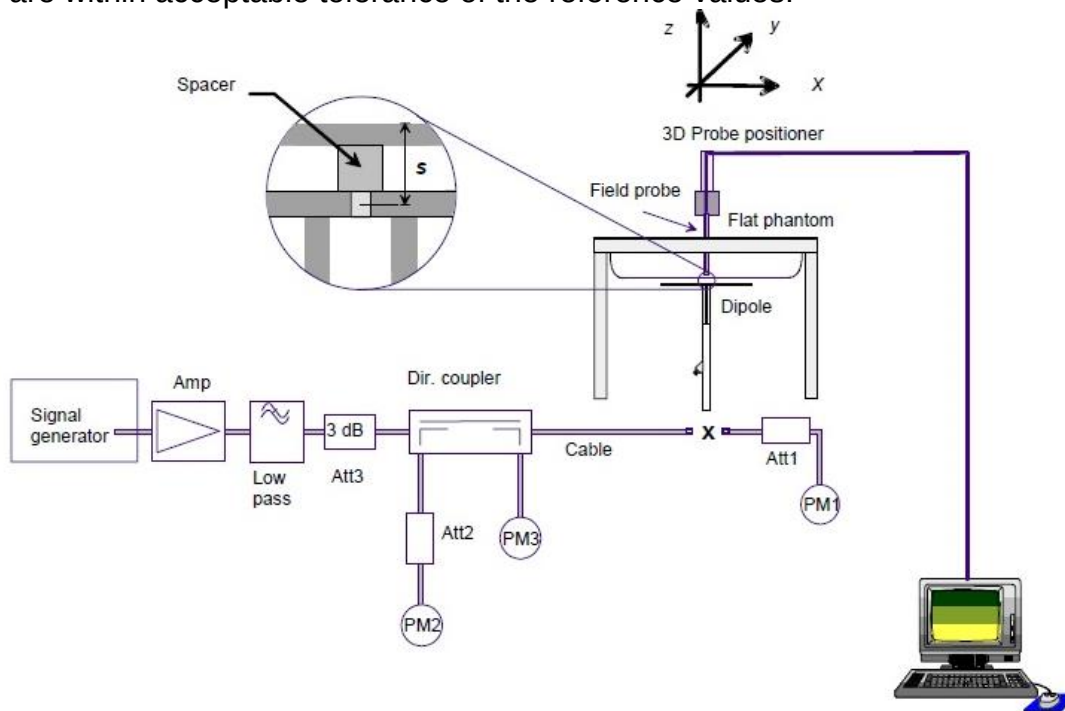
Broad-band head tissue simulating liquids	SPEAG Product	Frequency range (MHz)	Main Ingredients
	HBBL600-10000V6	600 - 10000	Water, Oil

System check

The microwave circuit arrangement for system check is sketched in below. The daily system accuracy verification occurs within the flat section of the SAM phantom and ELI phantom. A SAR measurement was performed to see if the measured SAR was within +/- 10% from the target SAR values.

The tests were conducted on the same days as the measurement of the DUT. The obtained results from the system accuracy verification are displayed with SAR values normalized to 1W forward power delivered to the dipole.

During the tests, the liquid depth from the center of the flat phantom to the liquid top surface was 15 cm above in all the cases. It is seen that the system is operating within its specification, as the results are within acceptable tolerance of the reference values.



The block diagram of system check

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System check results

Validation Kit	S/N	Frequency (MHz)	1W Target 1g-SAR (W/kg)	pin=250mW Measured 1g-SAR (W/kg)	Normalized to 1W 1g-SAR (W/kg)	Deviation (%)	Limit	Measurement Date
D2450V2	727	2450	52.6	12.9	51.6	-1.90	± 10%	Sep.08,2025
Validation Kit	S/N	Frequency (MHz)	1W Target 1g-SAR (W/kg)	pin=100mW Measured 1g-SAR (W/kg)	Normalized to 1W 1g-SAR (W/kg)	Deviation (%)	Limit	Measurement Date
D5GHzV2	1349	5850	79.9	7.86	78.6	-1.63	± 10%	Sep.08,2025
Validation Kit	S/N	Frequency (MHz)	1W Target 1g-SAR (W/kg)	pin=100mW Measured 1g-SAR (W/kg)	Normalized to 1W 1g-SAR (W/kg)	Deviation (%)	Limit	Measurement Date
D6.5GHzV2	1029	6500	294	28.1	281	-4.42	± 10%	Sep.08,2025

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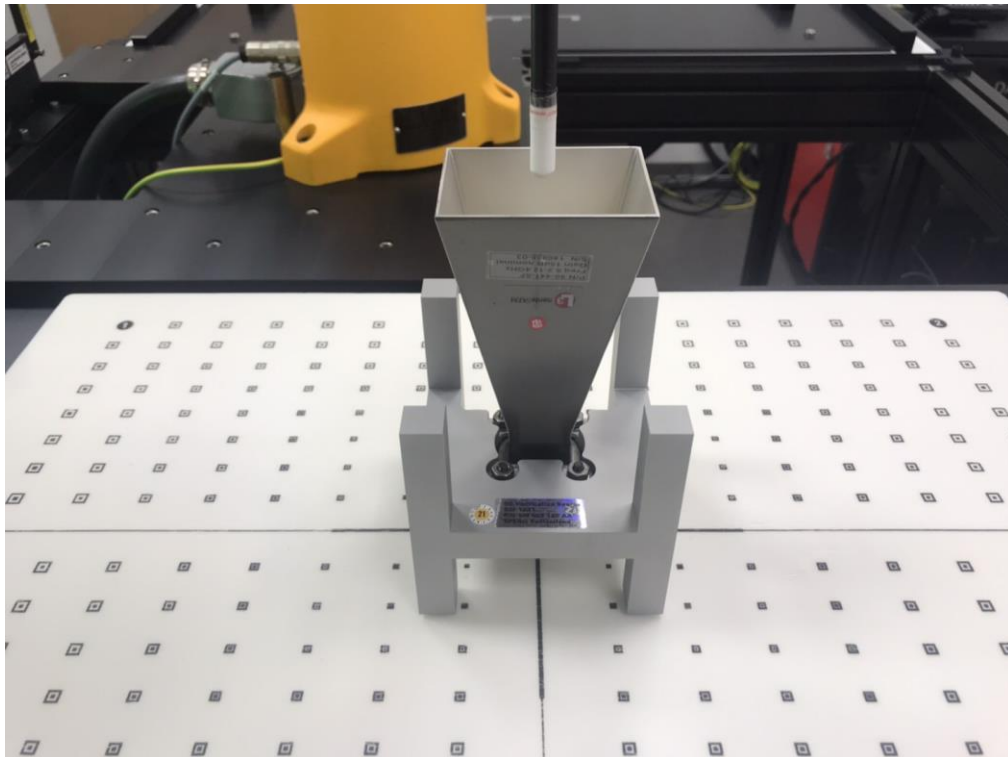
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PD SYSTEM VERIFICATION

System check

The system was verified to be within ± 0.66 dB of the power density targets on the calibration certificate according to the test system specification in the user's manual and calibration facility recommendation. The 0.66 dB deviation threshold represents the expanded uncertainty for system performance checks using SPEAG's mmWave verification sources. The same spatial resolution and measurement region used in the source calibration was applied during the system check.

The measured power density distribution of verification source was also confirmed through visual inspection to have no noticeable differences, both spatially (shape) and numerically (level) from the distribution provided by the manufacturer, per November 2017 TCBC Workshop Notes.



System Verification Setup Photo

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System check result

The system was verified to be within ± 0.66 dB of the power density targets on the calibration certificate according to the test system specification in the user's manual and calibration facility recommendation. The 0.66 dB deviation threshold represents the expanded uncertainty for system performance checks using SPEAG's mmWave verification sources. The same spatial resolution and measurement region used in the source calibration was applied during the system check. The measured power density distribution of verification source was also confirmed through visual inspection to have no noticeable differences, both spatially (shape) and numerically (level) from the distribution provided by the manufacturer, per November 2017 TCBC Workshop Notes.

Frequency (MHz)	PD Verification Source (MHz)	Probe S/N	DAE S/N	Distance (mm)	Prad (mW)	Measured 4cm^2 (W/m^2)	Target 4cm^2 (W/m^2)	Deviation (dB)	Date
10000	10000	9616	856	10	93.3	51	55.5	-0.37	Sep.08,2025

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APPENDIX D. UNCERTAINTY BUDGET

Measurement Uncertainty evaluation template for DUT SAR test (3-6G)

A	c	D	e		f	g	h=c * f / e	i=c * g / e	k
Source of Uncertainty	Tolerance/ Uncertainty	Probability Distributio	Div	Div Value	ci (1g)	ci (10g)	Standard uncertainty	Standard uncertainty	vi, or Veff
Measurement system									
Probe calibration	6.55%	N	1	1	1	1	6.55%	6.55%	∞
<i>Isotropy , Axial</i>	3.50%	R	√3	1.732	1	1	2.02%	2.02%	∞
<i>Isotropy, Hemispherical</i>	9.60%	R	√3	1.732	1	1	5.54%	5.54%	∞
Modulation Response	2.40%	R	√3	1.732	1	1	1.40%	1.40%	∞
Boundary Effect	1.00%	R	√3	1.732	1	1	0.58%	0.58%	∞
Linearity	4.70%	R	√3	1.732	1	1	2.71%	2.71%	∞
Detection Limits	1.00%	R	√3	1.732	1	1	0.58%	0.58%	∞
Readout Electronics	0.30%	N	1	1	1	1	0.30%	0.30%	∞
Response time	0.80%	R	√3	1.732	1	1	0.46%	0.46%	∞
Integration Time	2.60%	R	√3	1.732	1	1	1.50%	1.50%	∞
Measurement drift (class A evaluation)	1.75%	R	√3	1.732	1	1	1.01%	1.01%	∞
RF ambient condition - noise	3.00%	R	√3	1.732	1	1	1.73%	1.73%	∞
RF ambient conditions - reflections	3.00%	R	√3	1.732	1	1	1.73%	1.73%	∞
Probe positioner Mechanical restrictions	0.40%	R	√3	1.732	1	1	0.23%	0.23%	∞
Probe Positioning with respect to phantom shell	2.90%	R	√3	1.732	1	1	1.67%	1.67%	∞
Post-processing	1.00%	R	√3	1.732	1	1	0.58%	0.58%	∞
Max SAR Eval	1.00%	R	√3	1.732	1	1	0.58%	0.58%	∞
Test Sample related									
Test sample positioning	2.90%	N	1	1	1	1	2.90%	2.90%	M-1
Device Holder Uncertainty	3.60%	N	1	1	1	1	3.60%	3.60%	M-1
Drift of output power	5.00%	R	√3	1.732	1	1	2.89%	2.89%	∞
Phantom and Setup									
Phantom Uncertainty	4.00%	R	√3	1.732	1	1	2.31%	2.31%	∞
Liquid permittivity (mea.)	2.81%	N	1	1	0.64	0.43	1.80%	1.21%	M
Liquid Conductivity (mea.)	2.75%	N	1	1	0.6	0.49	1.65%	1.35%	M
Combined standard uncertainty		RSS					11.97%	11.85%	
Expant uncertainty (95% confidence interval), K=2							23.94%	23.69%	

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Measurement Uncertainty evaluation template for DUT SAR test (0.3-3G)

A	c	D	e		f	g	h=c * f / e	i=c * g / e	k
Source of Uncertainty	Tolerance/ Uncertainty	Probability Distributio	Div	Div Value	ci (1g)	ci (10g)	Standard uncertainty	Standard uncertainty	vi, or Veff
Measurement system									
Probe calibration	6.00%	N	1	1	1	1	6.00%	6.00%	∞
Isotropy , Axial	3.50%	R	$\sqrt{3}$	1.732	1	1	2.02%	2.02%	∞
Isotropy, Hemispherical	9.60%	R	$\sqrt{3}$	1.732	1	1	5.54%	5.54%	∞
Modulation Response	2.40%	R	$\sqrt{3}$	1.732	1	1	1.40%	1.40%	∞
Boundary Effect	1.00%	R	$\sqrt{3}$	1.732	1	1	0.58%	0.58%	∞
Linearity	4.70%	R	$\sqrt{3}$	1.732	1	1	2.71%	2.71%	∞
Detection Limits	1.00%	R	$\sqrt{3}$	1.732	1	1	0.58%	0.58%	∞
Readout Electronics	0.30%	N	1	1	1	1	0.30%	0.30%	∞
Response time	0.80%	R	$\sqrt{3}$	1.732	1	1	0.46%	0.46%	∞
Integration Time	2.60%	R	$\sqrt{3}$	1.732	1	1	1.50%	1.50%	∞
Measurement drift (class A evaluation)	1.75%	R	$\sqrt{3}$	1.732	1	1	1.01%	1.01%	∞
RF ambient condition - noise	3.00%	R	$\sqrt{3}$	1.732	1	1	1.73%	1.73%	∞
RF ambient conditions - reflections	3.00%	R	$\sqrt{3}$	1.732	1	1	1.73%	1.73%	∞
Probe positioner Mechanical restrictions	0.40%	R	$\sqrt{3}$	1.732	1	1	0.23%	0.23%	∞
Probe Positioning with respect to phantom shell	2.90%	R	$\sqrt{3}$	1.732	1	1	1.67%	1.67%	∞
Post-processing	1.00%	R	$\sqrt{3}$	1.732	1	1	0.58%	0.58%	∞
Max SAR Eval	1.00%	R	$\sqrt{3}$	1.732	1	1	0.58%	0.58%	∞
Test Sample related									
Test sample positioning	2.90%	N	1	1	1	1	2.90%	2.90%	M-1
Device Holder Uncertainty	3.60%	N	1	1	1	1	3.60%	3.60%	M-1
Drift of output power	5.00%	R	$\sqrt{3}$	1.732	1	1	2.89%	2.89%	∞
Phantom and Setup									
Phantom Uncertainty	4.00%	R	$\sqrt{3}$	1.732	1	1	2.31%	2.31%	∞
Liquid permittivity (mea.)	2.54%	N	1	1	0.64	0.43	1.63%	1.09%	M
Liquid Conductivity (mea.)	2.67%	N	1	1	0.6	0.49	1.60%	1.31%	M
Combined standard uncertainty		RSS					11.64%	11.53%	

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DASY6 Uncertainty Budget
According to IEC/IEEE 62209-1528
(Frequency band: 6GHz - 10GHz range)

a	b	c	d		e	e	f=b * e / d	f=b * e / d
Source of Uncertainty	Uncertainty Value (±%)	Probability Distribution	Div.	Div. Value	(ci) 1g	(ci) 10g	Std. uncertainty (1g) (±%)	Std. uncertainty (10g) (±%)
Measurement system errors								
Probe calibration	18.6	N	2	2	1	1	9.3	9.3
Probe Calibration Drift	1.7	R	√3	1.732	1	1	1.0	1.0
Probe Linearity	4.7	R	√3	1.732	1	1	2.7	2.7
Broadband Signal	2.8	R	√3	1.732	1	1	1.6	1.6
Probe Isotropy	7.6	R	√3	1.732	1	1	4.4	4.4
Data Acquisition	0.3	N	1	1	1	1	0.3	0.3
RF Ambient	1.8	N	1	1	1	1	1.8	1.8
Probe positioning	0.2	N	1	1	0.67	0.67	0.1	0.1
Data Processing	3.5	N	1	1	1	1	3.5	3.5
Phantom and device errors								
Conductivity (meas.)DAK	2.5	N	1	1	0.78	0.71	2.0	1.8
Conductivity (temp.)BB	2.4	R	√3	1.732	0.78	0.71	1.1	1.0
Phantom Permittivity	14.0	R	√3	1.732	0.5	0.5	4.0	4.0
Distance DUT - TSL	2.0	N	1	1	2	2	4.0	4.0
Device Positioning (±0.5mm)	1.0	N	1	1	1	1	1.0	1.0
Device Holder	3.6	N	1	1	1	1	3.6	3.6
DUT Modulationm	2.4	R	√3	1.732	1	1	1.4	1.4
Time-average SAR	0.0	R	√3	1.732	1	1	0.0	0.0
DUT drift	2.5	N	1	1	1	1	2.5	2.5
Val Antenna Unc.	0.0	N	1	1	1	1	0.0	0.0
Unc. Input Power	0.0	N	1	1	1	1	0.0	0.0
Correction to the SAR results								
Deviation to Target	1.90	N	1	1	1	0.84	1.9	1.6
SAR scaling		R	√3	1.732	1	1	0.0	0.0
Combined Std. uncertainty							14.0	13.9
Expanded Std. uncertainty (95% confidence interval), K=2							28.0	27.8

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cDASY6 Module mmWave Uncertainty Budget for PD Evaluation Distances to the Antennas $\geq \lambda/5$ In Compliance with IEC/IEEE 63195

a	b	c	d		e	f=b * e / d	g
Source of Uncertainty	Uncertainty Value (+dB)	Probability Distribution	Div.	Div. Value	ci	Std. uncertainty (+dB)	(vi) Veff
Uncertainty terms dependent on the measurement system							
Probe calibration	0.49	N	1	1	1	0.49	∞
Probe correction	0.00	R	$\sqrt{3}$	1.732	1	0.00	∞
Frequency response (BW ≤ 1 GHz)	0.20	R	$\sqrt{3}$	1.732	1	0.12	∞
Sensor cross coupling	0.00	R	$\sqrt{3}$	1.732	1	0.00	∞
Isotropy	0.50	R	$\sqrt{3}$	1.732	1	0.29	∞
Linearity	0.20	R	$\sqrt{3}$	1.732	1	0.12	∞
Probe scattering	0.00	R	$\sqrt{3}$	1.732	1	0.00	∞
Probe positioning offset	0.30	R	$\sqrt{3}$	1.732	1	0.17	∞
Probe positioning repeatability	0.04	R	$\sqrt{3}$	1.732	1	0.02	∞
Sensor mechanical offset	0.00	R	$\sqrt{3}$	1.732	1	0.00	∞
Probe spatial resolution	0.00	R	$\sqrt{3}$	1.732	1	0.00	∞
Field impedance dependence	0.00	R	$\sqrt{3}$	1.732	1	0.00	∞
Amplitude and phase drift	0.00	R	$\sqrt{3}$	1.732	1	0.00	∞
Amplitude and phase noise	0.04	R	$\sqrt{3}$	1.732	1	0.02	∞
Measurement area truncation	0.00	R	$\sqrt{3}$	1.732	1	0.00	∞
Data acquisition	0.03	N	1	1	1	0.03	∞
Sampling	0.00	R	$\sqrt{3}$	1	1	0.00	∞
Field reconstruction	2.00	R	$\sqrt{3}$	1.732	1	1.15	∞
Forward transformation	0.00	R	$\sqrt{3}$	1.732	1	0.00	∞
Power density scaling	-	R	$\sqrt{3}$	1.732	1	-	∞
Spatial averaging	0.10	R	$\sqrt{3}$	1.732	1	0.06	∞
System detection limit	0.04	R	$\sqrt{3}$	1.732	1	0.02	∞
Uncertainty terms dependent on the DUT and environmental factors							
Probe coupling with DUT	0.00	R	$\sqrt{3}$	1.732	1	0.00	∞
Modulation response	0.40	R	$\sqrt{3}$	1.732	1	0.23	∞
Integration time	0.00	R	$\sqrt{3}$	1.732	1	0.00	∞
Response time	0.00	R	$\sqrt{3}$	1.732	1	0.00	∞
Device holder influence	0.10	R	$\sqrt{3}$	1.732	1	0.06	∞
DUT alignment	0.00	R	$\sqrt{3}$	1.732	1	0.00	∞
RF ambient conditions	0.04	R	$\sqrt{3}$	1.732	1	0.02	∞
Ambient reflections	0.04	R	$\sqrt{3}$	1.732	1	0.02	∞
Immunity / secondary reception	0.00	R	$\sqrt{3}$	1.732	1	0.00	∞
Drift of the DUT	-	R	$\sqrt{3}$	1.732	1	-	∞
Combined Std. uncertainty						1.33	
Expanded Std. uncertainty (95% confidence interval), K=2						2.67	

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16 SAR SYSTEM CHECK RESULTS

Date: 2025/9/8

Report No. :TESA2508000598ES

Dipole 2450 MHz_SN:727

Communication System: CW; Frequency: 2450 MHz; Duty cycle= 1:1

Medium parameters used: $f = 2450$ MHz; $\sigma = 1.848$ S/m; $\epsilon_r = 40.195$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Ambient temperature: 22.4°C; Liquid temperature: 22.1°C

DASY5 Configuration:

- Probe: EX3DV4 – SN7466; ConvF(7.38, 6.95, 6.92) @ 2450 MHz; Calibrated: 2025/1/28
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn856; Calibrated: 2025/4/17
- Phantom: SAM
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Area Scan (51x51x1): Interpolated grid: dx=12 mm, dy=12 mm

Maximum value of SAR (interpolated) = 20.3 W/kg

Zoom Scan (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm

Reference Value = 106.9 V/m; Power Drift = 0.02 dB

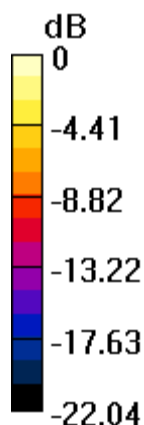
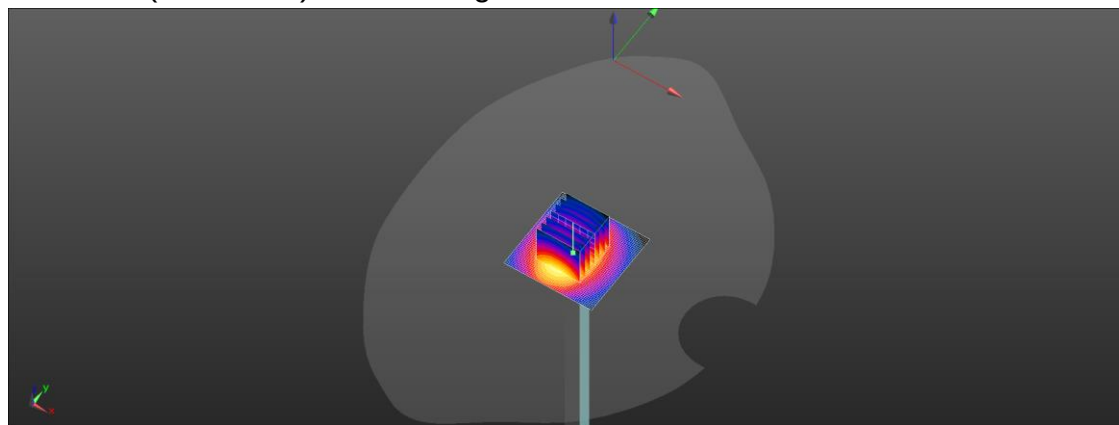
Peak SAR (extrapolated) = 26.5 W/kg

SAR(1 g) = 12.9 W/kg; SAR(10 g) = 6.1 W/kg

Smallest distance from peaks to all points 3 dB below = 10 mm

Ratio of SAR at M2 to SAR at M1 = 47.6%

Maximum value of SAR (measured) = 19.3 W/kg



0 dB = 19.3 W/kg = 12.86 dBW/kg

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Date: 2025/9/8

Report No. :TESA2508000598ES

Dipole 5850 MHz_SN:1349

Communication System: CW; Frequency: 5850 MHz; Duty cycle= 1:1

Medium parameters used: $f = 5850 \text{ MHz}$; $\sigma = 5.435 \text{ S/m}$; $\epsilon_r = 36.223$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Ambient temperature: 22.4°C; Liquid temperature: 22.1°C

DASY5 Configuration:

- Probe: EX3DV4 - SN7466; ConvF(5.07, 4.77, 4.75) @ 5850 MHz; Calibrated: 2025/1/28
- Sensor-Surface: 1.4mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn856; Calibrated: 2025/4/17
- Phantom: SAM
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Area Scan (61x61x1): Interpolated grid: $dx=10 \text{ mm}$, $dy=10 \text{ mm}$

Maximum value of SAR (interpolated) = 22.3 W/kg

Zoom Scan (7x7x12)/Cube 0: Measurement grid: $dx=4\text{mm}$, $dy=4\text{mm}$, $dz=2\text{mm}$

Reference Value = 63.69 V/m; Power Drift = 0.09 dB

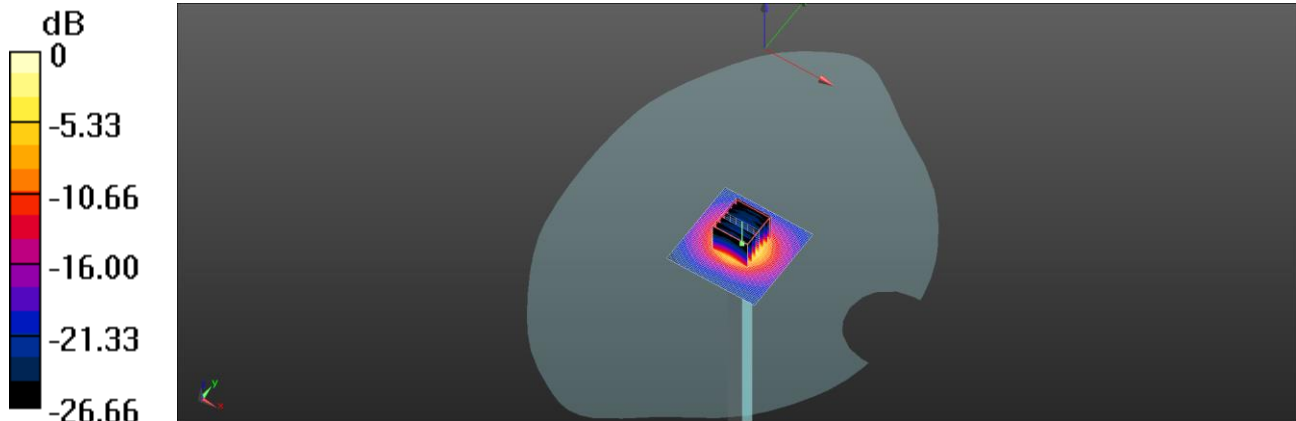
Peak SAR (extrapolated) = 43.1 W/kg

SAR(1 g) = 7.86 W/kg; SAR(10 g) = 2.15 W/kg

Smallest distance from peaks to all points 3 dB below = 7.2 mm

Ratio of SAR at M2 to SAR at M1 = 47%

Maximum value of SAR (measured) = 22.3 W/kg



0 dB = 22.3 W/kg = 13.48 dBW/kg

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Report No. :TESA2508000598ES

Dipole_D6500-SN:1029

Ambient temperature: 22.4°C; Liquid temperature: 22.1°C

Exposure Conditions

Phantom Section, TSL	Position, Test Distance [mm]	Frequency [MHz], Channel Number	Conversion Factor	TSL Conductivity [S/m]	TSL Permittivity
Flat, HSL	FRONT, 5.00	6500.000, 6500	5.34	6.237	35.464

Hardware Setup

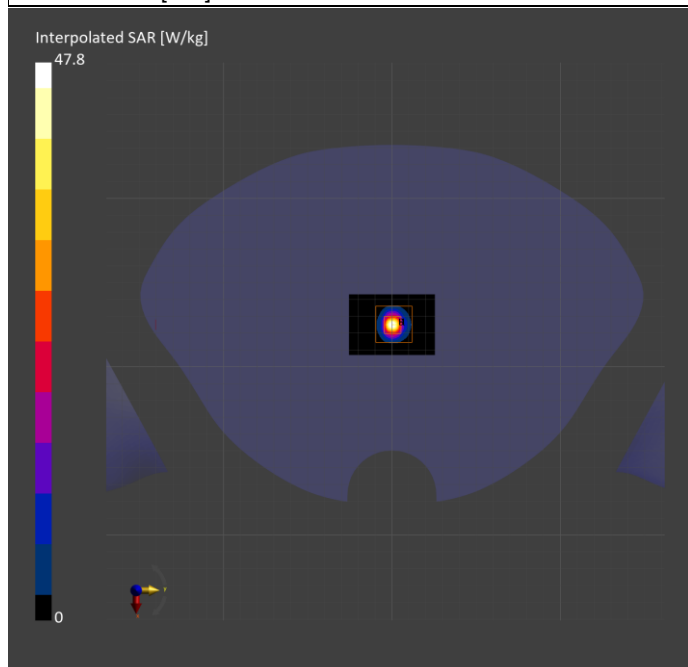
Phantom	Probe, Calibration Date	DAE, Calibration Date
SAM	EX3DV4 - SN7466, 2025-01-28	DAE4 Sn856, 2025-4-17

Scans Setup

	Area Scan	Zoom Scan
Grid Extents [mm]	36.0 x 51.0	22.0 x 22.0 x 22.0
Grid Steps [mm]	6.0 x 8.5	3.4 x 3.4 x 1.4
Sensor Surface [mm]	3.0	1.4

Measurement Results

	Area Scan	Zoom Scan
Date	2025-09-08	2025-09-08
psSAR1g [W/kg]	25.2	28.1
psSAR8g [W/kg]	5.93	6.52
psSAR10g [W/kg]	4.92	5.36
psPDab (4.0cm2, sq) [W/m2]		136
Power Drift [dB]	0.05	0.01
M2/M1 [%]		56.7
Dist 3dB Peak [mm]		5.0



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17 PD SYSTEM CHECK RESULTS

Report No. :TESA2508000598ES

Measurement Report

5G Verification Source 10GHz-SN:1021

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Conversion Factor
5G	FRONT, 10.00	1.0

Hardware Setup

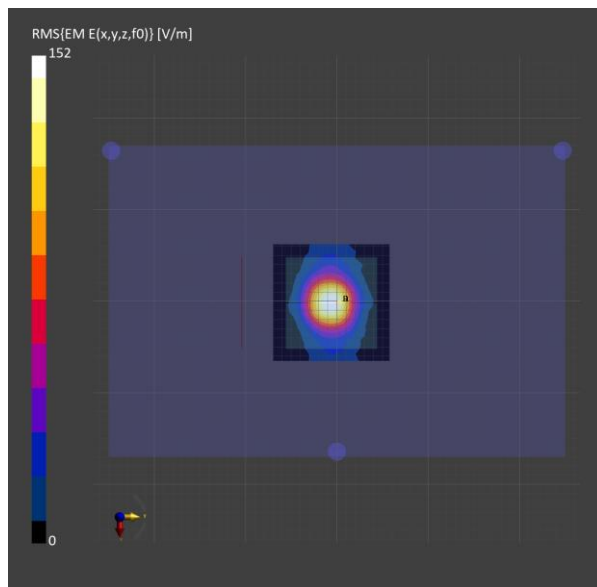
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave - 1076	Air -	EUmmWV4 - SN9616_F1-55GHz, 2025-03-14	DAE4 Sn856, 2025-04-17

Scans Setup

Scan Type	5G Scan
Grid Extents [mm]	120.0 x 120.0
Grid Steps [lambda]	0.25 x 0.25
Sensor Surface [mm]	10.0

Measurement Results

Scan Type	5G Scan
Date	2025-09-08
Avg. Area [cm ²]	4.00
psPDn+ [W/m ²]	51.0
psPDtot+ [W/m ²]	51.0
psPDmod+ [W/m ²]	51.4
E _{max} [V/m]	152
Power Drift [dB]	0.06



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Refer to separated files for the following appendixes.

18.1 SAR_Appendix E Photographs

18.2 SAR_Appendix F DAE & Probe Cal. Certificate

18.3 SAR_Appendix G Phantom Description & Dipole Cal. Certificate

18.4 SAR_Appendix H Dipole Extended Calibration Verification

- End of report -

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