PART 2 Test Under Dynamic Transmission Condition

No. 24T04Z102849-003

For

Guangdong OPPO Mobile Telecommunications Corp., Ltd.

Mobile Phone

Model Name: CPH2659

with

Hardware Version: 11

Software Version: Color OS 15.0

FCC ID: R9C-OP23216

Issued Date: 2025-04-21

Note:

The test results in this test report relate only to the devices specified in this report. This report shall not be reproduced except in full without the written approval of CTTL.

Test Laboratory:

CTTL, Telecommunication Technology Labs, CAICT

No. 52, Huayuan North Road, Haidian District, Beijing, P. R. China 100191.

Tel:+86(0)10-62304633-2512, Fax:+86(0)10-62304633-2504

Email: cttl_terminals@caict.ac.cn, website: www.caict.ac.cn

REPORT HISTORY

Report Number	Revision	Issue Date	Description
24T04Z102849-003	Rev.0	2025-04-16	Initial creation of test report
24T04Z102849-003	Rev.1	2025-04-21	Update the information for WLAN

TABLE OF CONTENT

1 Test Laboratory

1.1. Introduction & Accreditation

Telecommunication Technology Labs, CAICT is an ISO/IEC 17025:2017 accredited test laboratory under American Association for Laboratory Accreditation (A2LA) with lab code 7049.01, and is also an FCC accredited test laboratory (CN1349), and ISED accredited test laboratory (CAB identifier:CN0066). The detail accreditation scope can be found on A2LA website.

1.2. Testing Location

Location 1: CTTL(huayuan North Road)

Address:	No. 52, Huayuan North Road, Haidian District, Beijing, P. R. China 100191

1.3. Testing Environment

Normal Temperature:	18-25℃
Relative Humidity:	30-70%

1.4. Project data

Testing Start Date:	2024-09-25
Testing End Date:	2024-11-23

1.5. Signature

Wang Meng

(Prepared this test report)

Lin Jun

(Reviewed this test report)

Qi Dianyuan

Deputy Director of the laboratory

(Approved this test report)

2 Introduction

This EUT is a variant product and the report of original sample is No. 24T04Z101591_016. added WLAN evaluation. The results of evaluation are presented in the section 8/10.

FCC regulation allows time averaged RF power to demonstrate compliance to RF exposure safety limits. Because RF exposure is correlated to transmission power (TX power), e.g., lower RF exposure is correlated to lower TX power, the TX power can be controlled to meet FCC RF exposure.

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 SAR requirement. In the FCC regulation, the averaging window of SAR is 100 seconds for transmit frequencies less than 3GHz, 60 seconds for transmit frequencies between 3GHz and 6GHz.

This document describes the test plan, test procedures, measurement setup, and measurement results for the verification of the proposed TA-SAR algorithm being able to make RF exposure meet FCC requirement.

This purpose of the Part 2 report is to demonstrate the EUT complies with FCC exposure requirement under TX varying transmission scenarios, thereby validity of MediaTek TAS feature for FCC equipment authorization.

3 Operating Parameters for Algorithm Validation

Mediatek developed the TA-SAR algorithm to control instantaneous TX power for transmit frequencies, respectively, so that the total time-averaged RF exposures are less than FCC requirement.

TA-SAR algorithm validation has been performed for 2G,3G,LTE,5G NR,WLAN according to cases with different combinations of operating parameters listed in Table 3-1.

Table 3-1 TA-SAR operating parameters

Operating parameters	Description
P_{sub6_limit}	The time-averaged maximum power level limit for different band in sub6.
$P_{lowThresh\_offset}$	To calculate $P_{lowthresh}$. ($P_{lowThresh} = P_{sub6\_limit} - P_{lowThresh\_offset}$)
$P_{ue\_backoff\_offset}$	To calculate $P_{ue\_backoff}$. ($P_{ue\_backoff} = P_{sub6\_limit} - P_{l\ ue\_backoff\_offset}$)
$P_{ue\_max\_cust\_offset}$	To calculate $P_{ue\_max\_cust}$. P_{ue_max} is maximum TX power at which a UE can possibly transmit in sub6. ($P_{ue\_max\_cust}$ = mim (P_{ue_max} ,$P_{sub6\_limit} + P_{ue\_max\_cust\_offset}$)

4 Overview of TA-SAR/TA-PD

4.1 Overview of TA-SAR for WWAN

Scenario 1: test under different TA-SAR parameters to verify that the TA-SAR algorithm meets compliance requirements with different combinations of operating parameters.

Scenario 2: test under time-varying TX power to verify that the TA-SAR algorithm ensures SAR compliance through dynamic TX power.

Scenario 3: test under call drop and re-establishment conditions to ensure the TA-SAR algorithm control continuity and SAR compliance.

Scenario 4: test under RAT/band handover to ensure the TA-SAR algorithm control continuity and correctness.

Scenario 5: test under different ECIs (Exposure Condition Index) to ensure the TA-SAR algorithm control behaves as expected during ECI switching from one ECI to another. (e.g., head→ body worn)

Scenario 6: test under different transmission antennae to ensure the TA-SAR algorithm control works correctly during antenna switching from one antenna to another.

Scenario 7: test under different time windows to ensure the TA-SAR algorithm control functions correctly during time window switching form one time window setting to another.(e.g., time window 100s→60s)

Scenario 8: test under SAR exposure switching between two active radios (radio#1 dominant, radio#1+radio#2, and radio#2 dominant) to ensure the TA-SAR algorithm control continuity and SAR compliance.

4.2 Overview of TA-SAR/TA-PD for WLAN

Scenario 1: test TX mode change between normal mode and sleep mode to verify algorithm and SAR compliance.

Scenario 2: test band handover to ensure algorithm control continuity and correctness.

Scenario 3: test different transmission antennas to ensure algorithm control works correctly during antenna switch from one antenna to another.

Scenario 4: test different ECI (Exposure Condition Index) to ensure algorithm control behaves as expected during ECI switch from one ECI to another. (e.g., head→ body worn)

Scenario 5: the scenario is to test TER(total exposure ration) 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.

5 TA-SAR Test Scenarios and Test Procedures (WWAN)

In order to demonstrate that TA-SAR algorithm performs as expected under various operating scenarios, Table 5-1 lists the test scenarios and expected test sequences to validate TA-SAR algorithm in these scenarios. The test sequences 0,1,2 are defined in section 5.1. The details of each test procedures via conducted power and SAR measurements are described in section 5.2~5.9 and section 5.10, respectively.

Table 5-1 Test scenario list of TA-SAR validation

Test scenario		Test sequence #	Description
1	Range of TA-SAR parameters	0	Adjust parameters
2	Time-varying TX power	1 and 2	Test under time-varying TX power
3	Call disconnection and re-establishment	0	Test call drop and re-establishment
4	Band/RAT handover	0	Test band/RAT change
5	ECI (Exposure Condition Index) change	0	Test under ECI transition (e.g., head→ body worn)
6	Antenna switching	0	Change antenna
7	Time window switching	0	Switch frequency bands with larger frequency separation (e.g., time window 100s→ 60s)
8	SAR exposure switching	0	Switch RATs when testing (e.g., LTE→NR)

5.1 Test Sequences for All Scenarios

Two test sequences having possibly time-varying TX power are predefined for TA-SAR validation:

- **Test sequence 0**: EUT's TX power is requested to be maximum.
- **Test sequence 1**: EUT's TX power is requested to be at power less than $P_{LowThresh}$ for 300s, then at maximum power for 200s, and finally at $P_{LowThresh}$ -2dB for the remaining time.
- **Test sequence 2**: EUT's TX power to vary with time. This sequence is generated relative to measured P_{UE_max}, measured P_{sub6_limit} and calculated $P_{UE\_backoff}$ (= measured P_{sub6_limit} in dBm - $P_{UE\_backoff\_offset}$ in dB) of EUT based on measured P_{sub6_limit}.
- Test sequence is generated based on below parameters of the EUT:

  A. Measured maximum power (P_{UE_max})

  B. Measured Tx power at SAR_design_limit (P_{sub6_limit})

  C. Threshold of dynamic power reduction status determination: reserve hysteresis margin for instantaneous power ($P_{LowThresh}$)

  D. SAR_time_window (FCC: 100s for f<3GHz, 60s for 3GHz<f<6GHz)

The test sequence 0,1, and 2 are illustrated in Figure 5-1, Figure 5-2, and Figure 5-3, respectively. The waveforms of the three test sequences are listed in Table 5-2,Table 5-3, and Table 5-4.

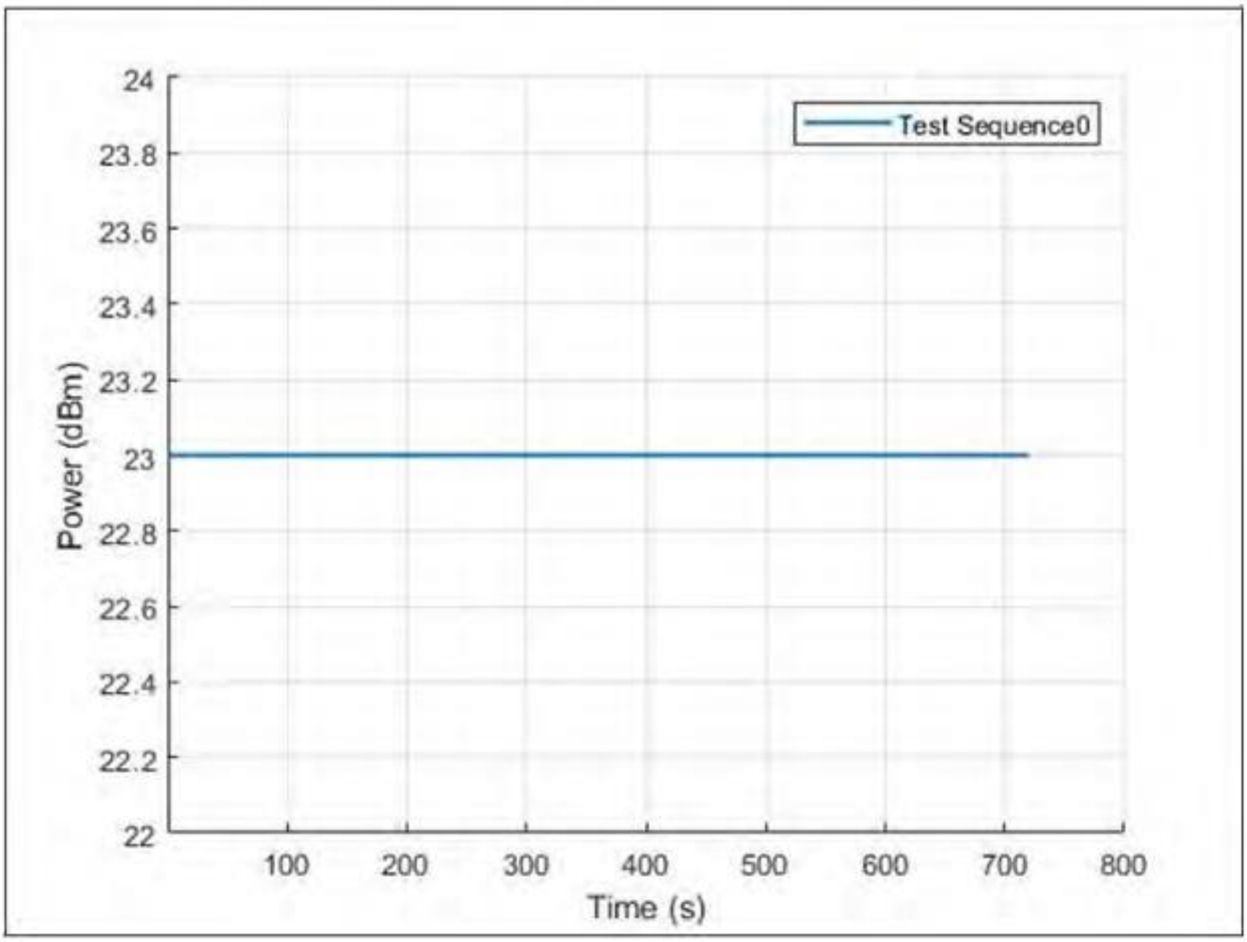


Figure 5-1 Test sequence 0

Table 5-2 Test sequence 1

Time	Duration	Power (dBm)	Note
720	720	23	P_{UE_max}

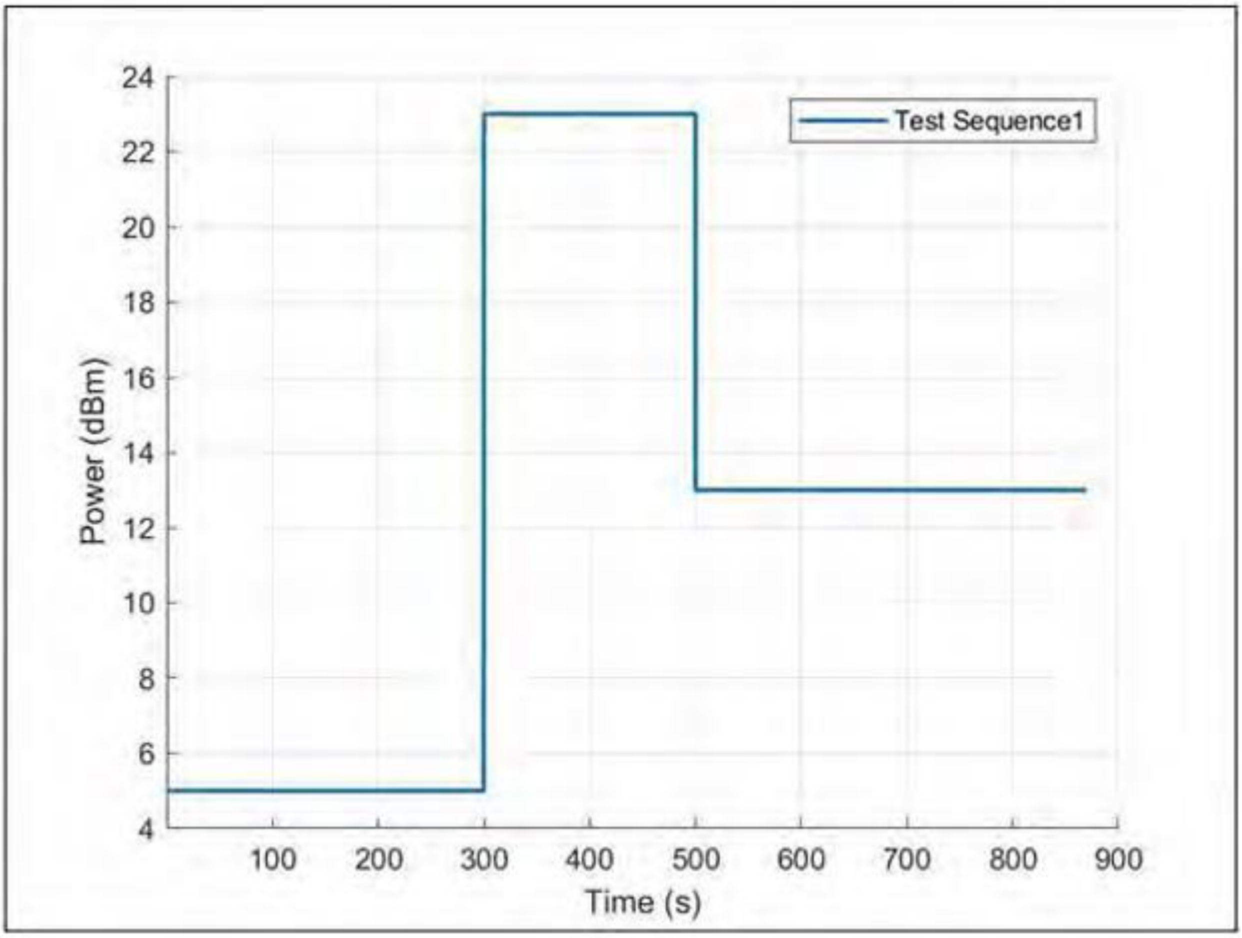


Figure 5-2 Test sequence 1

Table 5-3 Test sequence 1

Time	Duration	Power (dBm)	Note
300	300	5	$< P_{Lowthresh}$
500	200	23	P_{UE_max}
870	370	13	$P_{Lowthresh}$ – 2dB

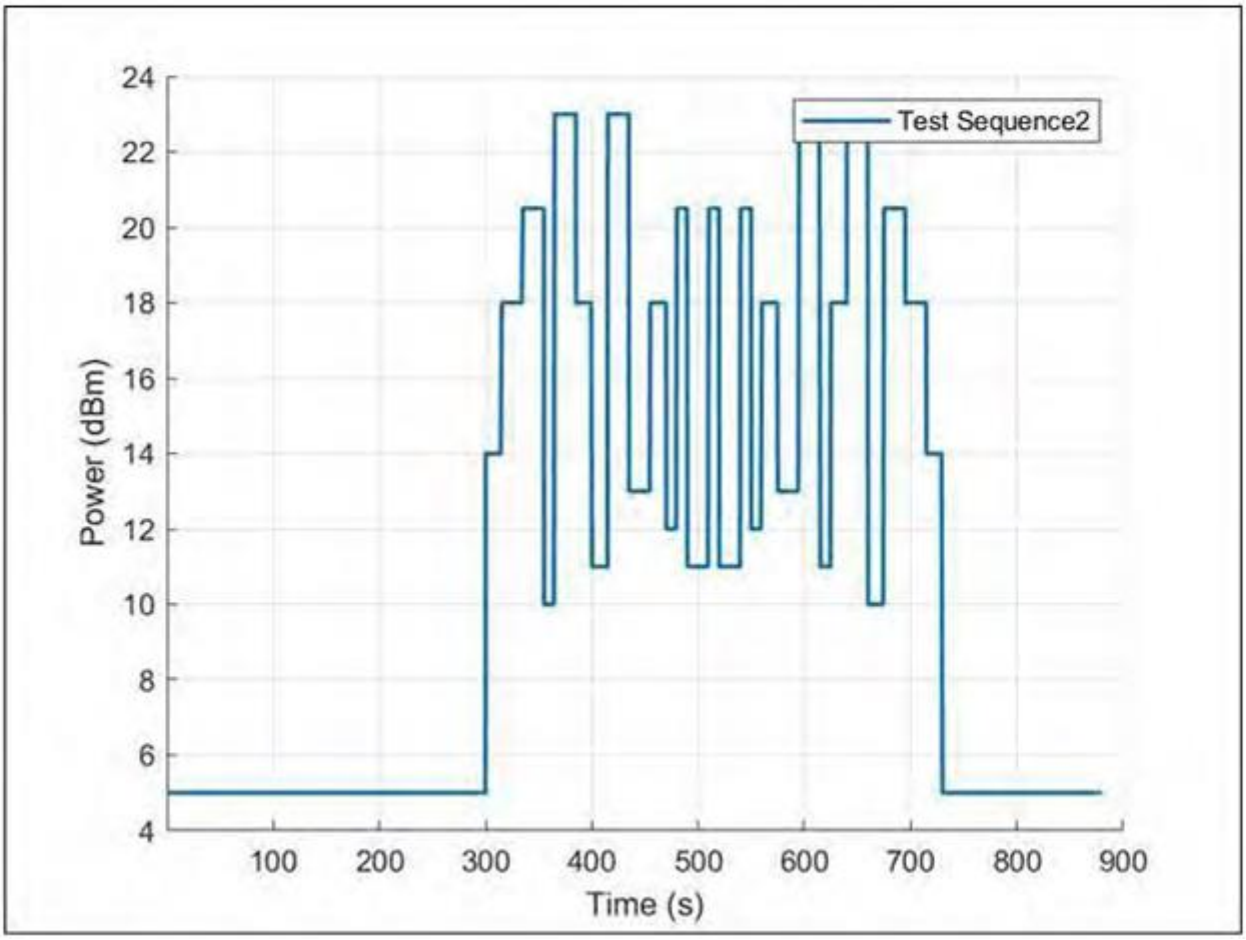


Figure 5-3 Test sequence 2

Table 5-4 Test sequence 2

Time	Duration	Power (dBm)	Note
300	300	5	< $P_{Lowthresh}$
315	15	14	P_{sub6_limit} – 4dB
335	20	18	P_{sub6_limit}
355	20	20.5	($P_{sub6\_limit} + P_{UE\_max}$)/2
365	10	10	P_{sub6_limit} – 8dB
385	20	23	P_{UE_max}
400	15	18	P_{sub6_limit}

415	15	11	P_{sub6_limit} – 7dB
435	20	23	P_{UE_max}
455	20	13	P_{sub6_limit} – 5dB
470	15	18	P_{sub6_limit}
480	10	12	P_{sub6_limit} – 6dB
490	10	20.5	$(P_{sub6\_limit} + P_{UE\_max})/2$
510	20	11	P_{sub6_limit} – 7dB
520	10	20.5	$(P_{sub6\_limit} + P_{UE\_max})/2$
540	20	11	P_{sub6_limit} – 7dB
550	10	20.5	$(P_{sub6\_limit} + P_{UE\_max})/2$
560	10	12	P_{sub6_limit} – 6dB
575	15	18	P_{sub6_limit}
595	20	13	P_{sub6_limit} – 5dB
615	20	23	P_{UE_max}
625	10	11	P_{sub6_limit} – 7dB
640	15	18	P_{sub6_limit}
660	20	23	P_{UE_max}
675	15	10	P_{sub6_limit} – 8dB
695	20	20.5	$(P_{sub6\_limit} + P_{UE\_max})/2$
715	20	18	P_{sub6_limit}
730	15	14	P_{sub6_limit} – 4dB
870	140	5	$< P_{Lowthresh}$

5.2 Test Configuration and Procedure for Scenario 1: Range of TA-SAR Parameters via Conducted Power Measurements

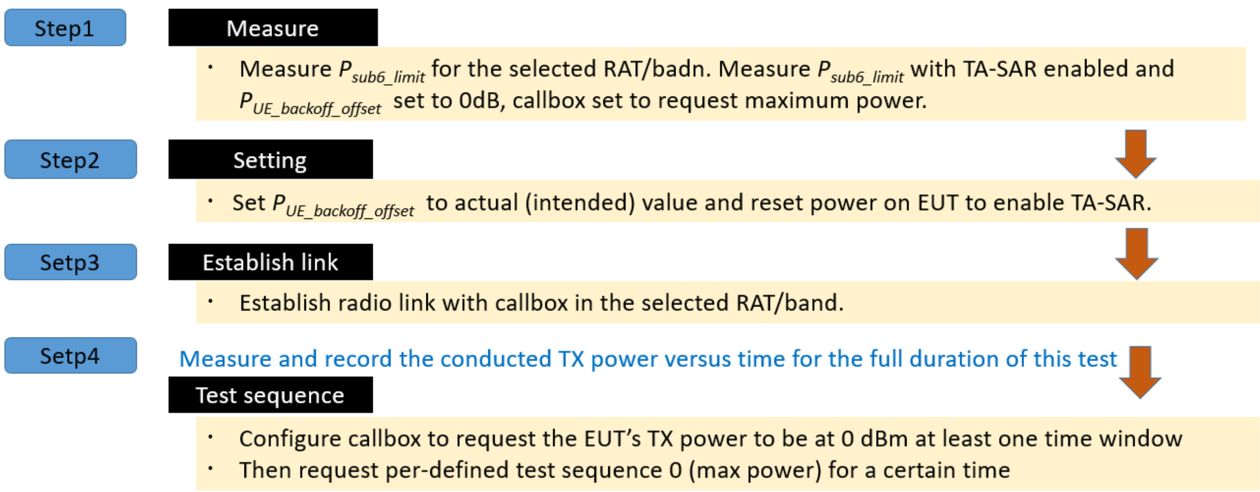
5.2.1 Configuration

This test is performed by changing the parameters ($P_{LowThresh\_offset}$, $P_{UE\_backoff\_offset}$, $P_{UE\_max\_cust\_offset}$) for the selected RAT (Radio Access Technologies) and band. Since Meditek’s TA algorithm operation is independent of RATs/bands/channels, any one RAT can be selected for this test and the selected band of the RAT has the least P_{sub6_limit}. In principle, two sets of the parameters are determined for this test (if applicable). If the parameters of the EUT are fixed (without a support of dynamic change), only the set of the default parameters needs to be tested.

5.2.2 Procedure

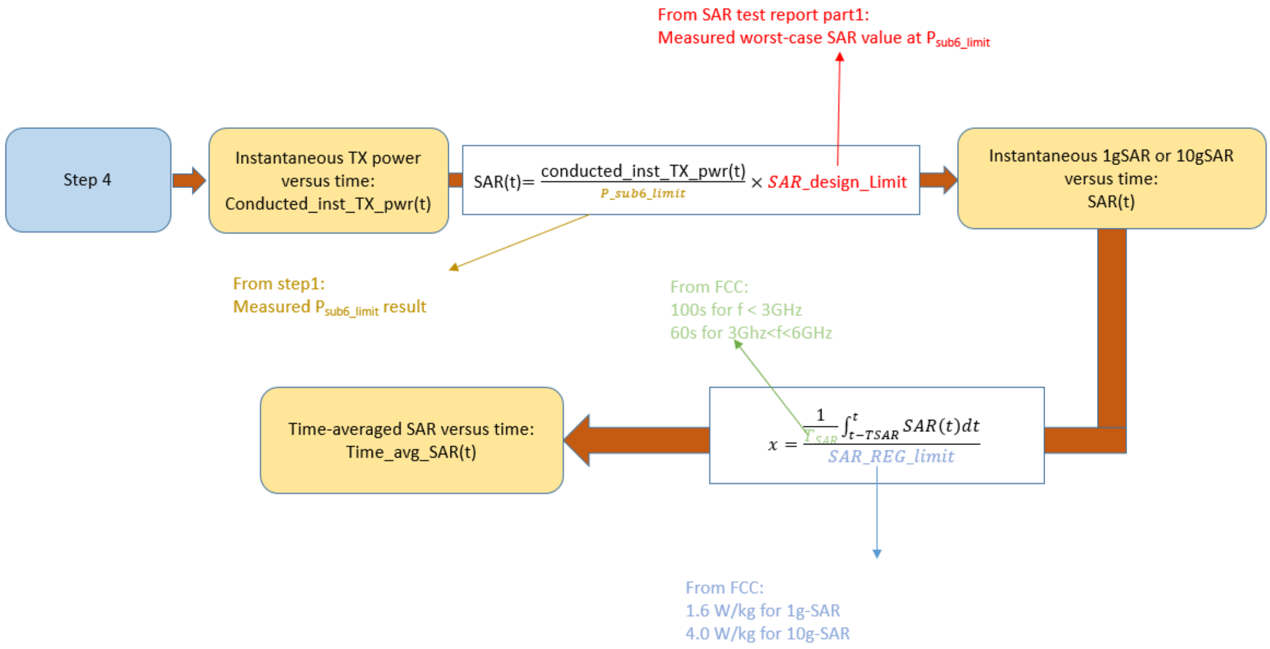
TX power is measured, recorded, and processed by the following steps:

- Step 1~4: measure and record TX power versus time for test scenario 1



- 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 10gSAR to determine time-averaged value versus time as follows,



- 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

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

5.3 Test Configuration and Procedure for Scenario 2: Time-varying TX Power via Conducted Power Measurements

5.3.1 Configuration

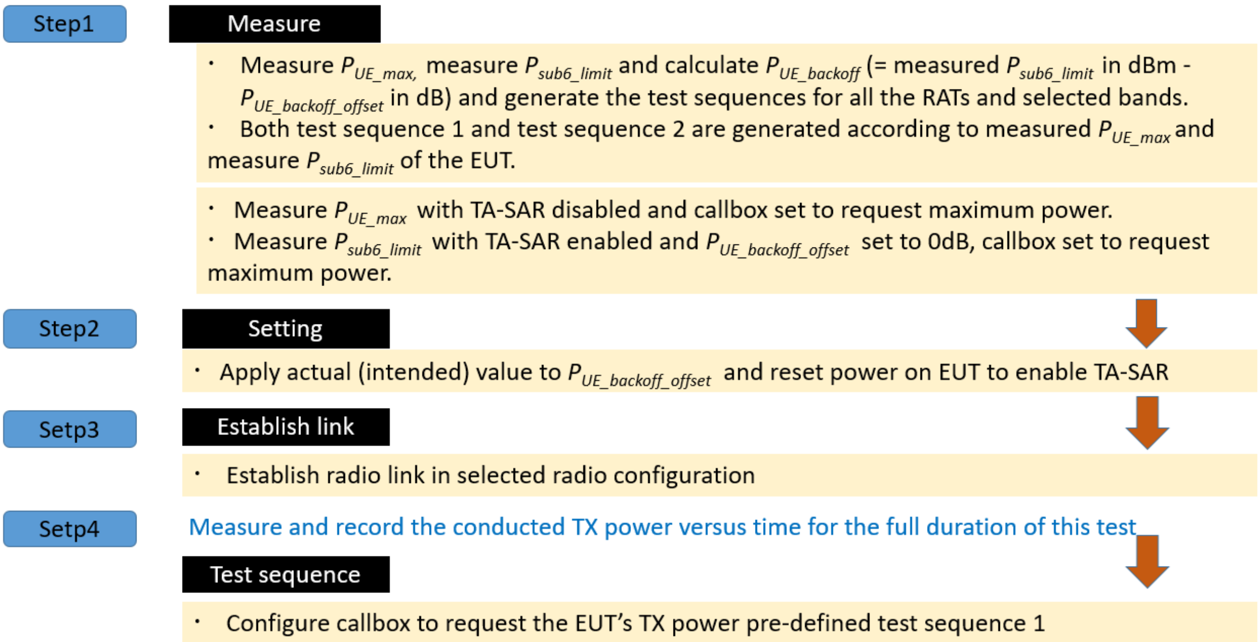
Since Mediatek's TA-SAR feature operation is independent of bands and channels for a given RAT, selecting one band per RAT is sufficient to validate this feature. One band per RAT are proposed for this test. The criteria for band selection for each RAT is based on the P_{sub6_limit} values (corresponding to SAR_design_limit) and is described as below:

- Select two bands, among the ones whose P_{sub6_limit} values are below P_{UE_max} , which correspond to least and highest P_{sub6_limit} values respectively.
  - Only one band needs to be tested if all the bands have same $P_{sub6\_limit.}$
  - Only one band needs to be tested if only the band has P_{sub6_limit} below $P_{UE\_max.}$
  - If the same least P_{sub6_limit} applies to multiple bands, select the band with the highest measured 1gSAR at $P_{sub6\_limit.}$
  - If P_{sub6_limit} values of all bands are all over P_{UE_max} (i.e., TA-SAR feature is not enabled), there is no need to test this RAT.

5.3.2 Procedure

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

- Step 1~4: measure and record TX power versus time for test scenario 2



- 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 10gSAR to determine time-averaged value versus time as below:

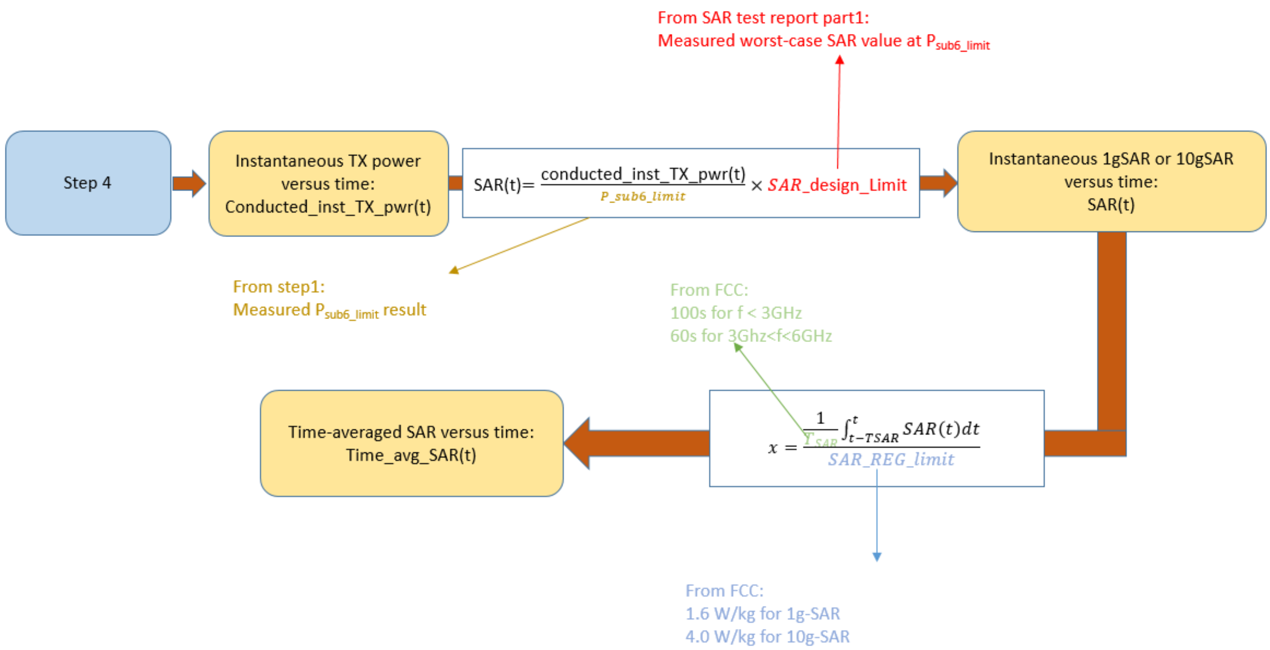
Time	t_1	t_2	...	t_n	t_{n+1}	...
Power or SAR	P_{t1}/SAR_{t1}	P_{t2}/SAR_{t2}	...	P_{tn}/SAR_{tn}	P_{tn+1}/SAR_{tn+1}	...

1st time window (e.g., 100s)

1st Time averaged P or SAR $= \frac{\sum_{i=1}^{n} P_{ti} \text{ or } SARti}{n}$

2nd time window (e.g., 100s)

2nd Time averaged P or SAR $= \frac{\sum_{i=2}^{n+1} P_{ti} \text{ or } SARti}{n}$



- Step 6: plot results

A. Make one power perspective plot containing

1. Instantaneous TX power
2. Requested power (test sequence1)
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)

- Step 7: repeat steps 2~6 for test sequence 2

Repeat steps 2 ~ 6 for pre-defined test sequence 2 and replace test sequence 1 in step 4 with test sequence 2.

- Step 8: repeat steps 2~7 for different bands

5.4 Test Configuration and Procedure for Scenario 3: Call Disconnection and Re-establishment via Conducted Power Measurements

5.4.1 Configuration

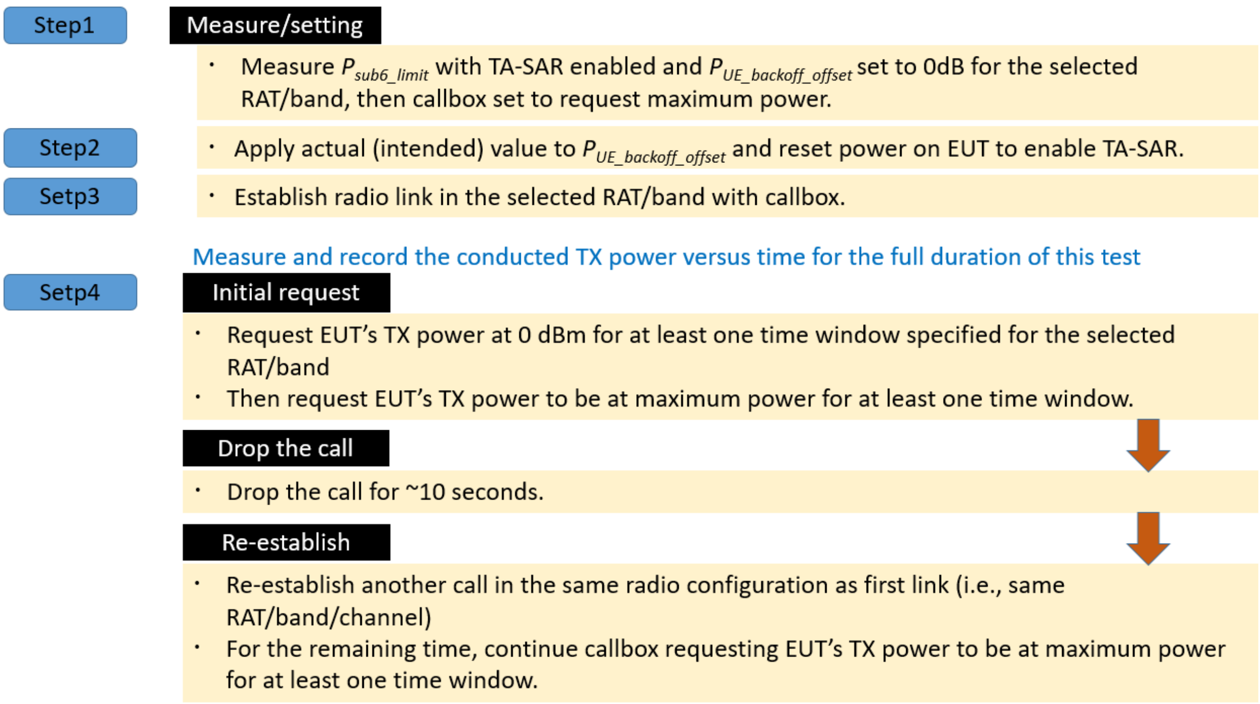
For call disconnection measurement, the criteria of selecting the test configuration is:

- Select the RAT/band with least P_{sub6_limit} among all supported RATs/bands.
- Select the RAT/band having the highest measured 1gSAR at P_{sub6_limit} if multiple RATs/bands having same least P_{sub6_limit}.
- Select the radio configuration in this RAT/band that corresponds to the highest measured 1gSAR at P_{sub6_limit}.

5.4.2 Procedure

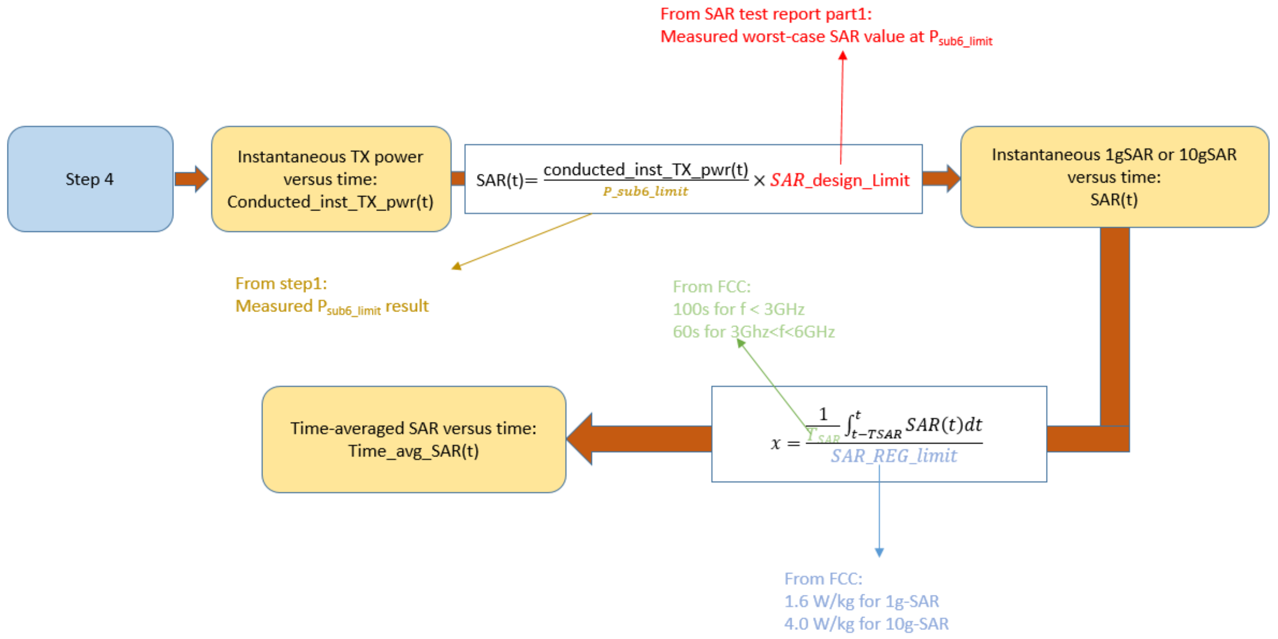
TX power is measured, recorded, and processed by the following steps:

- Step 1~4: measure and record TX power versus time for test scenario 3



- 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 10gSAR to determine time-averaged value versus time as follows:



- 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)

5.5 Test Configuration and Procedure for Scenario 4: Band Handover via Conducted Power Measurements

5.5.1 Configuration

For a given TX antenna, select a RAT/ band with the lowest P_{sub6_limit} and the other RAT/band with the highest P_{sub6_limit}. Both of them have P_{sub6_limit} values less than P_{UE_max} if possible.

- Select the RAT/band having the highest measured 1gSAR at P_{sub6_limit} if multiple RATs/bands have the same lowest P_{sub6_limit}.
- Select the RAT/band having the lowest measured 1gSAR at P_{sub6_limit} if multiple RATs/bands have the same highest P_{sub6_limit}.

5.5.2 Procedure

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

- Step 1~4: measure and record TX power versus time for test scenario 4

Step1

Measure/setting

- Measure P_{sub6_limit} for both the selected RATs and bands, Measure P_{sub6_limit} with TA-SAR enabled and $P_{UE\_backoff\_offset}$ set to 0dB, callbox set to request maximum power.

Step2

- Apply actual (intended) value to $P_{UE\_backoff\_offset}$ and reset power on EUT to enable TA-SAR.

Setp3

- Establish radio link in the selected RAT/band with callbox.

Measure and record the conducted TX power versus time for the full duration of this test

Setp4

Initial request

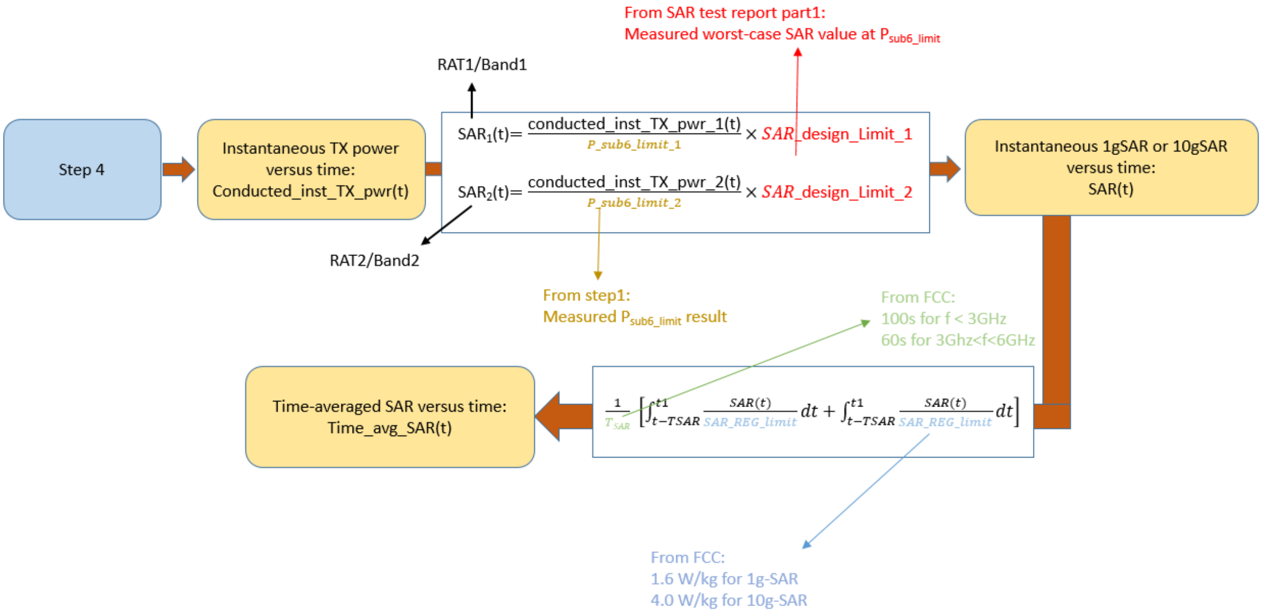
- Request EUT's TX power at 0 dBm for at least one time window specified for the selected RAT/band
- Then request EUT's TX power to be at maximum power for at least one time window.

RAT/Band switch

- Switch the radio link to second RAT/band selected.
- For the remaining time, continue callbox requesting EUT's TX power to be at maximum power for at least one time window.

- 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 10gSAR to determine time-averaged value versus time as follows,



- 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

5.6 Test Configuration and Procedure for Scenario 5: Exposure Condition Index (ECI) Change via Conducted Power Measurements

5.6.1 Configuration

Select any one RAT/band, which has at least two ECIs whose P_{sub6_limit} values are different and are below P_{UE_max}.

5.6.2 Procedure

The test procedure is identical to section 5.5.2 except the following 2 changes:

1. Replace band switch operation with ECI switch.
2. In step 4, the second ECI switching is arranged after the first one lasts for at least one time window, i.e., switch the second ECI back to the first ECI, and then continue with callbox requesting EUT’s TX power to be at maximum power for at least one time window.

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

- The correct power control is controlled by TA_SAR during ECI switches from one ECI to another.
- The validation criteria are, at all times, the time-averaged 1gSAR or 10gSAR versus time shall not exceed FCC limit of 1.6W/kg for 1gSAR or 4W/kg for 10gSAR.

5.7 Test Configuration and Procedure for Scenario 6: Antenna Switching via Conducted Power Measurements

5.7.1 Configuration

Among RATs/bands supporting TX antenna switches, select the RAT/band with the highest P_{sub6_limit} difference between a pair of supported TX antennas.

- Select the RAT/band having the highest measured 1gSAR at P_{sub6_limit} if multiple RATs/bands having the same P_{sub6_limit} difference between the supported TX antennas.
- Antenna selection order
    - Select the configuration with two antennas having P_{sub6_limit} values less than P_{UE_max}.
    - If the previous configuration does not exist, select the configuration with one antenna having P_{sub6_limit} value less than P_{UE_max}.
    - If the above two cannot be found, select one configuration with the two antennas having the least difference between their P_{sub6_limit} and P_{UE_max} (i.e., P_{sub6_limit} can be greater than P_{UE_max}).

5.7.2 Procedure

The test procedure is identical to section 5.5.2 except the following 2 changes:

1. Replace band switch operation with antenna switch.
2. In step 4, the second antenna switching is arranged after the first one lasts for at least one time window, i.e., switch the second antenna back to the first antenna, and then continue with callbox requesting EUT's TX power to be at maximum power for at least one time window.

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

- The correct power control is controlled by TA_SAR during antenna switches from one antenna to another.
- The validation criteria are, at all times, the time-averaged 1gSAR or 10gSAR versus time shall not exceed FCC limit of 1.6W/kg for 1gSAR or 4.0W/kg for 10gSAR.

5.8 Test Configuration and Procedure for Scenario 7: Time Window Switching via Conducted Power Measurements

5.8.1 Configuration

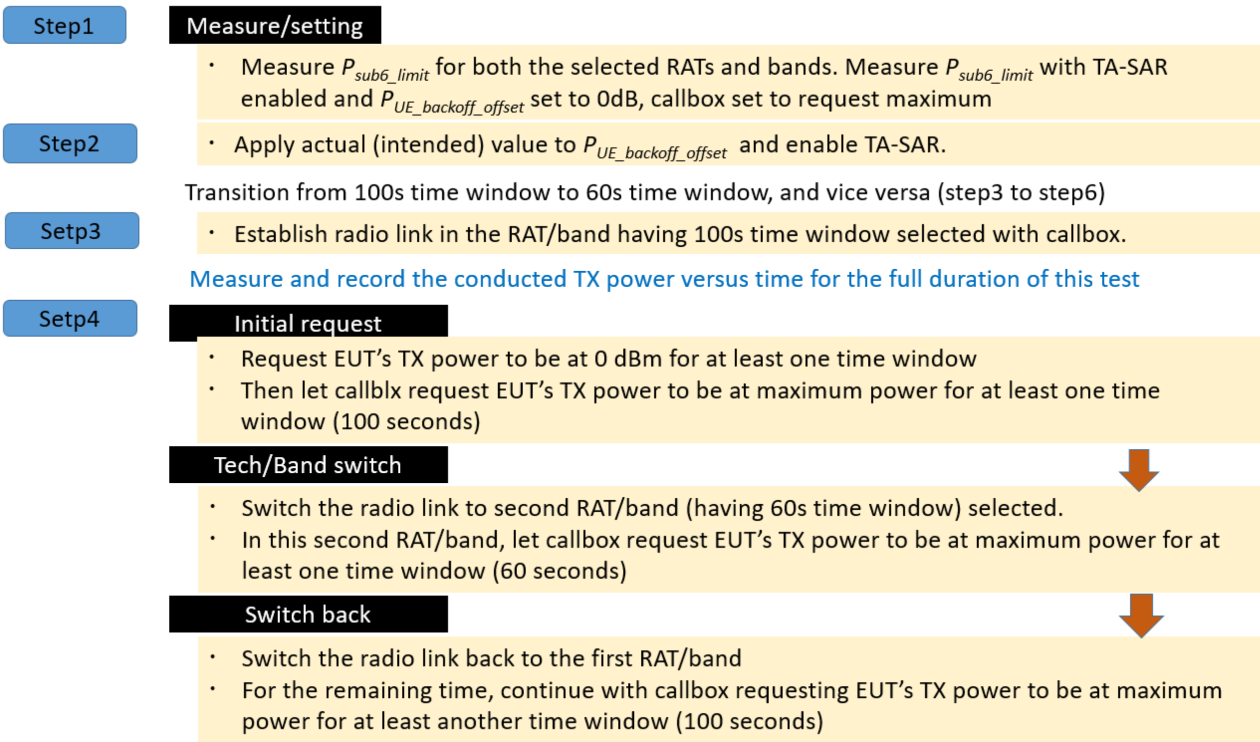
Select one RAT/band with 60-second time averaging window, and the other RAT/band with 100-second time averaging window. Both of them have P_{sub6_limit} values less than P_{UE_max} if possible.

- At least one of the selected RAT/band has its P_{sub6_limit} less than P_{UE_max}.

5.8.2 Procedure

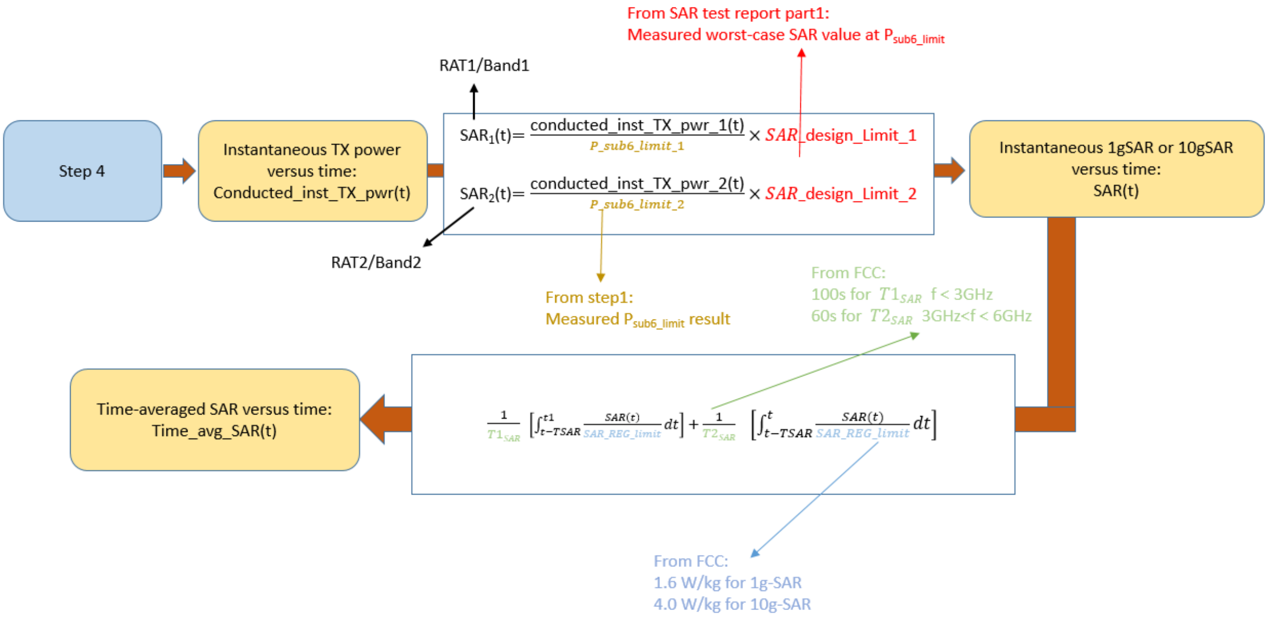
TX power is measured, recorded, and processed by the following steps:

- Step 1~4: measure and record TX power versus time for test scenario 7



- 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 10gSAR to determine time-averaged value versus time as follows,



- Step 6: plot results

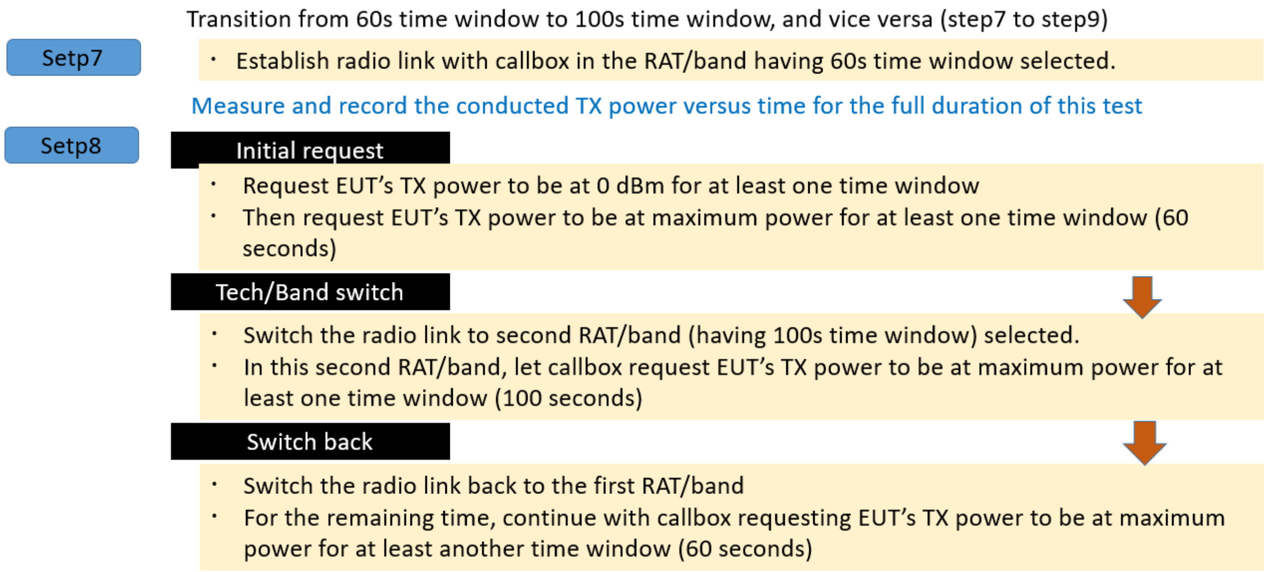
A. Make one power perspective plot containing

   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

- Step 7 ~ 8: measure and record TX power versus time in another time window change



- Step 9: convert the measurement and plot results

Convert the measured conducted TX power from step 8 into 1gSAR or 10gSAR value using the equation in step 5.

Repeat step 6 to generate the plots.

5.9 Test Configuration and Procedure for Scenario 8: SAR Exposure Switching via Conducted Power Measurements

5.9.1 Configuration

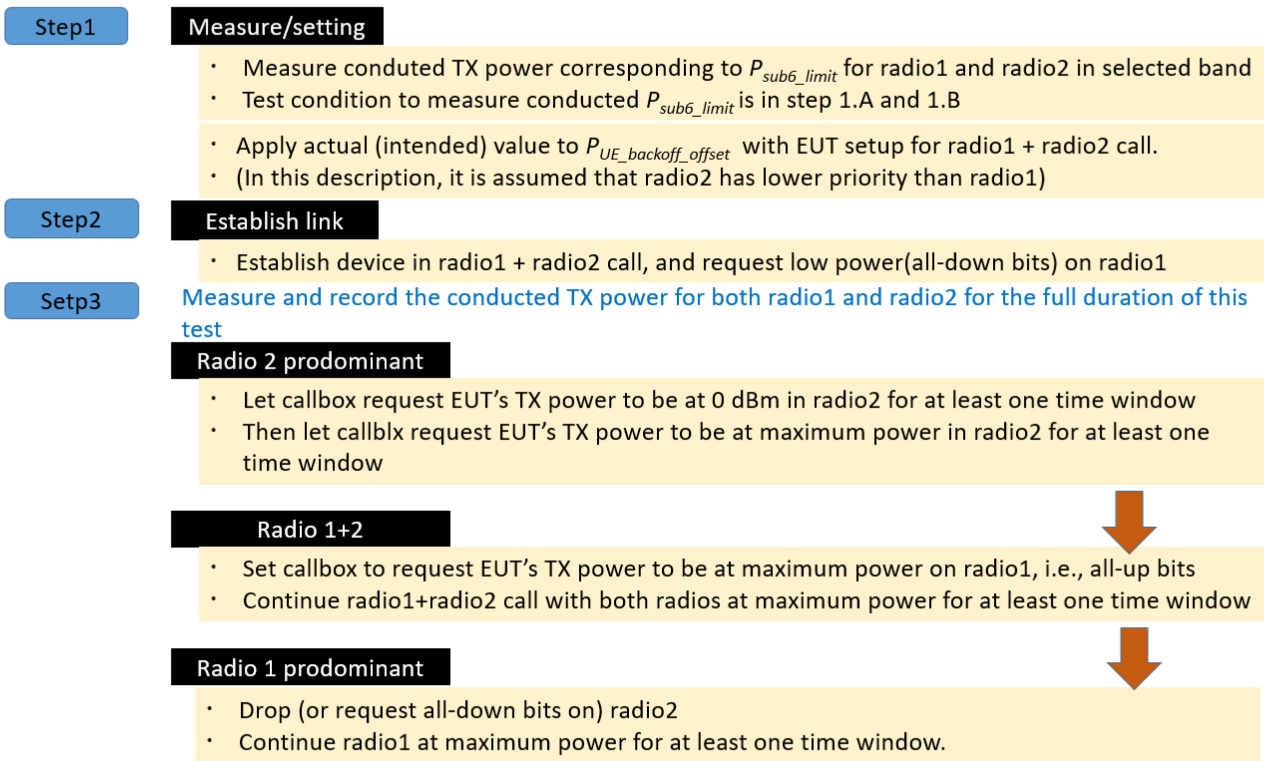
If supported, SAR exposure switch with two active radios having the same and different time averaging windows should be covered in this test. Mediatek's TA algorithm operation is independent of the source of SAR exposure (e.g., LTE vs. NR FR1) and ensures total time-averaged RF exposure compliance for SAR exposure among the scenarios of radio 1 only, radio 1 + radio 2, and radio 2 only.

- Select any two <6GHz RATs/bands that the EUT supports for simultaneous transmission (e.g., LTE + NR FR1).
- The selection order among all supported simultaneous transmission configurations is
  - Select one configuration with P_{sub6_limit} values of radio1 and radio2 less than their corresponding P_{UE_max}, and their P_{sub6_limit} values are different if possible.
  - If the previous configuration does not exist, at least one radio has its P_{sub6_limit} less than P_{UE_max}.
  - If above two cannot be found, select one configuration that has P_{sub6_limit} of radio 1 and radio 2 with the least difference between P_{sub6_limit} and P_{UE_max} (i.e., P_{sub6_limit} can be greater than P_{UE_max})
- One test with two active radios in any two different time windows is sufficient to cover this scenario.
- One SAR switching is sufficient because the TA algorithm operation is the same.

5.9.2 Procedure

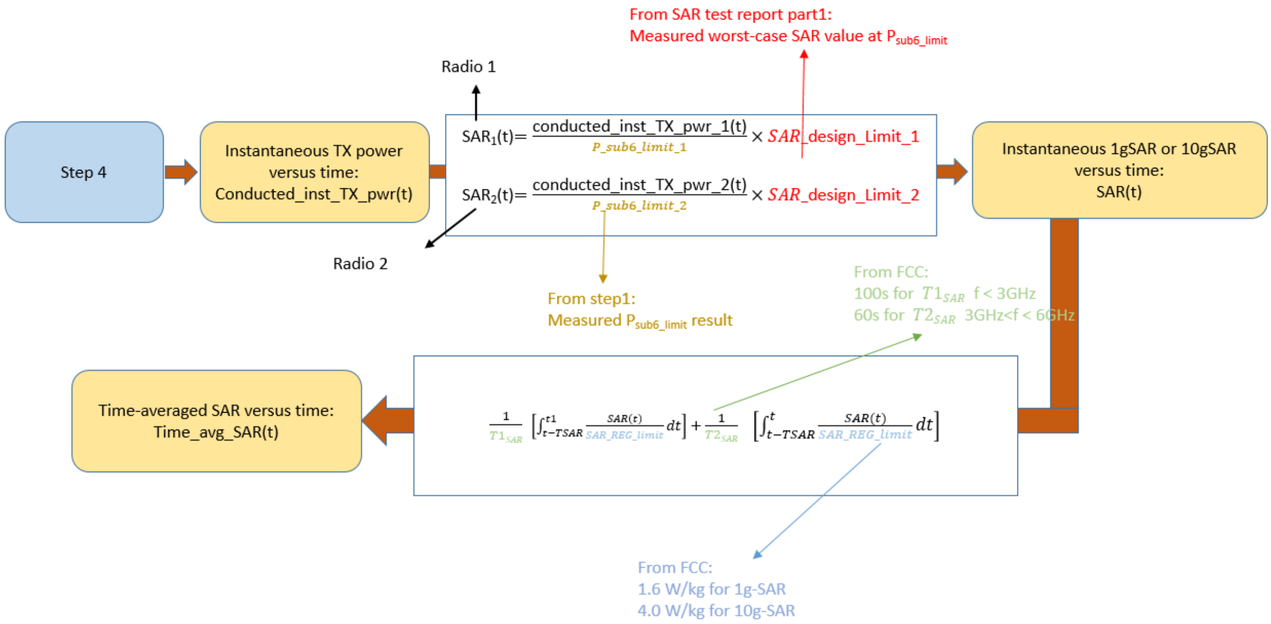
- Step 1~3: measure and record TX power versus time for test scenario 8

1. Measure conducted TX power corresponding to radio1 P_{sub6_limit}
    - Establish device in call with the callbox for radio1 band.
    - Measure conducted TX power corresponding to radio1 P_{sub6_limit} with TA-SAR enabled and $P_{UE\_backoff\_offset}$ set to 0dB, callbox set to request maximum power.
2. Measure conducted TX power corresponding to radio2 P_{sub6_limit}
    - Repeat above step to measure conducted TX power corresponding to radio2 P_{sub6_limit}.
    - If radio2 is dependent on radio1 (for example, non-standalone mode of NR FR1 requiring radio1 LTE as anchor), then establish radio1 + radio2 call with callbox, and request all down bits for radio1 LTE.
    - In this scenario, with callbox requesting maximum power from radio2 NR FR1, measured conducted TX power corresponds to radio2 Psub6_limit (as radio1 LTE is at all-down bits).



- 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 averaged to power and 1gSAR or 10gSAR to determine time-averaged value versus time as follows,



- Step 5: 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 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

5.10 Test Configuration and Procedure for Scenario 2: Time-varying TX Power via SAR Measurements

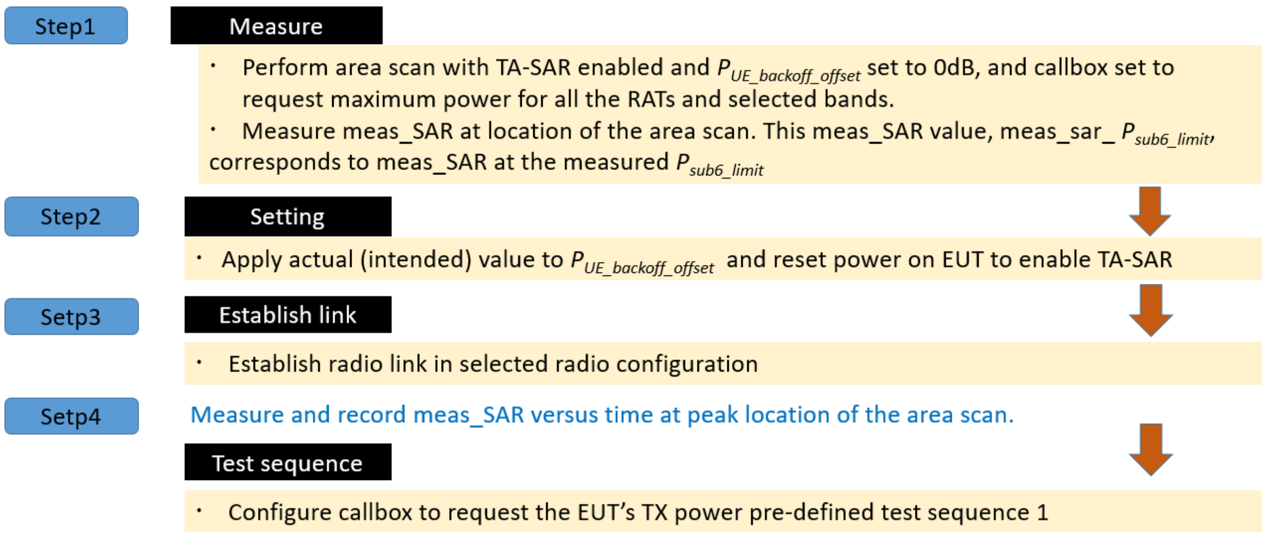
5.10.1 Configuration

Section 5.2 to 5.9 focus on Mediatek's TA feature compliance validation via conducted TX power measurements. This section further provides a SAR measurement procedure for time-varying TX power scenario described in section 5.3. Hence, this section follows the test configuration of section 5.3, and uses test sequences 1 and 2 defined in section 5.1.

5.10.2 Procedure

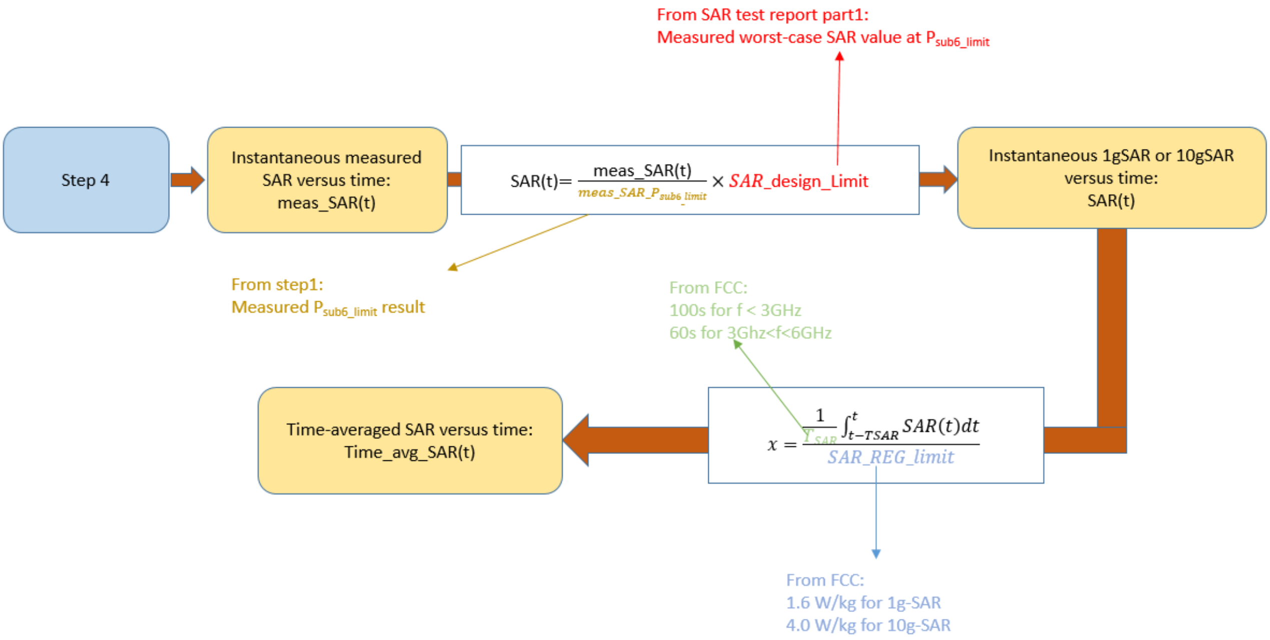
SAR is measured and recorded by the following steps:

- Step 1~4: measure and record SAR time



- Step 5: convert the measured SAR into time-averaged SAR

Convert the instantaneous measured SAR from step 4 into 1gSAR or 10gSAR value. Perform the running time average to 1gSAR or 10gSAR to determine time-averaged value versus time as follows,



where, meas_SAR_P_{sub6_limit} is the value determined in step 1, and meas_SAR(t) is the instantaneous measured SAR measured in step 4.

- Step 6: plot results

  A. Calculated time-averaged 1gSAR or 10gSAR

  B. FCC limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)

- Step 7: repeat steps 2~6 for pre-defined test sequence 2

Repeat steps 2 ~ 6 for pre-defined test sequence 2 and replace test sequence 1 in step 4 with test sequence 2.

- Step 8: repeat steps 2~7 for selected bands

The time-averaged SAR versus time shall not exceed FCC limit at all times.

6 TA-SAR Validation via Conducted Power Measurements (WWAN)

6.1 Measurement Setup

6.1.1 Test Bench Introduction

All of the test cases defined in this chapter are conducted by using the phone device, whose antenna placement for each RAT is illustrated in Figure 6-1.

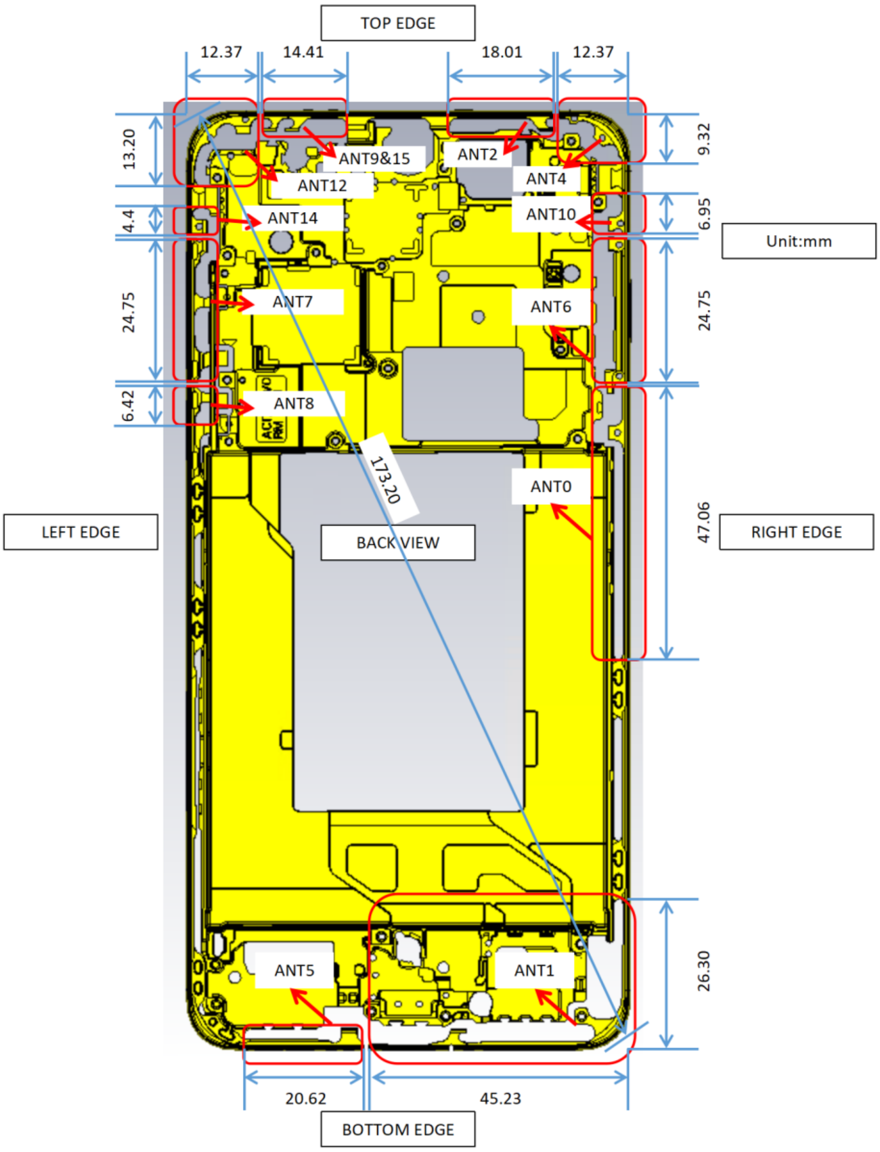


Figure 6-1 Antenna placement of the phone

The call boxes Keysight UXM (supporting sub6 NR and LTE) and Rohde & Schwarz CMW500 (supporting LTE, WCDMA and 2G) are used to validate the proposed TA-SAR mechanism. Figure 6-2 shows the block diagram of the measurement bench, which supports the following test scenarios.

- Test scenario 1: range of TA-SAR parameters
- Test scenario 2: time-varying TX power
- Test scenario 3: call disconnection and re-establishment
- Test scenario 5: ECI change

For these measurements, RF ports of the call box is connected to the EUT's antenna port, and the call box establishes a connection link through the test script console tool and the power meter measures the conducted output power of the EUT. The pictures of Figure 6-2 are relegated in Figures A-1 and A-2 in Appendix A.

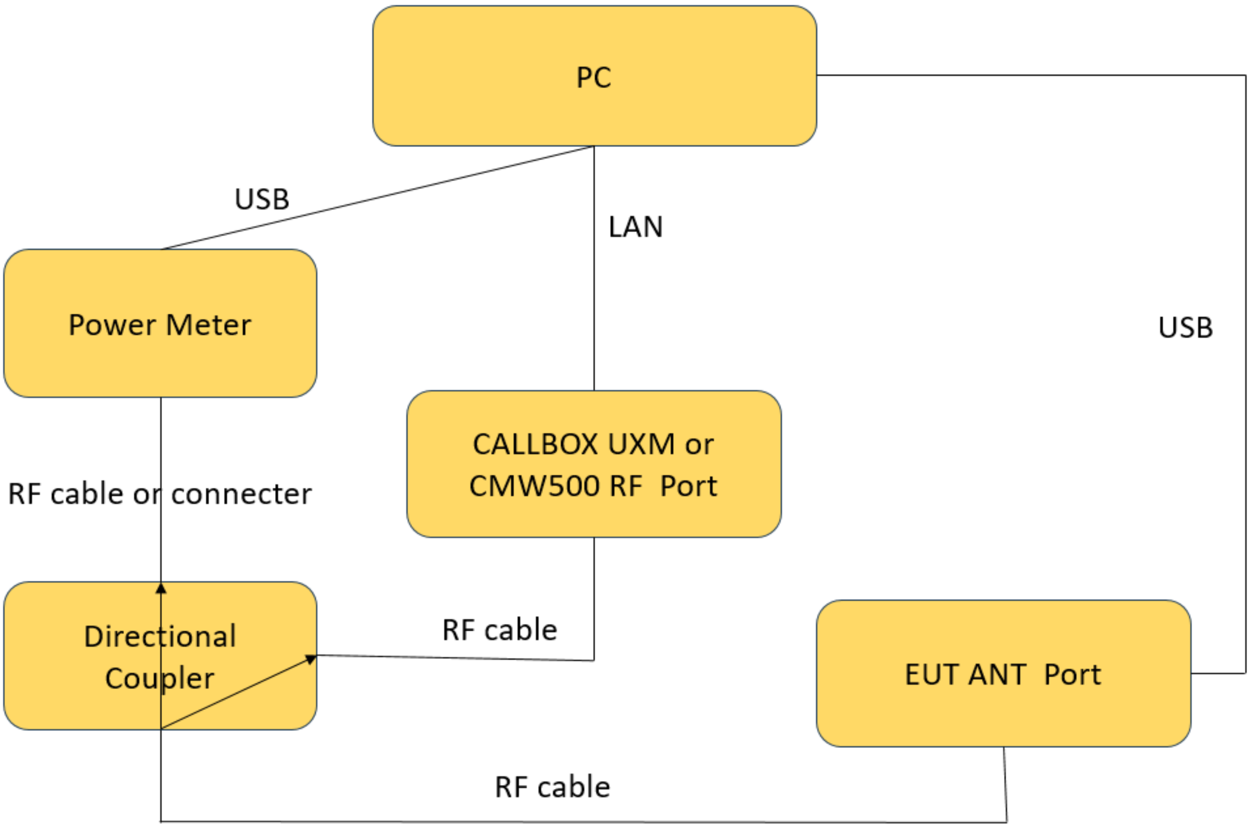


Figure 6-2 TA-SAR conductive power test setup block diagram for scenarios 1/2/3/5

Figure 6-3 shows the block diagram of the measurement bench, which support test scenario 4(band handover) and scenario 7 (time window switching). For these measurements, the RF port of the call box is connected with a 1-to-2 power divider, which allows the call box to transmit/receive signals from the two different system configurations set in these two test scenarios. Figure 6-4 shows the setup, which is highly similar to Figure 6-3, to support test scenario 6 (antenna switching); as seen in the figure, two EUT's antenna ports are individually connected with a RF cable. The pictures for these two setups are shown in Figures A-3 and A-4 in Appendix A.

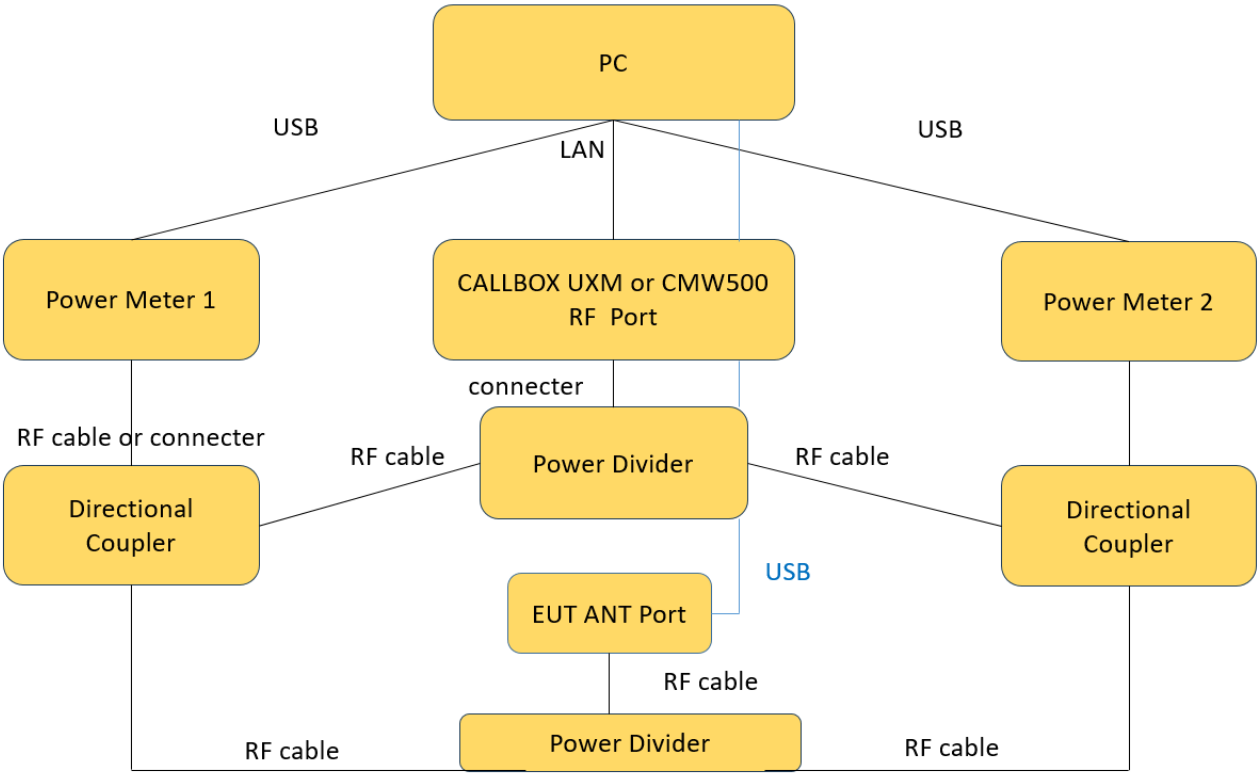


Figure 6-3 TA-SAR conductive power test setup block diagram for scenarios 4 and 7

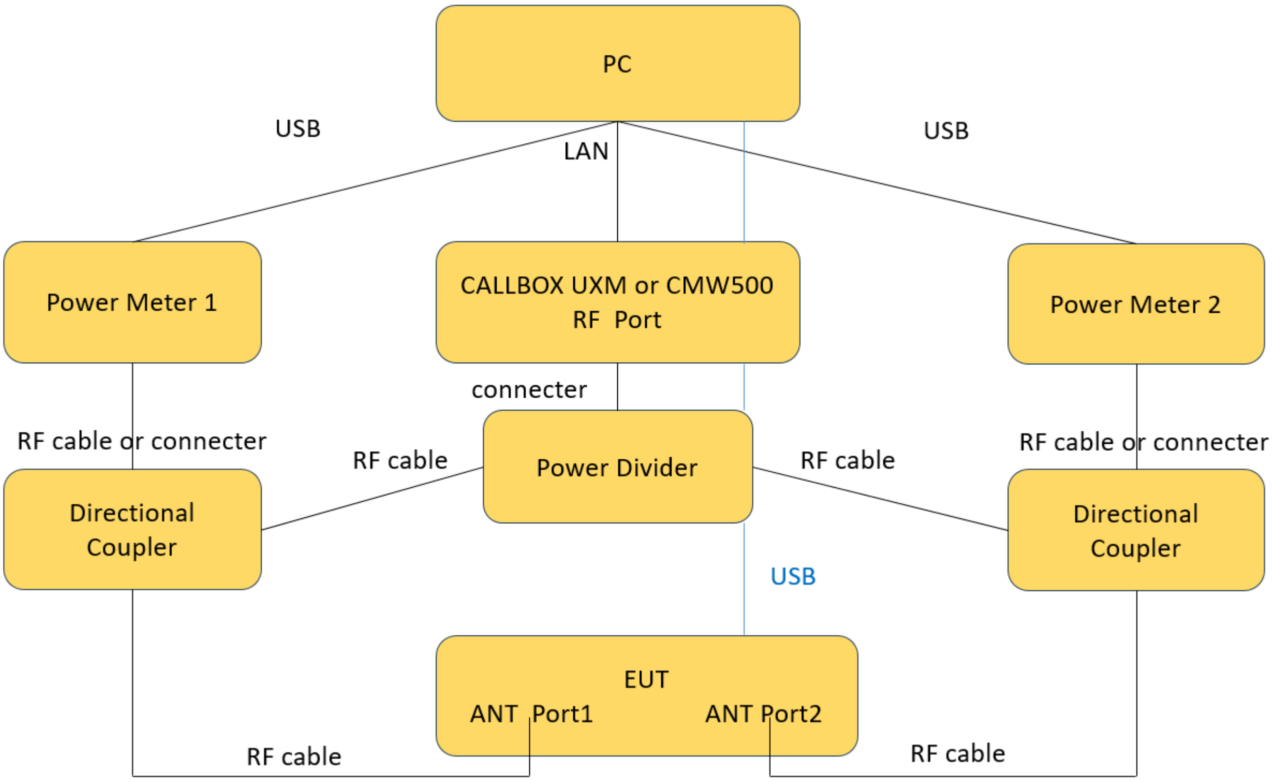


Figure 6-4 TA-SAR conductive power test setup block diagram for scenarios 6

Figure 6-5 shows the setup for test scenario 4 (RAT handover) and scenario 8 (SAR exposure switching). Since two RATs need to be controlled in these two scenarios, RF port of RAT #1 and RF port of RAT #2 of the call box are individually connected to an antenna port of the EUT through a directional coupler. It is noted that each of the two RATs individually transmit signals though one antenna port. The antenna port assignment of each RAT for these two scenarios is described in Figure 6-1. The pictures of Figure 6-5 are shown in Figures A-5 and A-6 in Appendix A.

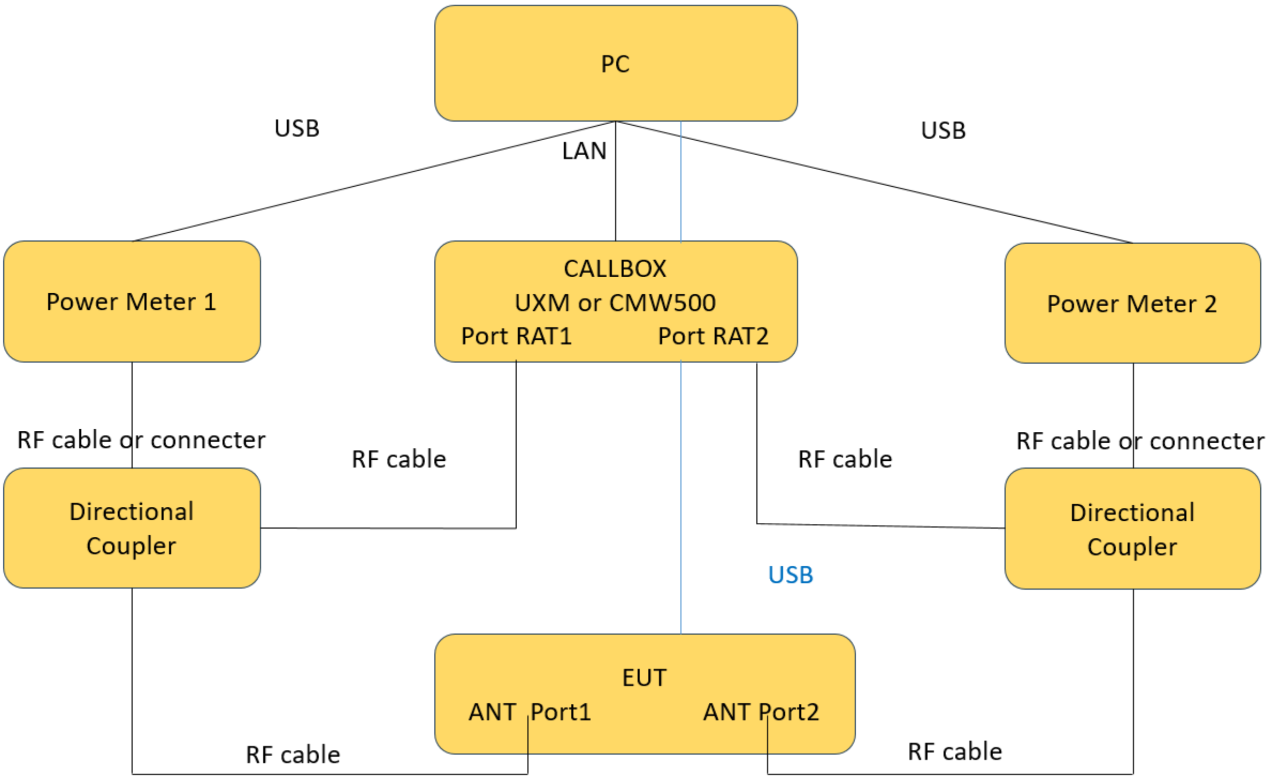


Figure 6-5 TA-SAR conductive power test setup block diagram for scenarios 4/8

6.1.2 Sub NR/LTE/3G/2G Power Limit Table and Test Configurations

For the supported bands/channels/antennas of each technology, the measured power limit (P_{sub6_limit}), corresponding to SAR_design_limit, is listed in the Table 6-1. The SAR_design_limit is determined by taking device uncertainty into consideration. Please note that for TDD bands with TX duty cycles less than or equal to 100%, the measured power limit corresponds to the burst averaged power level which does not account for TX duty cycle.

Table 6-1 Summary table of power limit (Psub6_limit) for all supported RAT

Band	Antenna	Duty Cycle	DSI 1	DSI 2	DSI 3	DSI 4	DSI 5	DSI 6	Pmax*
			brust power	brust power	brust power	brust power	brust power	brust power	brust power
GSM850	0	12.50%	32.1	30.6	30.5	29.8	29.3	28.8	32.6
GSM1900	5		30	30	28.2	30	26.9	30	30
WCDMA Band 2	5	100%	21	24.2	19	24.2	17.7	24.2	24.2
	6		19	15.2	17.1	14.4	15.7	13.4	24.1
WCDMA Band 4	5		19.2	24.2	17.3	24.2	16.1	24.2	24.2
	6		19.9	13.8	17.9	13	16.6	12	24.2
WCDMA Band 5	0		23.6	21.1	22.2	20.3	20.9	19.3	23.6
	1		24.1	24.1	24.1	24.1	22.7	24.1	24.1
LTE Band2	5	100%	17.7	23.7	15.8	23.7	14.6	23.7	24.2
	6		16	13.4	14.2	12.5	12.9	11.6	23.9
LTE Band4	5		21	23.7	19.7	23.7	18.4	23.7	24.2
	6		19	16	16.7	13.7	15.4	12.7	23.7
	4		15.2	17.2	13.3	16.3	12.1	15.4	21.8
	7		20.1	17.6	18.3	16.8	17	15.7	24
LTE Band5	0		22.8	22.8	20.8	21.8	19.8	20.8	23.8
	1		24.2	24.2	24.2	24.2	23.5	24.2	24.2
LTE Band7	5		19.6	24.2	17.7	24.2	16.3	24.2	24.2
	6		18.3	16.9	15	14.6	13.7	13.7	23.8
	4		16.3	15	14.3	14.2	13	13.2	21
	7		18.4	14.4	16.6	13.6	15.3	12.6	23.9
LTE Band12	0		21.4	21.2	19.6	20.3	18.4	19.3	23.4
	1		23.8	23.8	22.7	23.8	21.4	23.8	23.8
LTE Band13	0		21.7	21.5	19.9	20.6	18.7	19.6	23.7
	1		24	24	22.9	24	21.6	24	24
LTE Band17	0		21.4	21.2	19.6	20.3	18.4	19.3	23.4
	1		23.8	23.8	22.7	23.8	21.4	23.8	23.8
LTE Band25	5		17.7	23.7	15.8	23.7	14.6	23.7	24.2
	6		16	13.4	14.2	12.5	12.9	11.6	23.9
LTE Band26	0		22.8	22.8	20.8	21.8	19.8	20.8	23.8
	1		24.2	24.2	24.2	24.2	23.5	24.2	24.2
LTE Band38	5	63.30%	20.3	24.2	18.3	24.2	16.9	24.2	24.2
	6		19.5	16.9	15.7	14.2	14.3	13.2	24.2
	4		19.2	16.7	15.7	14.2	14.4	13.2	21
	7		18.5	16.5	16.7	15.5	15.4	14.5	24
LTE Band41 PC2	5	43.30%	20.2	26	16.8	26	15.4	26	26
	6		20.7	19.5	15.8	15.7	14.5	14.7	25.2
	4		19.7	18.5	16.3	16.2	15	15.2	23
	7		20.3	16.3	17	14	15.7	13	26
LTE Band41 PC3	5	63.30%	19	23	13.8	23	12.4	23	23
	6		19.4	18.2	13.2	13.1	11.9	12.1	22.6
	4		18.5	17.2	13.3	13.2	12	12.2	20
	7		19	15	14	11	12.7	10	23
LTE Band66	5	100%	21	23.7	19.7	23.7	18.4	23.7	24.2
	6		19	16	16.7	13.7	15.4	12.7	23.7
	4		15.2	17.2	13.3	16.3	12.1	15.4	21.8
	7		20.1	17.6	18.3	16.8	17	15.7	24
N2	5	100%	19.6	24	18.1	24	16.8	24	24
	6		17.4	15.3	16.2	14.9	14.9	13.9	24.2
N5	0		21	21.2	19.2	20.3	18	19.3	23.8
	1		24.1	24.1	22.2	24.1	20.9	24.1	24.1
N7	5		19.6	24.2	17.7	24.2	16.3	24.2	24.2
	6		17.4	16.9	15.4	16	14.1	15.1	24.2
	4		13.4	12.1	11.4	11.3	10.1	10.3	21.2
	7		16.7	15.7	14.7	14.7	13.7	13.7	24.2
N12	0		19.8	19.8	19.2	19.8	18	19.3	23.8
	1		24.2	24.2	22.2	24.2	20.9	24.2	24.2
N25	5		19.8	24	17.9	24	16.6	24	24
	6		18.1	15.4	17.3	15.4	15.9	14.5	24.2
N26	0		21	21.2	19.2	20.3	18	19.3	23.8
	1		24.2	24.2	22.2	24.2	20.9	24.2	24.2
N38	5		20.3	24.2	18.3	24.2	16.9	24.2	24.2
	6		17.7	17.1	15.7	16.2	14.3	15.3	24.2
	4		13.6	12.3	11.6	11.5	10.3	10.5	21.2
	7		18.7	16.2	16.9	15.2	15.6	14.2	24.2
N41	5		18.7	25.3	16.8	25.3	15.4	25.3	25.3
	6		18	18.4	16	17.5	14.7	16.5	26
	4		16.8	15.5	14.8	14.7	13.5	13.7	24
	7		17.3	15	15.5	14	14.5	13	26.5
N66	5		20	23	18.2	23	16.9	23	24.2
	6		17.8	14.3	16	13.5	14.7	12.5	24
	4		12.8	13.8	10.9	13	9.7	12	21.8
	7		19.8	16.3	18.5	15.8	17.2	14.8	24.2

Table 6-2 summarizes the test configurations of all RATs, and the corresponding worst-case measured SAR for each RAT under the power limit.

Table 6-2 Test configurations of radio technologies and worst-case measured SAR

Test case	Test Scenario	Tech	Band	ANT	ECI	Channel	Frequency	Modulation	RB	BW (MHz)	SAR Exposure Scenario	Position	Worst-case Measured SAR at P_sub6_limit W/kg
1	Range of TA-SAR parameters	WCDMA	5	0	3	4233	846.6	RMC	/	/	Body 10mm	Left	0.932
2.1 ~ 2.2	Time-varying TX power	Sub6 NR	5	1	3	167300	836.5	DFT-OFDM QPSK	12_6	5M	Body 10mm	Rear	0.117
2.3 ~ 2.4		Sub6 NR	7	4	5	507000	2535	DFT-OFDM QPSK	12_6	5M	Body 10mm	Rear	0.061
2.5 ~ 2.6		LTE	26	0	2	26865	831.5	QPSK	1@0	15M	head	Left Cheek	0.782
2.7 ~ 2.8		LTE	41	7	6	40185	2549.5	QPSK	50@50	20M	head	Left Cheek	0.273
2.9 ~ 2.10		WCDMA	5	0	3	4233	846.6	RMC	/	/	Body 10mm	Left	0.932
2.11 ~ 2.12		WCDMA	4	6	6	1412	1732.4	RMC	/	/	head	Right Cheek	0.334
2.13 ~ 2.14		GSM	850	0	6	190	836.6	1TX	/	/	head	Right Cheek	647
2.15 ~ 2.16		GSM	1900	5	3	810	1909.8	4TX	/	/	Body 10mm	Bottom	0.622
3.1	Call disconnection and re-establishment	Sub6 NR	5	1	3	167300	836.5	DFT-OFDM QPSK	12_6	5M	Body 10mm	Rear	0.117
4.1	Band handover	LTE	41	7	6	40185	2549.5	QPSK	50@50	20M	head	Left Cheek	0.273
		WCDMA	5	0	6	4233	846.6	RMC	/	/	head	Right Cheek	0.709
5.1	ECI change	WCDMA	4	6	6	1412	1732.4	RMC	/	/	head	Right Cheek	0.334
		WCDMA	4	6	1	1312	1712.4	RMC	/	/	Body 10mm	Left	0.648
6.1	Antenna switching	LTE	26	0	5	26965	841.5	QPSK	1_0	15M	Body 10mm	Left	0.953
		LTE	26	1	5	26865	831.5	QPSK	1_0	15M	Body 10mm	Rear	0.381
7.1	SAR exposure switching	LTE	7	4	3	21350	2560	QPSK	50_0	20M	Body 10mm	Top	0.576
		Sub6 NR	5	1	3	167300	836.5	DFT-OFDM QPSK	12_6	5M	Body 10mm	Rear	0.117

6.2 Conducted Power Measurement Results for Scenario 1: Range of TA-SAR Parameters

In this scenario, two TA-SAR parameters are swept to validate Mediatek's TA-SAR algorithm. The parameter sets are summarized in Table 6-2, and the test procedure follows section 5.2.2. The measurement setup is shown in Figure 6-3. The high-level summary of the final validation results are also listed in the last column of the table, which concludes that Mediatek's TA-SAR algorithm can maintain the time-averaged SAR is always below the FCC requirement for all test case. The following section will demonstrate case-by-case to show how Mediatek's TA-SAR algorithm behaves for different parameters.

Table 6-3 TA-SAR parameters setting for scenario 1

Test case	RAT	Test band	Test seq.	ECI	Max power (dBm)	P_{sub6_limit} (dBm)	$P_{LowThresh}$ (dBm)	$P_{UE\_backoff}$ (dBm)	$P_{UE\_max\_cust}$ (dBm)	Pass /Fail SAR limit
1	WCDMA	5	0	3	23.6	22.2	21.7	19.2	23.6	Pass

These test cases are for 3G WCDMA and are conducted under WCDMA B5 with ECI = 3. The corresponding detailed test procedure is described in 5.2.2. For the figure set of each case, the first figure demonstrates the ETU's instantaneous conducted TX power, the time-averaged conducted TX power behavior over time, and the power limit (P_reg_sub6_limit = P_{sub6_limit} + device uncertainty). The second figure illustrates the corresponding time-averaged SAR over time converted from the TX time-averaged power by using the equation listed in section 5.2.2. For all test cases, the time-averaged SAR does not exceed the FCC limit.

Case 0 in table 6-3

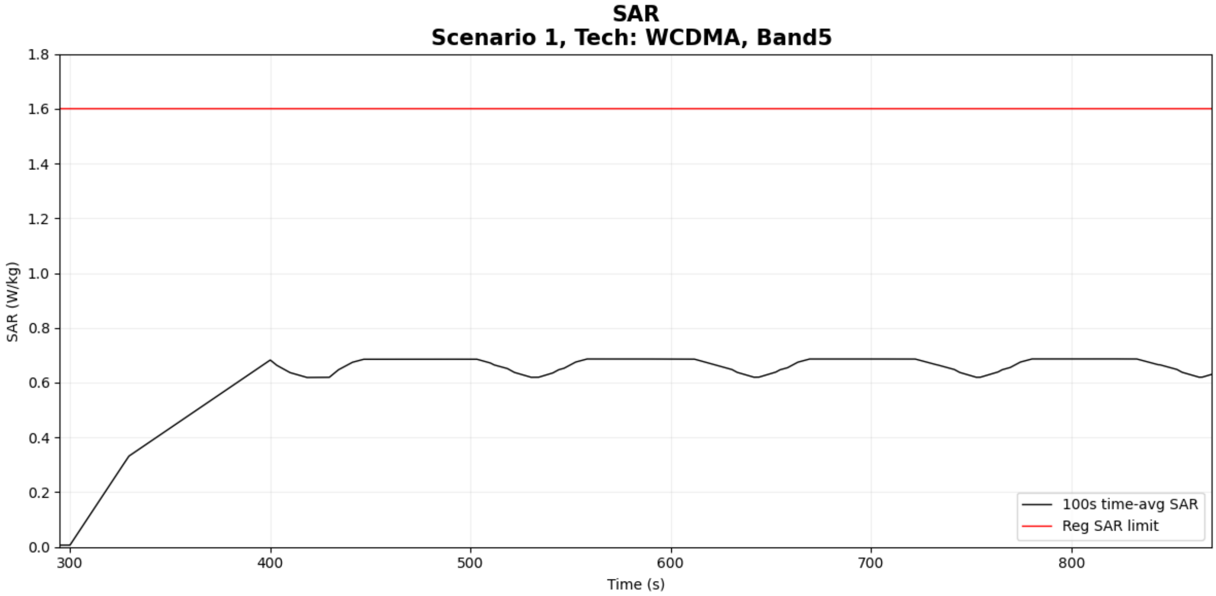


Figure 6-6 Time-averaged SAR for case 0

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.687 W/kg
Validation result: Pass	

6.3 Conducted Power Measurement Results for Scenario 2: Time-Varying TX Power

In this scenario, Mediatek's TA-SAR algorithm is tested under more dynamic power test sequences. The test sequence #1 is shown in section 5.1 and test sequence #2 is tabulated in Table 5-4. All of the test cases for this scenario are relegated in Table 6-2, and the test procedure follows section 5.3.2. The measurement setup is shown in Figure 6-4. The high-level summary of the final validation results are also listed in the last column of the table, which concludes that Mediatek's TA-SAR algorithm can maintain the time-averaged SAR is always below the FCC requirement for all test cases. The following sections will demonstrate case-by-case to show how Mediatek's TA-SAR algorithm behaves for each RAT.

Table 6-4 TA-SAR parameters setting for scenario 2

Test case	RAT	Test band	Test seq.	ECI	Max power (dBm)	P_{sub6_limit} (dBm)	$P_{LowThresh}$ (dBm)	$P_{UE\_backoff}$ (dBm)	$P_{UE\_max\_cust}$ (dBm)	Pass /Fail SAR limit
1	Sub6 NR	5	1	3	24.1	22.2	21.7	19.2	24.1	Pass
2	Sub6 NR	5	2	3	24.1	22.2	21.7	19.2	24.1	Pass
3	Sub6 NR	7	1	5	21.2	10.1	9.6	7.1	13.1	Pass
4	Sub6 NR	7	2	5	21.2	10.1	9.6	7.1	13.1	Pass
5	LTE	26	1	2	23.8	22.8	22.3	19.8	23.8	Pass
6	LTE	26	2	2	23.8	22.8	22.3	19.8	23.8	Pass
7	LTE	41	1	6	23.8	10.8	10.3	7.8	13.8	Pass
8	LTE	41	2	6	23.8	10.8	10.3	7.8	13.8	Pass
9	WCDMA	5	1	3	23.6	22.2	21.7	19.2	23.6	Pass
10	WCDMA	5	2	3	23.6	22.2	21.7	19.2	23.6	Pass
11	WCDMA	4	1	6	24.2	12	11.5	9	15	Pass
12	WCDMA	4	2	6	24.2	12	11.5	9	15	Pass
13	GSM	850	1	6	32.6	28.8	28.3	25.8	31.8	Pass
14	GSM	850	2	6	32.6	28.8	28.3	25.8	31.8	Pass
15	GSM	1900	1	3	30	28.2	27.7	25.2	30	Pass
16	GSM	1900	2	3	30	28.2	27.7	25.2	30	Pass

6.3.1 Measurement results for NR

These test cases are for sub6 NR and is conducted under NR bands n5 and n7 with ECI=3/5. The corresponding detailed test procedure is described in 5.3.2. For the figure set of each case, the first figure demonstrates the EUT's instantaneous conducted TX power, the time-averaged conducted TX power behavior over time, and the power limit (P_reg_sub_limit = P_{sub6_limit} + device uncertainty). The second figure illustrates the corresponding time-averaged SAR over time converted from the TX time-averaged power by using the equation listed in section 5.3.2. For all test cases, the time-averaged SAR does not exceed the FCC limit.

- **Case 2.1 in table 6-4: NR n5 result for test sequence 1**

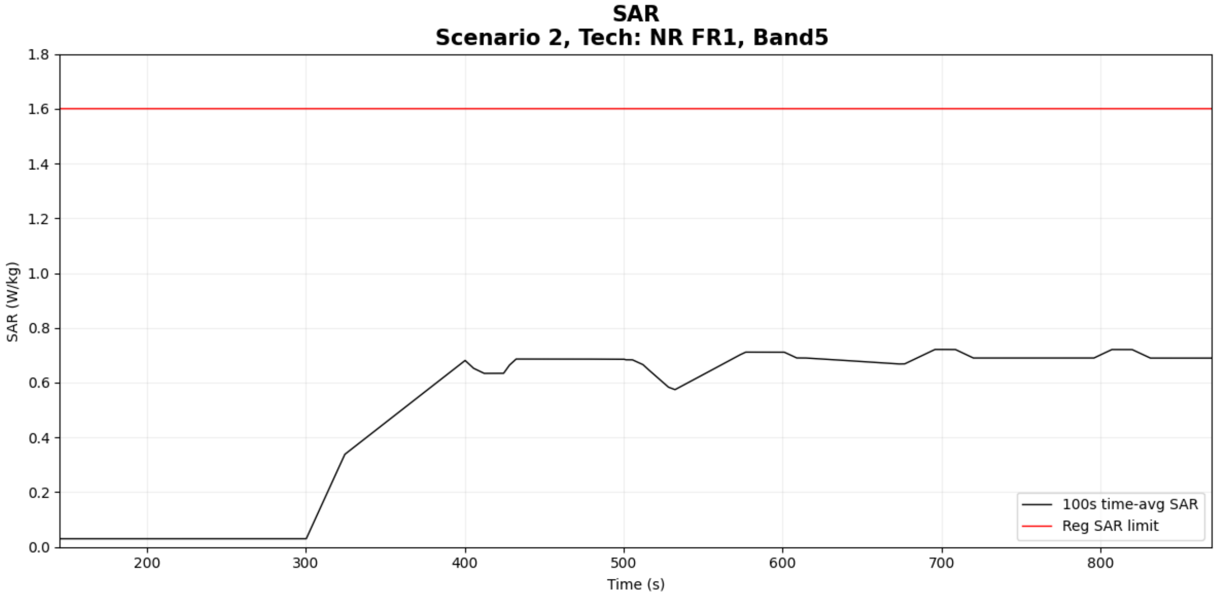


Figure 6-7 Time-averaged SAR for case 2.1(sub6 NR n5)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.721 W/kg
Validation result: Pass	

- **Case 2.2 in table 6-4: NR n5 result for test sequence 2**

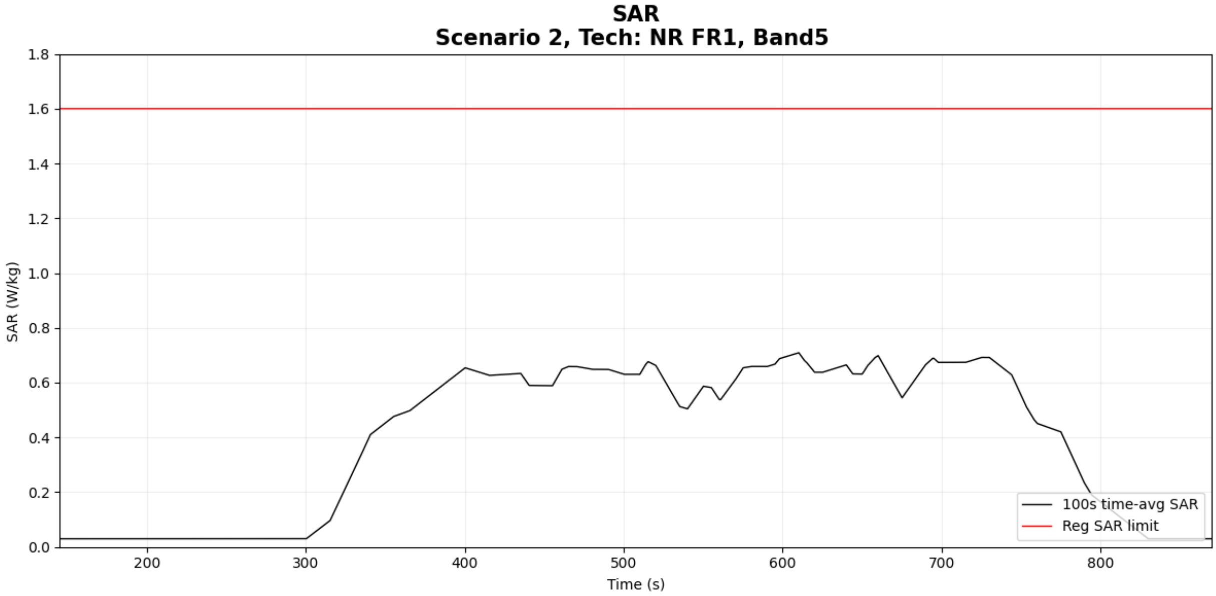


Figure 6-8 Time-averaged SAR for case 2.2(sub6 NR n38)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.709 W/kg
Validation result: Pass	

- **Case 2.3 in table 6-4: NR n7 result for test sequence 1**

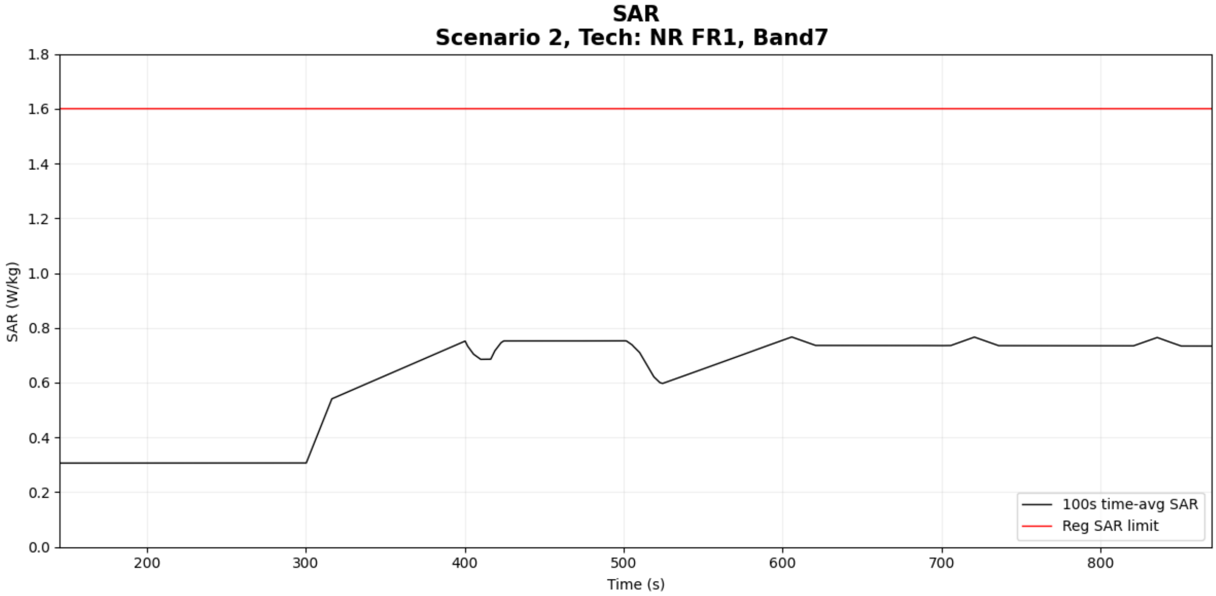


Figure 6-9 Time-averaged SAR for case 2.3(sub6 NR n7)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.767 W/kg
Validation result: Pass	

- **Case 2.4 in table 6-4: NR n7 result for test sequence 2**

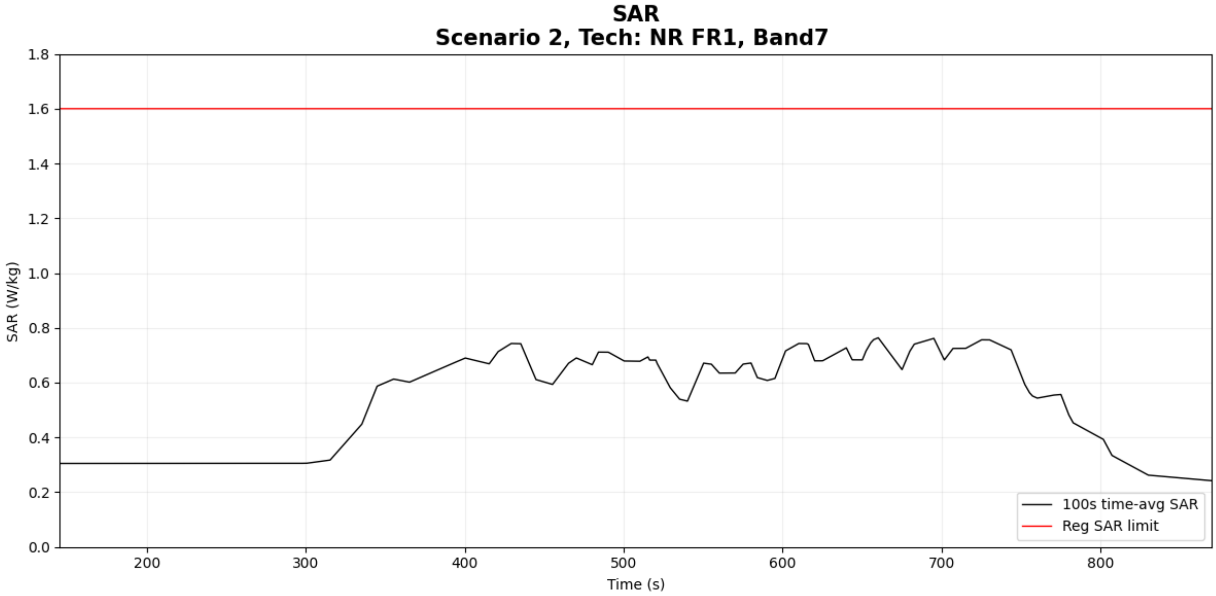


Figure 6-10 Time-averaged SAR for case 2.4(sub6 NR n7)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.764 W/kg
Validation result: Pass	

6.3.2 Measurement results for LTE

These test cases are for 4G LTE and are conducted under LTE bands B26 and B41 with ECI=2/6. The corresponding detailed test procedure is described in 5.3.2. For the figure set of each case, the first figure demonstrates the EUT's instantaneous conducted TX power, the time-averaged conducted TX power behavior over time, and the power limit (P_reg_sub_limit = P_{sub6_limit} + device uncertainty). The second figure illustrates the corresponding time-averaged SAR over time converted from the TX time-averaged power by using the equation listed in section 5.3.2. For all test cases, the time-averaged SAR does not exceed the FCC limit.

- **Case 2.5 in table 6-4: LTE B26 result for test sequence 1**

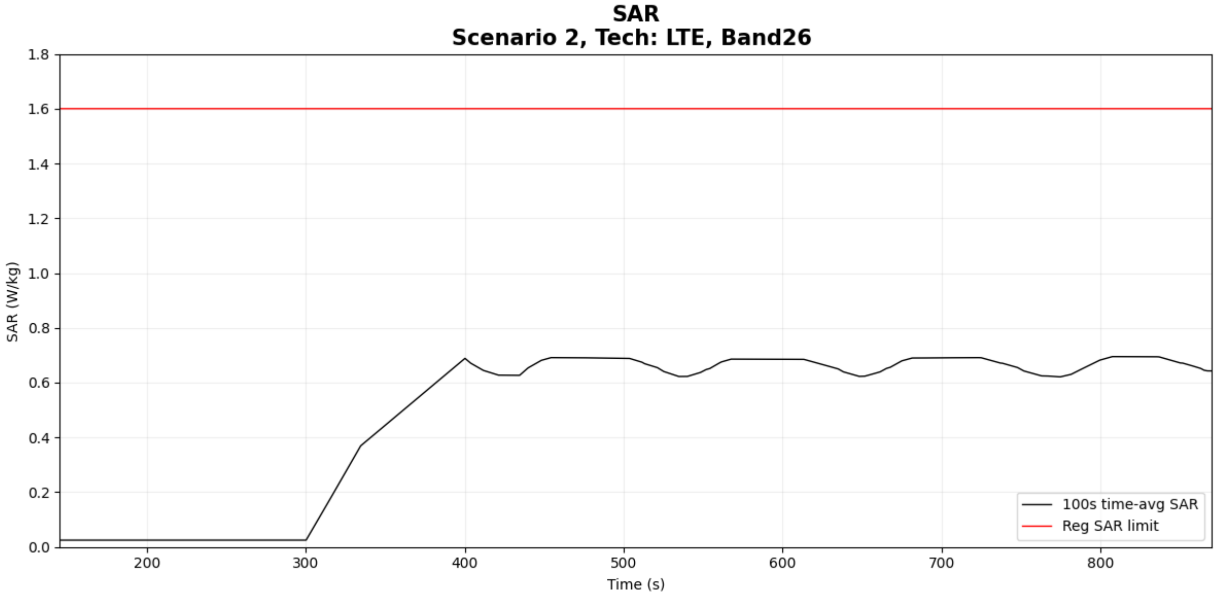


Figure 6-11 Time-averaged SAR for case 2.5(LTE B26)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.695 W/kg
Validation result: Pass	

- **Case 2.6 in table 6-4: LTE B26 result for test sequence 2**

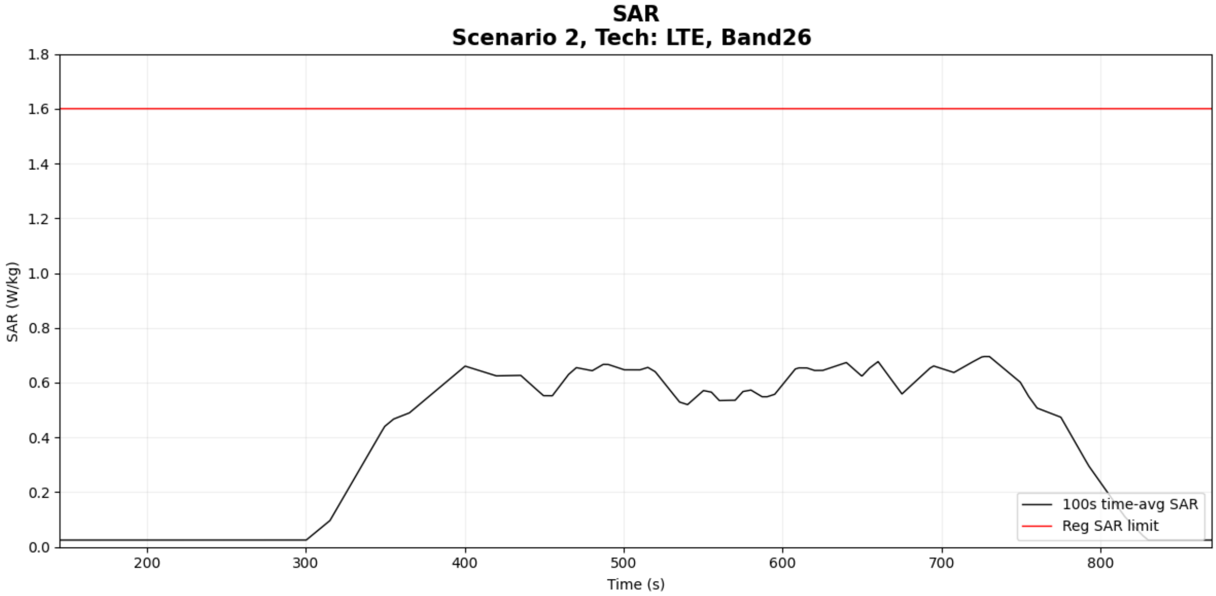


Figure 6-12 Time-averaged SAR for case 2.6(LTE B26)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.696 W/kg
Validation result: Pass	

- **Case 2.7 in table 6-4: LTE B41 result for test sequence 1**

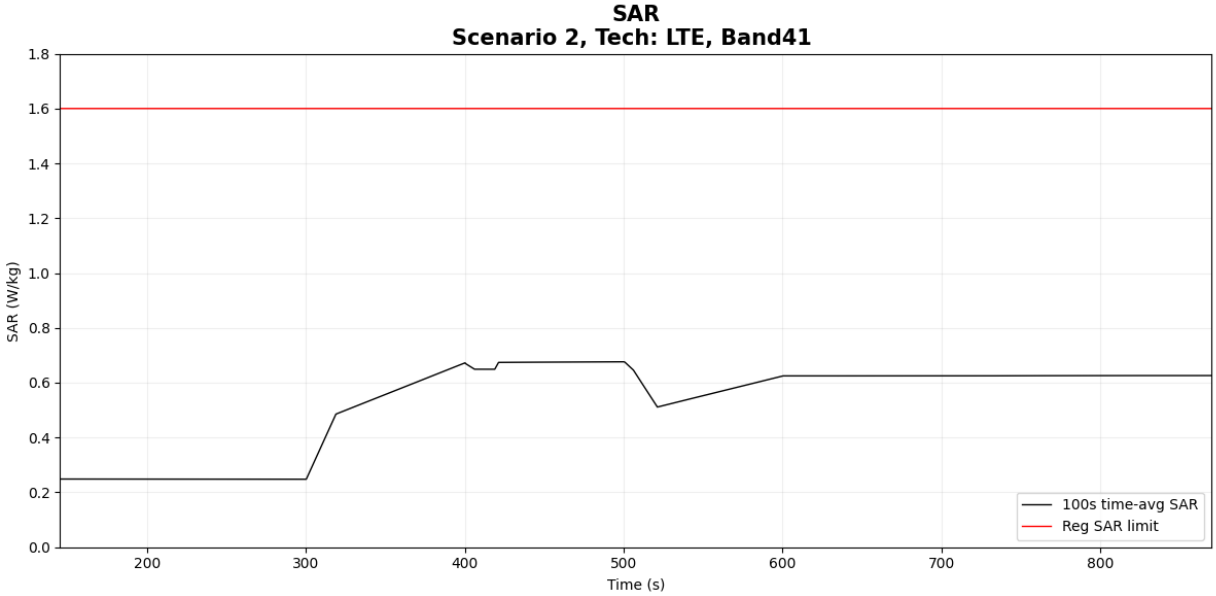


Figure 6-13 Time-averaged SAR for case 2.7(LTE B41)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.676 W/kg
Validation result: Pass	

- **Case 2.8 in table 6-4: LTE B41 result for test sequence 2**

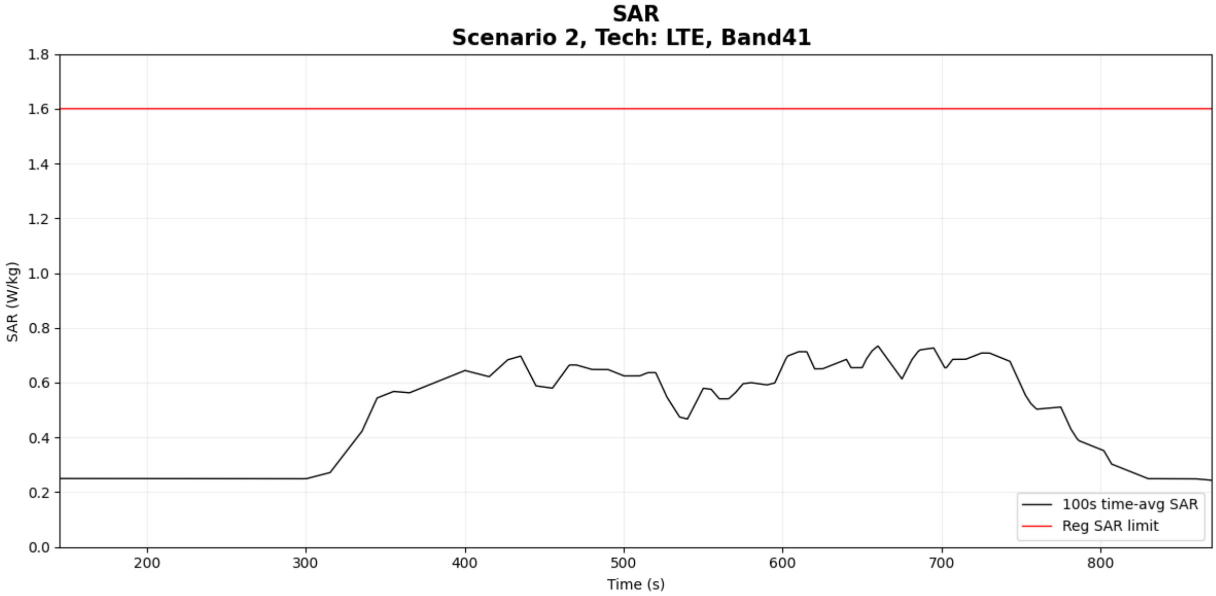


Figure 6-14 Time-averaged SAR for case 2.8(LTE B41)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.733 W/kg
Validation result: Pass	

6.3.3 Measurement results for 3G WCDMA

These test cases are for 3G WCDMA and are conducted under WCDMA B5 and B4 with ECI=3/6. The corresponding detailed test procedure is described in 5.3.2. For the figure set of each case, the first figure demonstrates the EUT's instantaneous conducted TX power, the time-averaged conducted TX power behavior over time, and the power limit (P_reg_sub_limit = P_{sub6_limit} + device uncertainty). The second figure illustrates the corresponding time-averaged SAR over time converted from the TX time-averaged power by using the equation listed in section 5.3.2. For all test cases, the time-averaged SAR does not exceed the FCC limit.

- **Case 2.9 in table 6-4: WCDMA B5 result for test sequence 1**

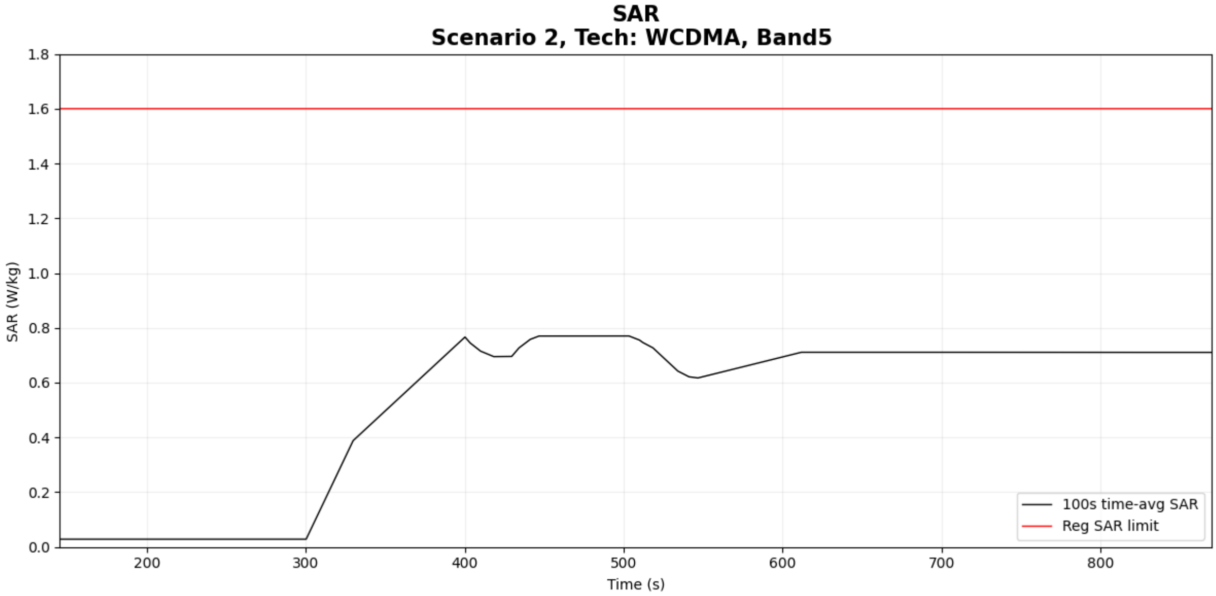


Figure 6-15 Time-averaged SAR for case 2.9(WCDMA B5)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.771 W/kg
Validation result: Pass	

- **Case 2.10 in table 6-4: WCDMA B5 result for test sequence 2**

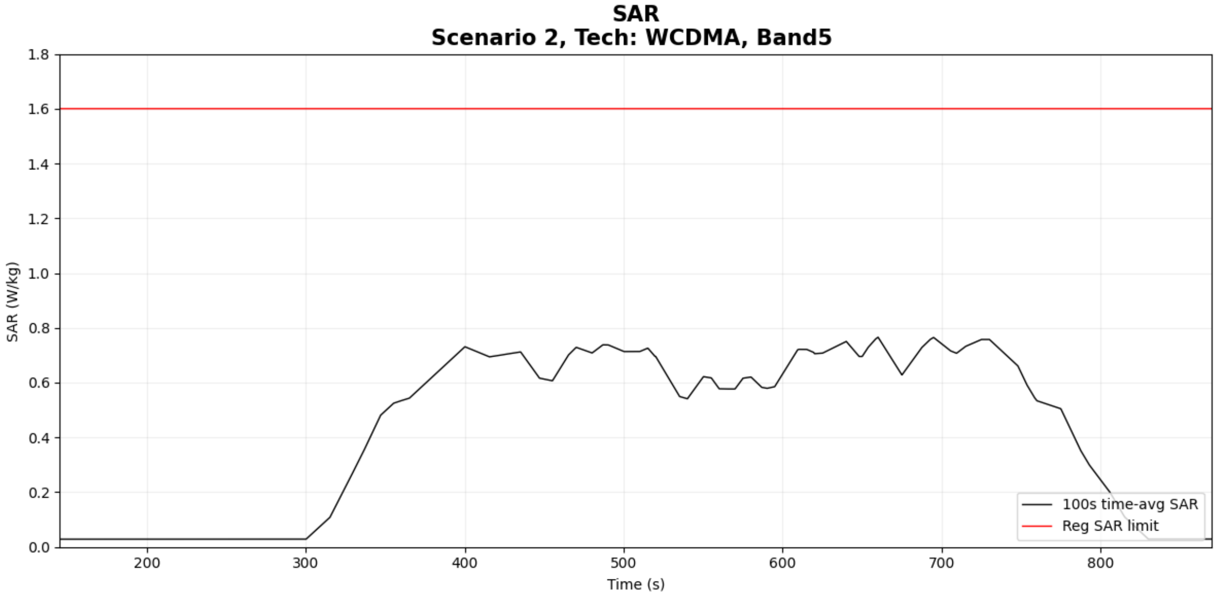


Figure 6-16 Time-averaged SAR for case 2.10(WCDMA B5)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.766 W/kg
Validation result: Pass	

- **Case 2.11 in table 6-4: WCDMA B4 result for test sequence 1**

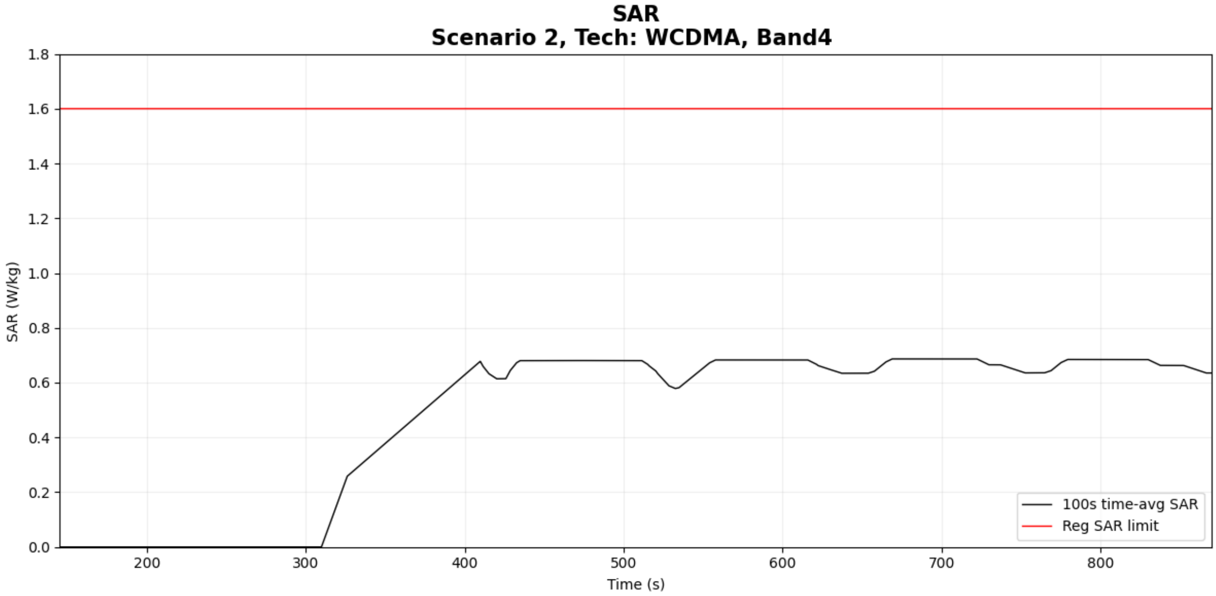


Figure 6-17 Time-averaged SAR for ase 2.11(WCDMA B4)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.687 W/kg
Validation result: Pass	

- **Case 2.12 in table 6-4: WCDMA B4 result for test sequence 2**

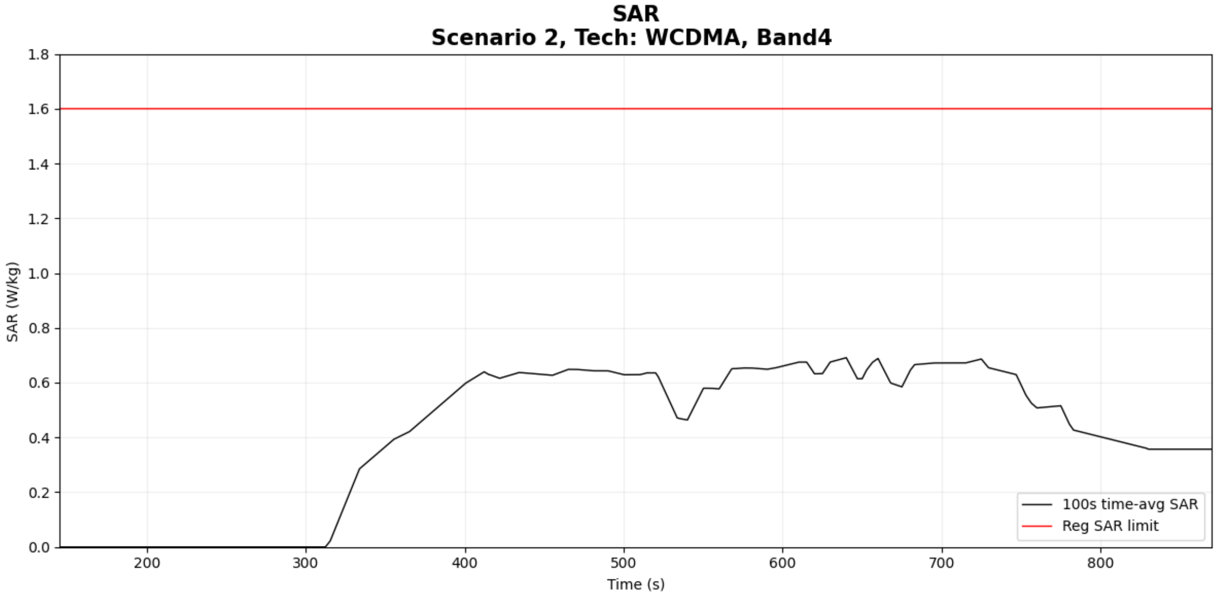


Figure 6-18 Time-averaged SAR for case case 2.12(WCDMA B4)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.691 W/kg
Validation result: Pass	

6.3.4 Measurement results for 2G

These test cases are for 2G and are conducted under 2G band PCS1900 and GSM850 with ECI=6/3. The corresponding detailed test procedure is described in 5.3.2. For the figure set of each case, the first figure demonstrates the EUT's instantaneous conducted TX power, the time-averaged conducted TX power behavior over time, and the power limit (P_reg_sub_limit = P_{sub6_limit} + device uncertainty). The second figure illustrates the corresponding time-averaged SAR over time converted from the TX time-averaged power by using the equation listed in section 5.3.2. For all test cases, the time-averaged SAR does not exceed the FCC limit.

- **Case 2.13 in table 6-4: 2G GSM 850 result for test sequence 1**

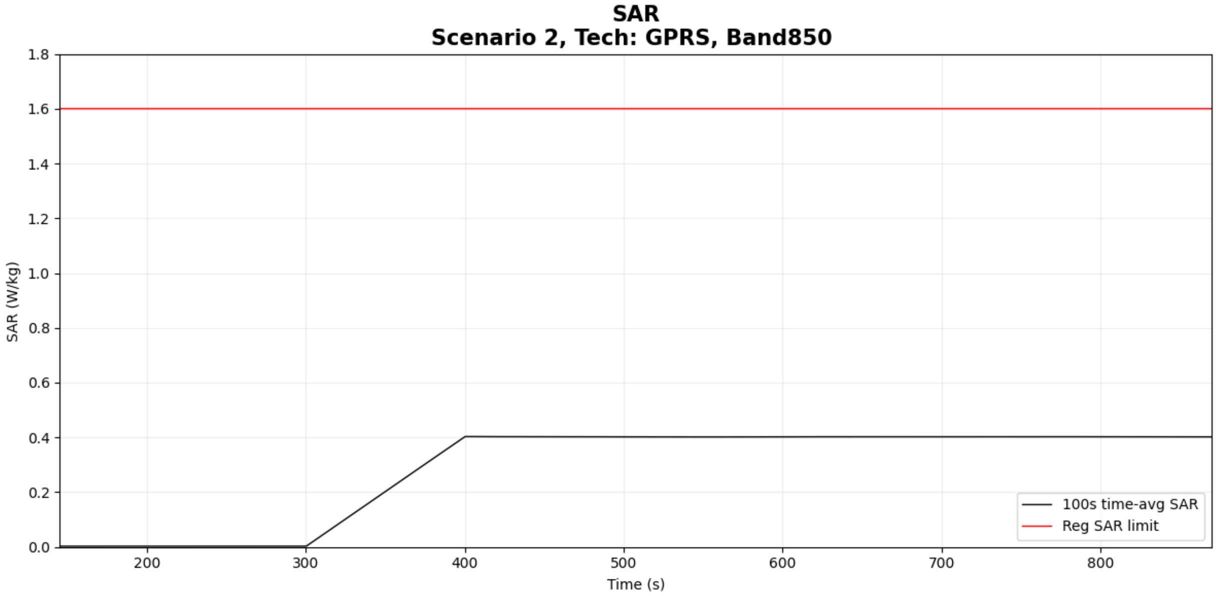


Figure 6-19 Time-averaged SAR for case 2.13(2G GSM850)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.403 W/kg
Validation result: Pass	

- **Case 2.14 in table 6-4: 2G GSM 850 result for test sequence 2**

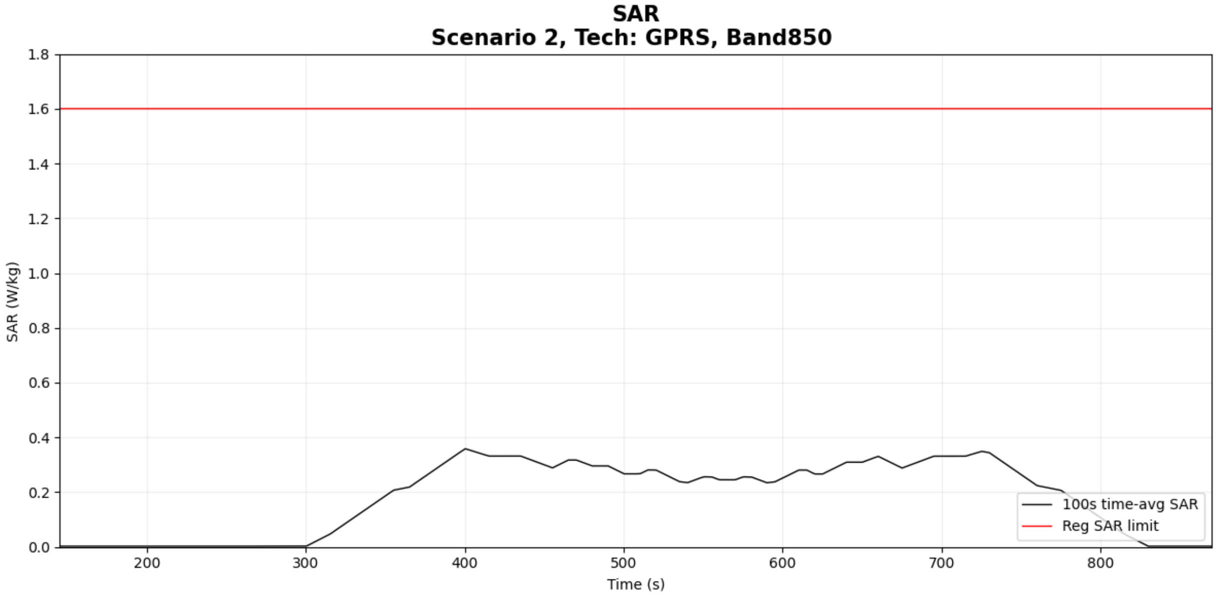


Figure 6-20 Time-averaged SAR for case 2.14(2G GSM 850)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.359 W/kg
Validation result: Pass	

- **Case 2.15 in table 6-4: 2G PCS 1900 result for test sequence 1**

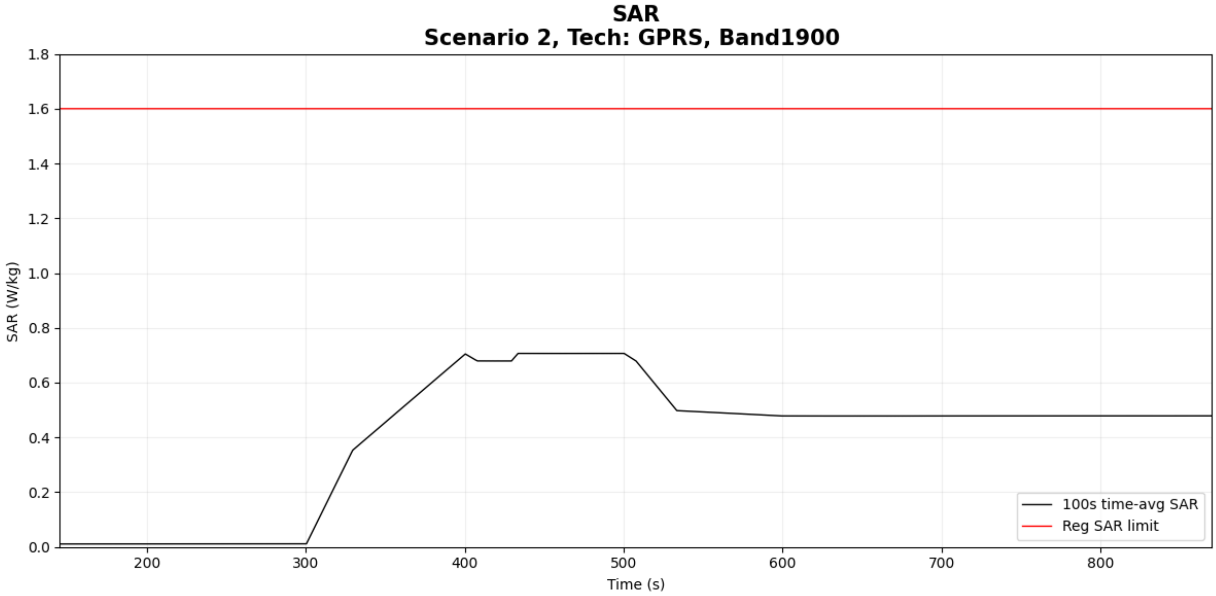


Figure 6-21 Time-averaged SAR for ase case 2.15(2G PCS1900)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.707 W/kg
Validation result: Pass	

- **Case 2.16 in table 6-4: 2G PCS 1900 result for test sequence 2**

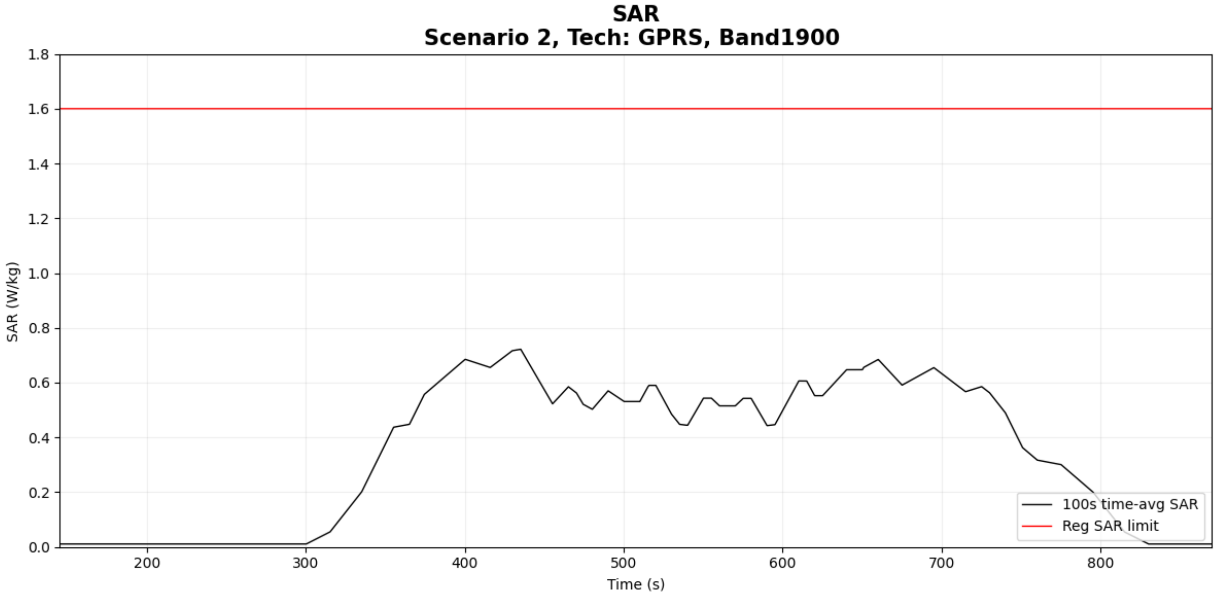


Figure 6-22 Time-averaged SAR for case 2.16(2G PCS1900)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.722 W/kg
Validation result: Pass	

6.4 Conducted Power Measurement Results for Scenario 3: Call Disconnection and Re-establishment

In this scenario, the test power sequence #0 (i.e., maximum TX power is requested by a call box for each RAT) is used, and the call drop is manually configured for a pre-defined period and then the call is re-established to continue data transmission. The test case for this scenario is relegated in Table 6-5, and the test procedure follows section 5.4.2. The measurement setup is Figure 6-2. The high-level summary of the final validation results is also listed in the last column of the table, which concludes that Mediatek's TA-SAR algorithm can maintain the time-averaged SAR is always below the FCC requirement. The following section will demonstrate how Mediatek's TA-SAR algorithm behaves.

Table 6-5 TA-SAR parameters setting for scenario 3

Test case	RAT	Test band	Test seq.	ECI	Max power (dBm)	P_{sub6_limit} (dBm)	$P_{LowThresh}$ (dBm)	$P_{UE\_backoff}$ (dBm)	$P_{UE\_max\_cust}$ (dBm)	Pass /Fail SAR limit
3.1	Sub6 NR	5	0	3	24.1	22.2	21.7	19.2	24.1	Pass

This test is for sub6 NR and is conducted under NR band n5 with ECI = 3. The corresponding detailed test procedure is described in 5.4.2. Figure 6-36 demonstrates the EUT's instantaneous conducted TX power, the time-averaged conducted TX power behavior over time, and the power limit (P_reg_sub6_limit = P_{sub6_limit} + device uncertainty). Figure 6-37 illustrates the corresponding time-averaged SAR over time converted from the TX time-averaged power by using the equation listed in section 5.4.2. As seen in this figure, the time-averaged SAR does not exceed the FCC limit.

- **Case 3.1 in table 6-5: call drop happens at the time instance of 500 seconds**

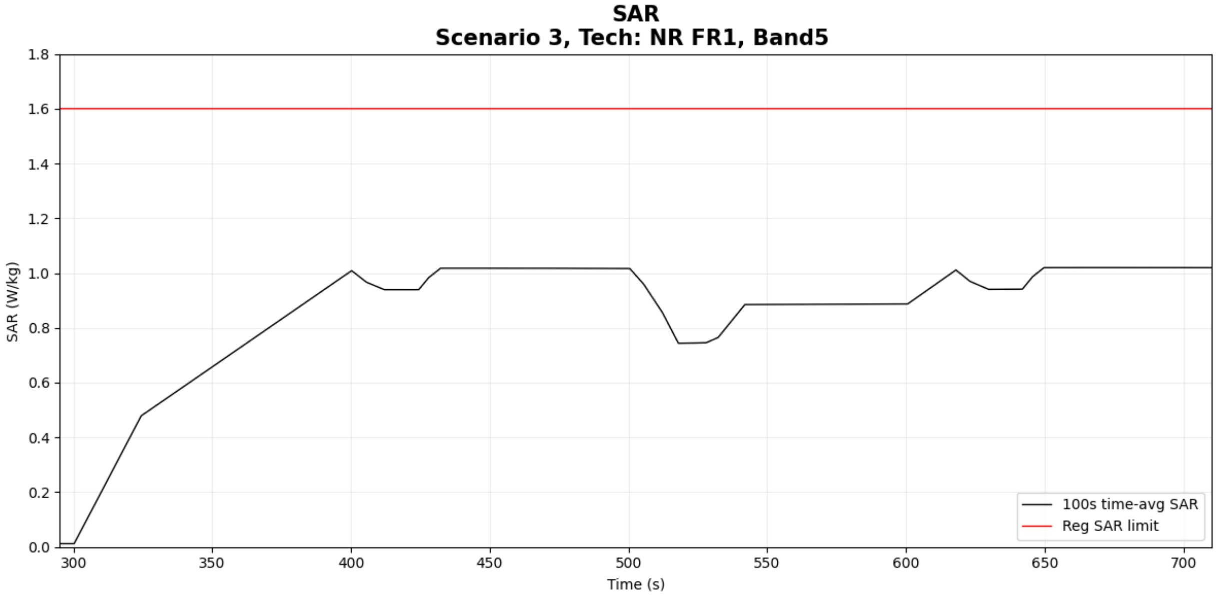


Figure 6-23 Time-averaged SAR for case 3.1(sub6 NR n5)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	1.02 W/kg
Validation result: Pass	

6.5 Conducted Power Measurement Results for Scenario 4: Band Handover

In this scenario, the test power sequence #0 (i.e., maximum TX power is requested by a call box for each RAT) is used, and band (and RAT) handover is manually configured at a specific time instance. The test case widely cover handover scenarios between two RATs. The test case for this scenario is relegated in Table 6-6, and the test procedure follows section 5.5.2. The measurement setup is shown in Figure 6-3 (band handover) and Figure 6-5 (RAT handover). The high-level summary of the final validation results are also listed in the last column of the table, which concludes that Mediatek's TA-SAR algorithm can maintain the time-averaged SAR is always below the FCC requirement. The following sections will demonstrate how Mediatek's TA-SAR algorithm behaves.

Table 6-6 TA-SAR parameters setting for scenario 4

Test case	RAT	Test band	Test seq.	ECI	Max power (dBm)	P_{sub6_limit} (dBm)	$P_{LowThresh}$ (dBm)	$P_{UE\_backoff}$ (dBm)	$P_{UE\_max\_cust}$ (dBm)	Pass /Fail SAR limit
4.1	LTE	41	0	6	23.8	10.8	10.3	7.8	13.8	Pass
	WCDMA	5	0	6	23.6	19.3	18.8	16.3	22.3	Pass

This test aims to validate the TA-SAR algorithm with a handover from LTE band B41 to WCDMA band B5 and ECI = 6. The corresponding detailed test procedure is described in 5.5.2. The first figure demonstrates the EUT's instantaneous conducted TX power and the time-averaged conducted TX power behavior over time, and the power Limit (P_reg_sub6_limit = P_{sub6_limit} + device uncertainty). The handover is configured at the time instance of 500 seconds. It is observed in the figure that the time-averaged TX power of the individual RAT is below its own P_{sub6_limit}. The second figure illustrates the corresponding time-averaged normalized SAR over time converted from the TX time-averaged power by using the equation listed in section 5.5.2. The figure shows that the time-averaged normalized SAR does not exceed the normalized FCC limit of 1.

- **Case 4.1 in table 6-6: band handover happens at the time instance of 500 seconds**

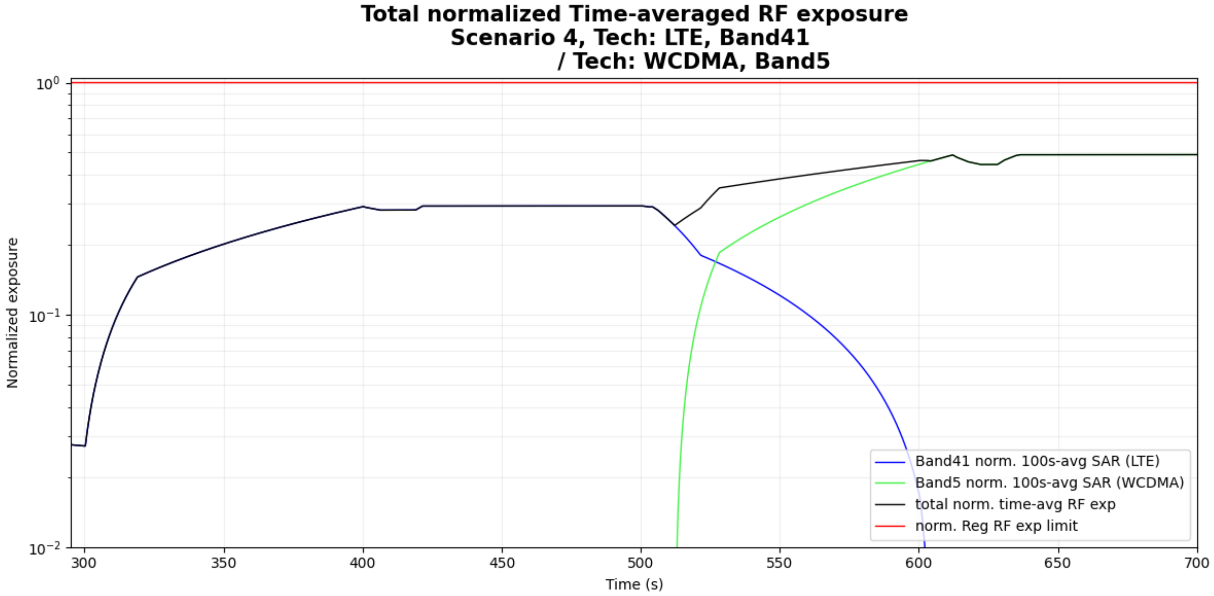


Figure 6-24 Time-averaged SAR for case 4.1(WCDMA B5, LTE B41)

FCC limit of total RF exposure (normalized)	1.0
Max total normalized time-averaged RF exposure	0.490
Validation result: Pass	

6.6 Conducted Power Measurement Results for Scenario 5: ECI Change

In this scenario, the test power sequence #0 (i.e., maximum TX power is requested by a call box for each RAT) is used, and ECI change at the EUT side is manually configured at a specific time instance. The test case cover ECI switching scenarios between two ECIs. The test case for this scenario is relegated in Table 6-7, and the test procedure follows section 5.6.2. The measurement setup is shown in Figure 6-2. The high-level summary of the final validation results are also listed in the last column of the table, which concludes that Mediatek's TA-SAR algorithm can maintain the time-averaged SAR is always below the FCC requirement. The following sections will demonstrate how Mediatek's TA-SAR algorithm behaves.

Table 6-7 TA-SAR parameters setting for scenario 5

Test case	RAT	Test band	Test seq.	ECI	Max power (dBm)	P_{sub6_limit} (dBm)	$P_{LowThresh}$ (dBm)	$P_{UE\_backoff}$ (dBm)	$P_{UE\_max\_cust}$ (dBm)	Pass /Fail SAR limit
5.1	WCDMA	4	0	6	24.2	12	11.5	9	15	Pass
	WCDMA	4	0	1	24.2	19.9	19.4	16.9	22.9	Pass

This test aims to validate the TA-SAR algorithm with ECI change from 3G WCDMA B4 with ECI = 6 to ECI = 1. The corresponding detailed test procedure is described in 5.6.2. The first figure demonstrates the EUT's instantaneous conducted TX power and the time-averaged conducted TX power behavior over time, and the power Limit (P_reg_sub6_limit = P_{sub6_limit} + device uncertainty). During the test period, there are two ECI change events configured individually at the time instance of 500 seconds and 700 seconds. The 1st change is from ECI = 6 to ECI = 1 and 2nd change is from ECI= 1 back to ECI = 6. It is observed in the figure that the time-averaged TX power of the individual RAT is below its own P_{sub6_limit}. The second figure illustrates the corresponding time-averaged normalized SAR over time converted from the TX time-averaged power by using the equation listed in section 5.6.2. The figure shows that the time-averaged normalized SAR does not exceed the normalized FCC limit of 1.

- **Case 5.1 in table 6-7: two ECI changes happens at the time instance of 500 seconds and 700 seconds,respectivly**

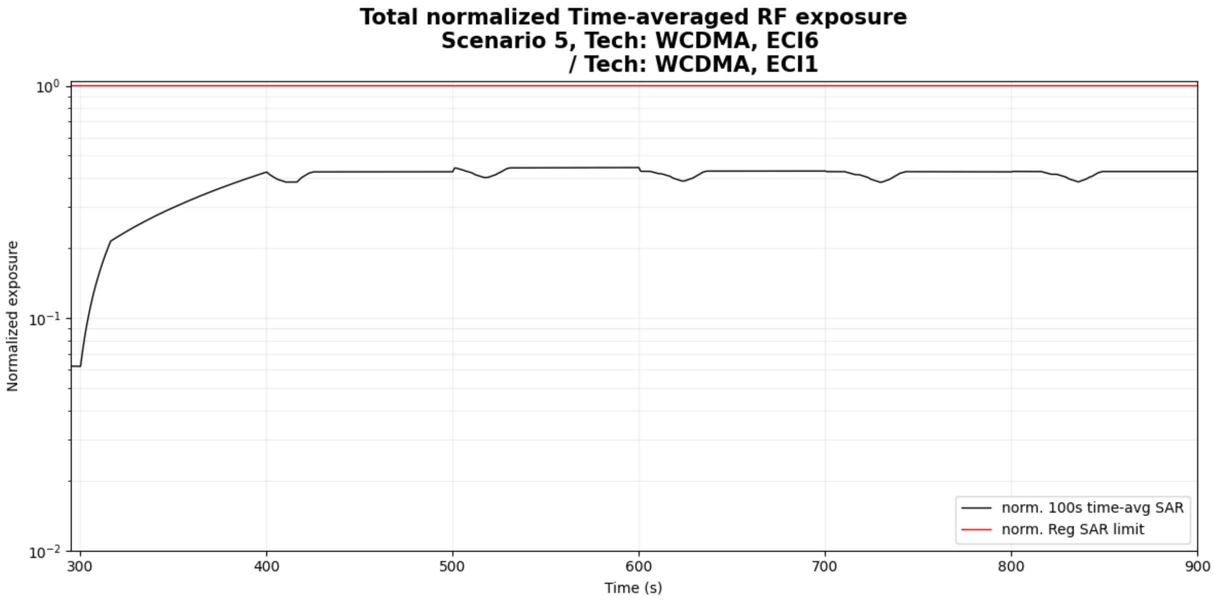


Figure 6-25 Time-averaged SAR for case 5.1(WCDMA B4)

FCC limit of total RF exposure (normalized)	1.0
Max total normalized time-averaged RF exposure	0.445
Validation result: Pass	

6.7 Conducted Power Measurement Results for Scenario 6: Antenna Handover

In this scenario, the test power sequence #0 (i.e., maximum TX power is requested by a call box for each RAT) is used, and antenna change at the EUT side is manually configured at a specific time instance. The test case for this scenario is relegated in Table 6-8, and the test procedure follows section 5.7.2. The measurement setup is shown in Figure 6-4. The high-level summary of the final validation results are also listed in the last column of the table, which concludes that Mediatek's TA-SAR algorithm can maintain the time-averaged SAR is always below the FCC requirement. The following sections will demonstrate how Mediatek's TA-SAR algorithm behaves.

Table 6-8 TA-SAR parameters setting for scenario 6

Test case	RAT	Test band	Test seq.	ANT	ECI	Max power (dBm)	P_{sub6_limit} (dBm)	$P_{LowThresh}$ (dBm)	$P_{UE\_backoff}$ (dBm)	$P_{UE\_max\_cust}$ (dBm)	Pass /Fail SAR limit
6.1	LTE	26	0	0	5	23.8	19.8	19.3	16.8	22.8	Pass
	LTE	26	0	1	5	24.2	23.5	23	20.5	24.2	Pass

This test aims to validate the TA-SAR algorithm with antenna change during the test period for LTE B26 with ECI = 5. The corresponding detailed test procedure is described in 5.7.2. The first figure demonstrates the EUT's instantaneous conducted TX power and the time-averaged conducted TX power behavior over time, and the power Limit (P_reg_sub6_limit = P_{sub6_limit} + device uncertainty). During the test period, there are two antenna change events configured individually at the time instances 500 seconds and 700 seconds. The 1st change is from ANT0 to ANT1 and 2nd change is ANT1 back to ANT0. It is observed in the figure that the time-averaged TX power during the transition of the change is maintained below the power limitation. The second figure illustrates the corresponding time-averaged normalized SAR over time converted from the TX time-averaged power by using the equation listed in section 5.7.2. The figure shows that the time-averaged normalized SAR does not exceed the normalized FCC limit of 1.

- **Case 6.1 in table 6-6: band handover happens at the time instance of 500 seconds**

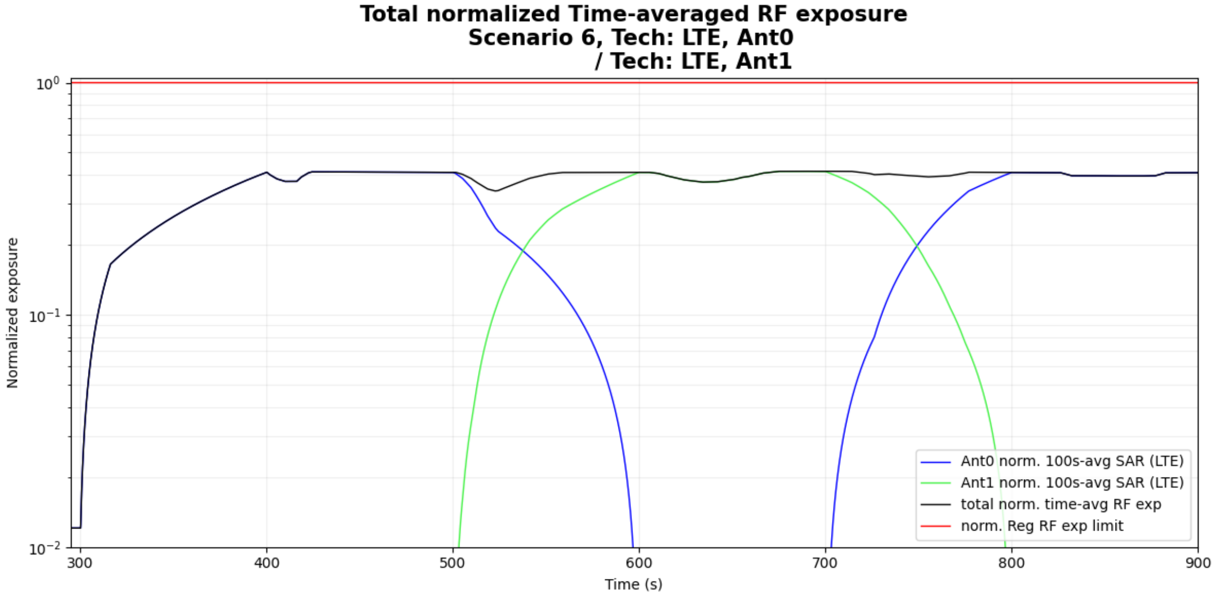


Figure 6-26 Time-averaged SAR for case 4.1(WCDMA B4, LTE B4)

FCC limit of total RF exposure (normalized)	1.0
Max total normalized time-averaged RF exposure	0.415
Validation result: Pass	

6.8 Conducted Power Measurement Results for Scenario 7: SAR Exposure Switching

In this scenario, the test power sequence #0 (i.e., maximum TX power is requested by a call box for each RAT) is used, and LTE and NR FR1 are turned on at the same time for a pre-defined period during the test. This scenario aims to validate whether the TA-SAR algorithm is able to maintain TER below the FCC limit when the two radios change TX power dynamically. The experiment parameters are summarized in Table 6-9, and the test procedure follows section 5.9.2. The measurement setup is shown in Figure 6-5.

Table 6-9 TA-SAR parameters setting for scenario 7

Test case	RAT	Test band	Test seq.	ANT	ECI	Max power (dBm)	P_{sub6_limit} (dBm)	$P_{LowThresh}$ (dBm)	$P_{UE\_backoff}$ (dBm)	$P_{UE\_max\_cust}$ (dBm)	Pass /Fail SAR limit
7.1	LTE	7	0	4	3	21	14.3	13.8	11.3	17.3	Pass
	Sub6 NR	5	0	1	3	21.1	22.2	21.7	19.2	25.2	Pass

During the test period,

- Time = 300s~500s: NR FR1-dominant scenario.
- Time = 500s~7000s: LTE + NR FR1 scenario.
- Time = 700s~900s: LTE-dominant scenario.

The first figure demonstrates the EUT's instantaneous conducted TX power and the time-averaged conducted TX power behavior over time, and the power limit (P_reg_sub6_limit = P_{sub6_limit} + device uncertainty). It is observed in the figure that the time-averaged TX power in all time periods is maintained below the power limitation. The second figure illustrates the corresponding time-averaged normalized SAR over time converted from the TX time-averaged power by using the equation listed in section 5.9.2. The figure shows that the time averaged normalized SAR does not exceed the normalized FCC limit of 1.

- **Case 7.1 in table 6-9**

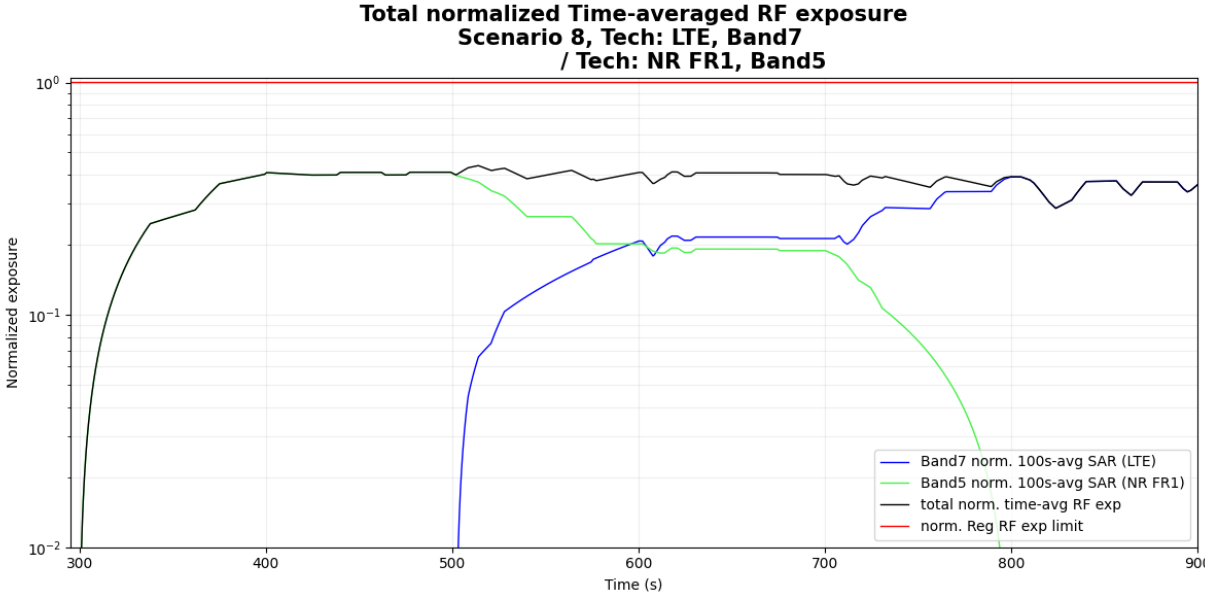


Figure 6-27 Normalized Time-averaged SAR

FCC limit of total RF exposure (normalized)	1.0
Max total normalized time-averaged RF exposure	0.439
Validation result: Pass	

7 TA-SAR Test Scenarios and Test Procedures (WLAN)

In order to demonstrate that TA-SAR algorithm performs as expected under various operating scenarios, Table 7-1 lists the test scenarios and expected test sequences to validate TA-SAR algorithm in these scenarios.

Table 7-1 Test scenario list of TA-SAR validation

Test scenario		Description
1	TX mode change between normal mode and sleep mode	Test normal mode and sleep mode switch
2	Band handover	Test 2.4GHz/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

7.1 Test Sequences for All Scenarios

The test sequence is predefined for TA-SAR:

- **Test sequence**: Wi-Fi is requested to transmit static and maximum power with high duty..

The test sequence is illustrated in Figure 7-1. The waveform of the test sequence is listed in Tabela 7-2.

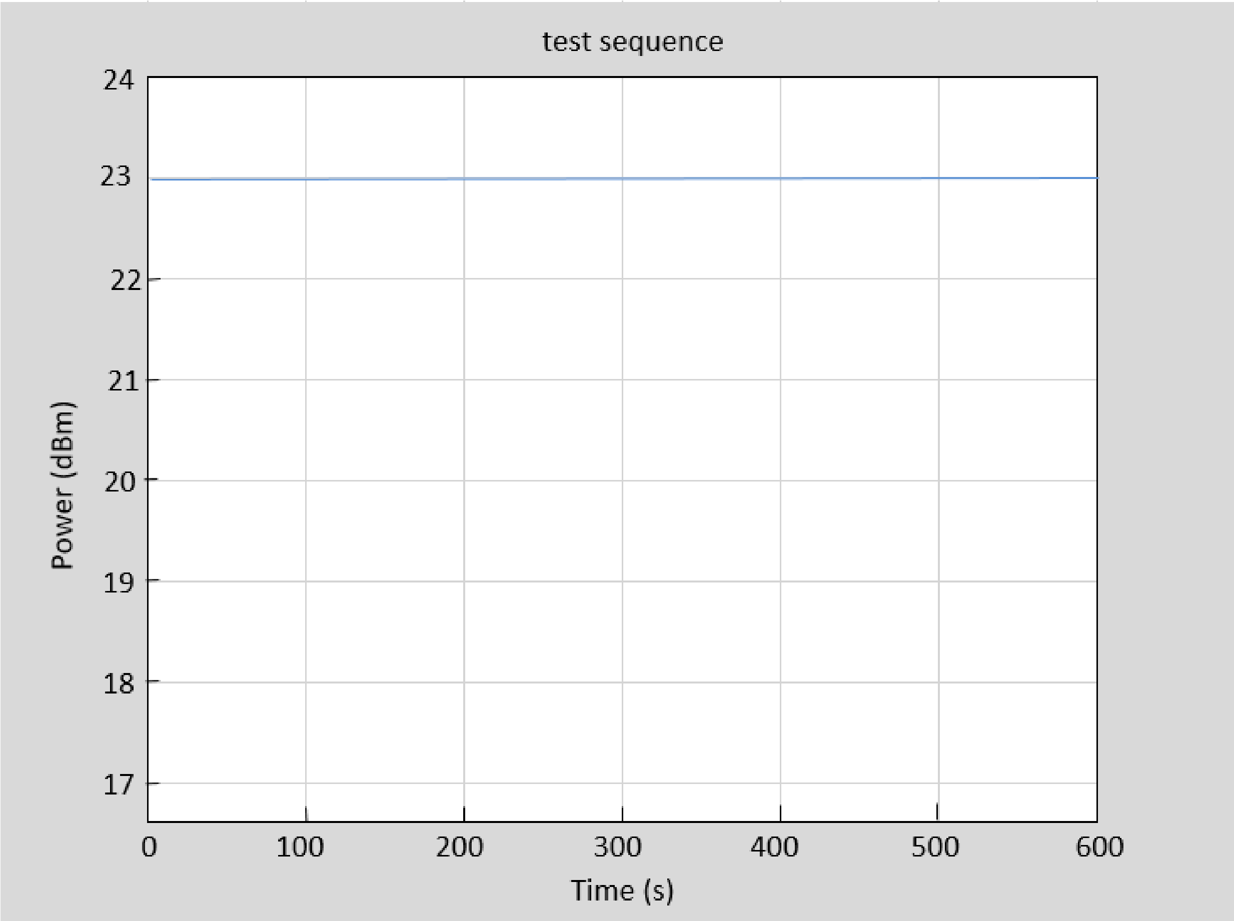


Figure 7-1 Test sequence

Table 7-2 Test sequence 1

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

7.2 Test Configuration and Procedure for Scenario 1: TX Mode Change between Normal Mode and Sleep Mode via Conducted Power Measurements

7.2.1 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 *WF_SAR_design_limit*) and are described as below:

- Select one band/channel with least *P_WF_SAR_limit* amone 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 bans.

7.2.2 Procedure

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

- 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 per-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 mormal 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 10gSAR to determine time-averaged value versus time as follows.

Instantaneous 1gSAR or 10gSAR versus time: SAR(t)

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

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 1.6W/kg (1gSAR) or 4.0W/kg (10gSAR)

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

7.3.1 Configuration

The scenario test 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.*

7.3.2 Procedure

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

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

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

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

  Dual band mode (DBDC) connection: Wi-Fi connects to 2.4GHz and 5GHz bands simultaneously for 400s.

- Step 5:Convert the measured conducted TX power into SAR.

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

Instantaneous 1gSAR or 10gSAR versus time: SAR_1(t) (band1), SAR_2(t) (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.

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 1.6W/kg (1gSAR) or 4.0W/kg (10gSAR)
3. Normalized time-averaged 1gSAR /1.6 or 10gSAR/4.0

7.4 Test Configuration and Procedure for Scenario 3: Antenna Switching via Conducted Power Measurements

7.4.1 Configuration

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

- Select the band having the highest measured 1gSAR at *P_WF_SAR_limit* if multiple bands have the same *P_WF_SAR_limit* among supported antennas.
- Antenna selection order

  · Select the configuration with two antennas having *P_WF_SAR_limit* values less than *P_WF_SAR_MAX*.

  · If the pervious configuration does not exist, select the configuration with one antenna having *P_WF_SAR_limit* value less the *P_WF_SAR_MAX*.

  · If tha 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*.

7.4.2 Procedure

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

- Step 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 bands.

  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 scenario1.
- 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 1.6W/kg (1gSAR) or 4.0W/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 realized by TA-SAR algorithm when antenna switches from one to anthoer.
- The validation critera are, at al times, the time-averaged 1gSAR or10gSAR versus time shall not exceed FCC limit of 1.6W/kg for 1gSAR or 4.0/kg for 10gSAR.

7.5 Test Configuration and Procedure for Scenario 4: Exposure Condition Index(ECI) Change via Conducted Power Measurements

7.5.1 Configuration

The scenario tests the time-averaged TX power is less than the perdefined 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.

7.5.2 Procedure

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

- Step 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 PWF_SAR_limit for 400s.

- Step 5:Convert the measured conducted TX power into SAR based on the formulas for scenario1.

- 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 1.6W/kg (1gSAR) or 4.0W/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 critera are, at al times, the time-averaged 1gSAR or10gSAR versus time shall not exceed FCC limit of 1.6W/kg for 1gSAR or 4.0/kg for 10gSAR.

7.6 Test Configuration and Procedure for Scenario 5: Simultaneous SAR and PD via Conducted Power Measurements

7.6.1 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*.

7.6.2 Procedure

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

- Step 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 radio link with AP in the selected band and enable TA-SAR and TA-PD.
  - Step 3: Configure pre-defined TX power sequence to DUT and measure TX power versus time.
  - Step 4: Wi-Fi transmits packets at 2.4GHz band and 6Ghz band.

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

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

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

For TA-PD of each band at 6GHz band

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

Instantaneous 1gSAR or10gSAR versus time: SAR(t), PD(t)

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

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

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 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 show 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)

3. FCC TER limit of 1

8 TA-SAR/TA-PD Validation via Conducted Power Measurements (WLAN)

8.1 Measurement Setup

8.1.1 Test Bench Introduction

The spectrum analyzer are used to validate the proposed TA-SAR/TA-PD mechanism. Figure 8-1 shows the block diagram of the measurement bench, which supports the following test scenarios..

- Test scenario 1: TX mode change between normal mode and sleep mode
- Test scenario 4: ECI change

For these measurements, RF ports of the spectrum analyzer is connected to the EUT's antenna port, and the spectrum analyzer establishes a connection link through the test script console tool and the power meter measures the conducted output power of the EUT.

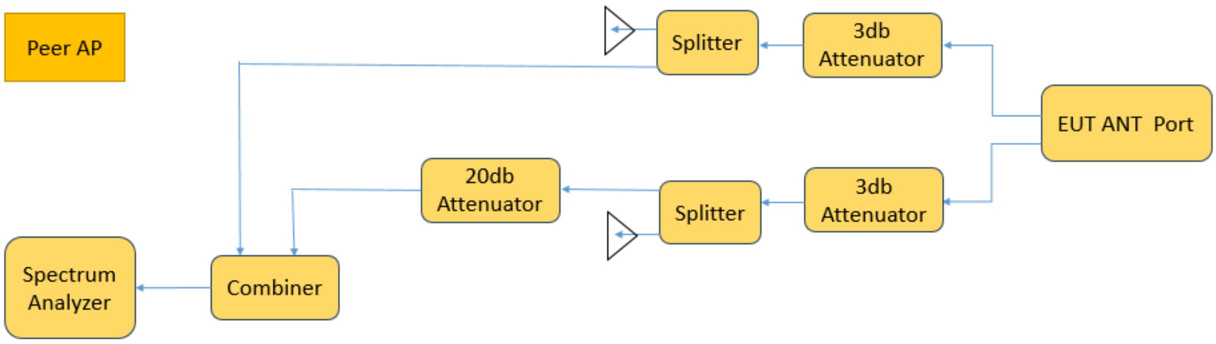


Figure 8-1 TA-SAR/TA-PD conductive power test setup block diagram for scenarios 1/4

Figure 8-2 shows the block diagram of the measurement bench, which support test scenario 2(band handover), scenario 3 (antenna switching) and scenario 5 (simultaneous SAR and PD) .

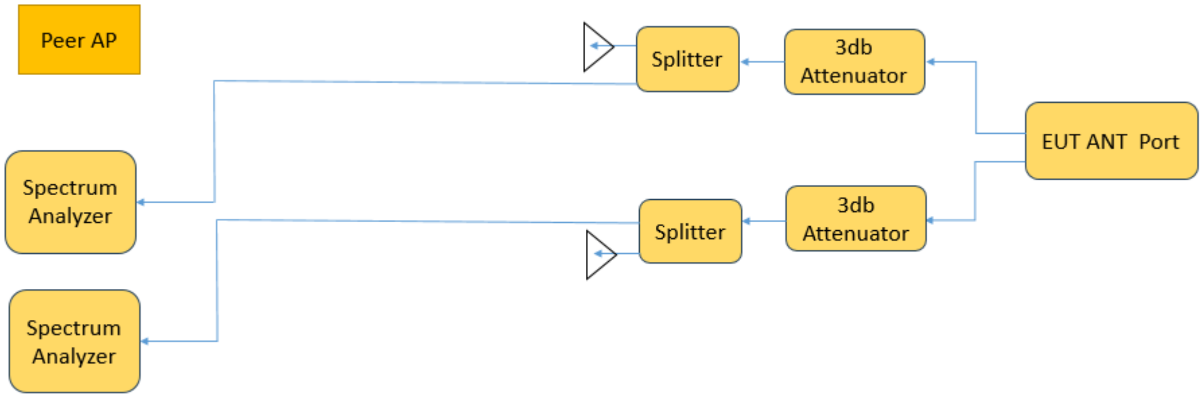


Figure 8-2 TA-SAR/TA-PD conductive power test setup block diagram for scenarios 2/3/5

8.1.2 Wi-Fi Power Limit Table and Test Configurations

Table 8-1 Summary table of power limit

Band	Antenna	ECI 1	ECI 2	ECI 3	ECI 4	ECI 5	ECI 6	ECI 7	ECI 8	ECI 9	ECI 10	ECI 11	ECI 12	ECI 13	ECI 14	ECI 15	ECI 16	Pmax*
Wi-Fi 2.4GHz	12	17	17	17	17	16	15	16	15	16	14	14	12	16	14	14	12	20.5
	7	17	17	17	17	16	15	16	15	16	14	14	12	16	14	14	12	20.5
	MIMO	17.5	17.5	17.5	17.5	16.5	15.5	16.5	15.5	16.5	14.5	14.5	12.5	16.5	14.5	14.5	12.5	20.5
Wi-Fi 5GHz	9	13	12	13	12	13	12	13	12	11	9	10	7	11	9	10	7	20
	10	13	12	13	12	13	12	13	12	11	9	10	7	11	9	10	7	20
	14	13	12	13	12	13	12	13	12	11	9	10	7	11	9	10	7	20
	MIMO	14	13	14	13	14	13	14	13	12	10	11	8	12	10	11	8	21
Wi-Fi 6E	9	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	10
	10	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	10
	14	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	10
	MIMO	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	11

Table 8-2 ECI and Corresponding Exposure Scenarios

Scenario	Description
ECI1	Body (Standalone)
ECI2	Head (Standalone)
ECI3	Body (WIFI2.4GHz+5GHz/6GHz)
ECI4	Head (WIFI2.4GHz+5GHz/6GHz)
ECI5	Body (WIFI2.4GHz/5GHz/6GHz+BT)
ECI6	Head (WIFI2.4GHz/5GHz/6GHz+BT)
ECI7	Body (WIFI2.4GHz+5GHz/6GHz+BT)
ECI8	Head (WIFI2.4GHz+5GHz/6GHz+BT)
ECI9	Body (WIFI2.4GHz/5GHz/6GHz+WWAN)
ECI10	Head (WIFI2.4GHz/5GHz/6GHz+WWAN)
ECI11	Body (WIFI2.4GHz/5GHz/6GHz+WWAN+BT)
ECI12	Head (WIFI2.4GHz/5GHz/6GHz+WWAN+BT)
ECI13	Body (WIFI2.4GHz+5GHz/6GHz+WWAN)
ECI14	Head (WIFI2.4GHz+5GHz/6GHz+WWAN)
ECI15	Body (WIFI2.4GHz+5GHz/6GHz+WWAN+BT)
ECI16	Head (WIFI2.4GHz+5GHz/6GHz+WWAN+BT)

8.2 Conducted Power Measurement Results for 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 8-1, 8-2 and 8-3 demonstrates the DUT's instantaneous conducted TX power, the time-averaged conducted TX power behavior over time, and the power limit for scenario 1-1 and 1-2. 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	PWF_SAR_limit
2.4GHz	14Bm

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

Test band	PWF_SAR_limit
6Hz	6Bm

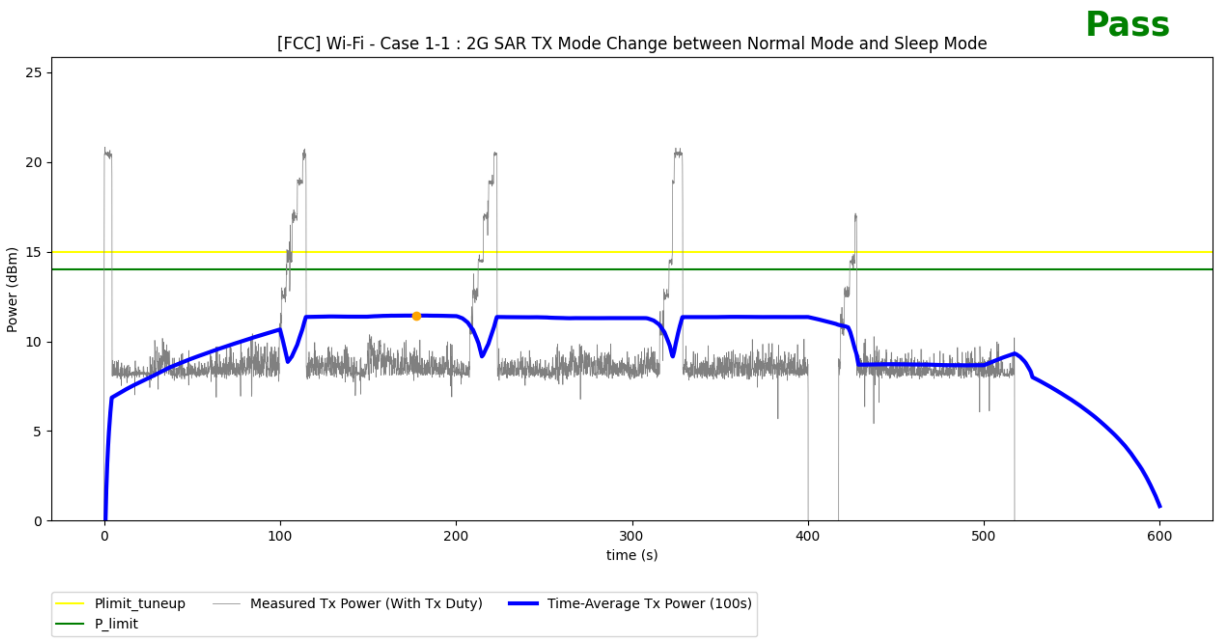


Figure 8-1 Conducted power simulation result for test senario 1-1

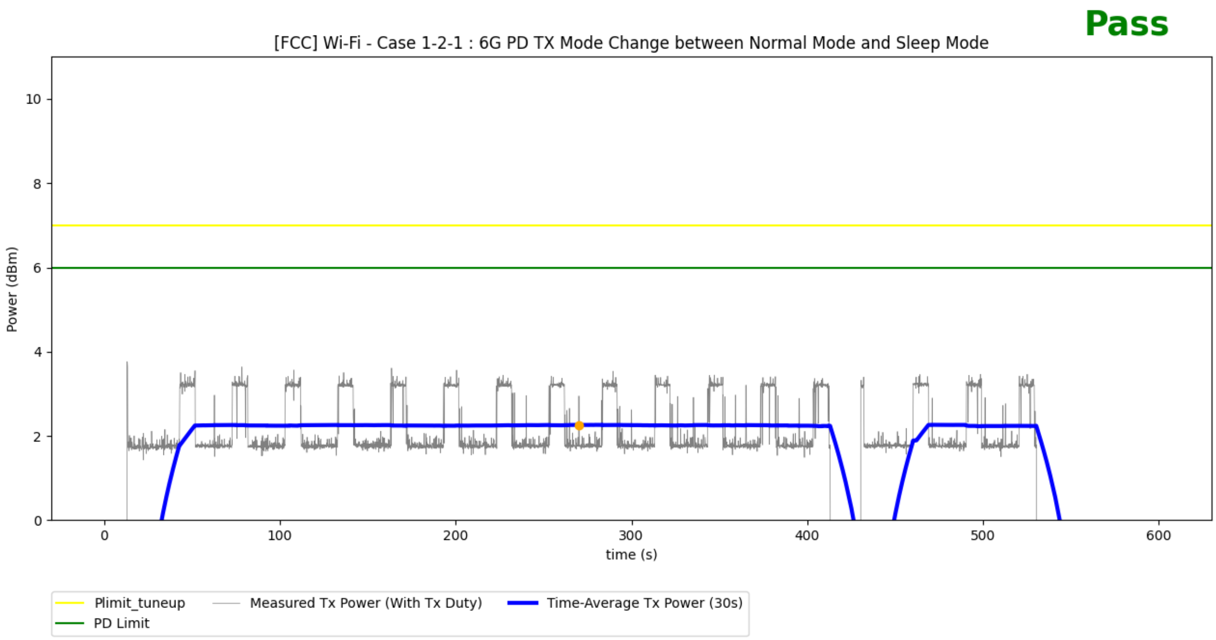


Figure 8-2 Conducted power simulation result for test senario 1-2-1

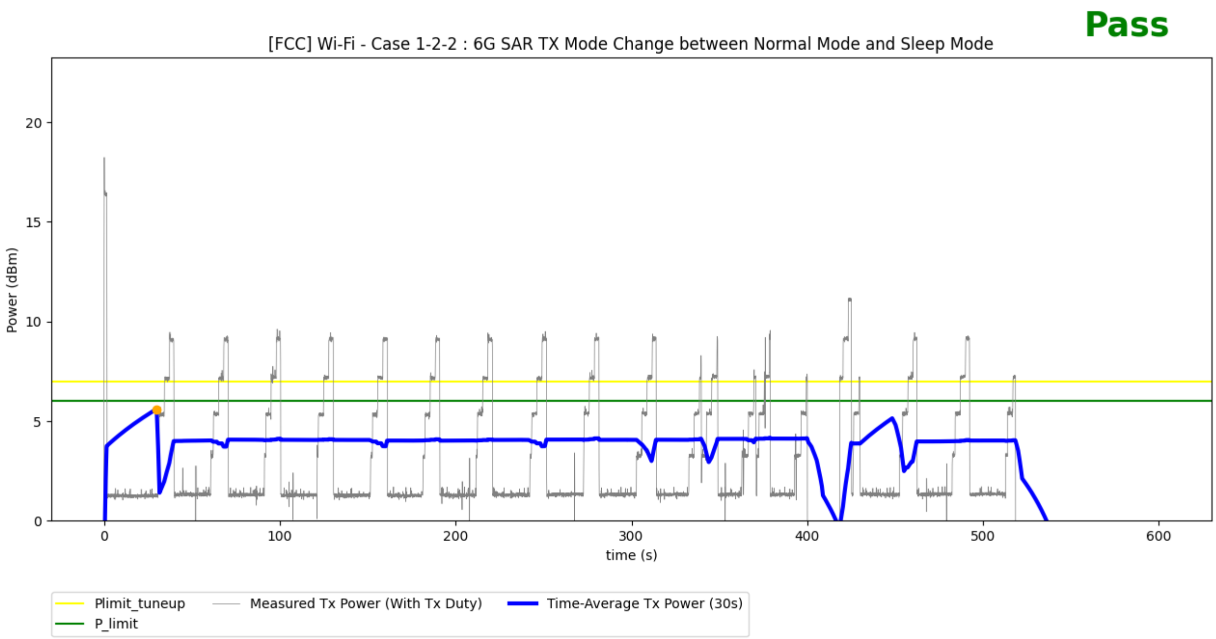


Figure 8-3 Conducted power simulation result for test senario 1-2-2

8.3 Conducted Power Measurement Results for 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 8-4 demonstrates the DUT's instantaneous conducted TX power, the time-averaged conducted TX power behavior over time, and the power limit.

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

Test band	Switch time	PWF_SAR_limit
2.4GHz	0~400s	14dBm
5GHz	400~800s	11dBm
2.4GHz+5GHz	800~1200s	/

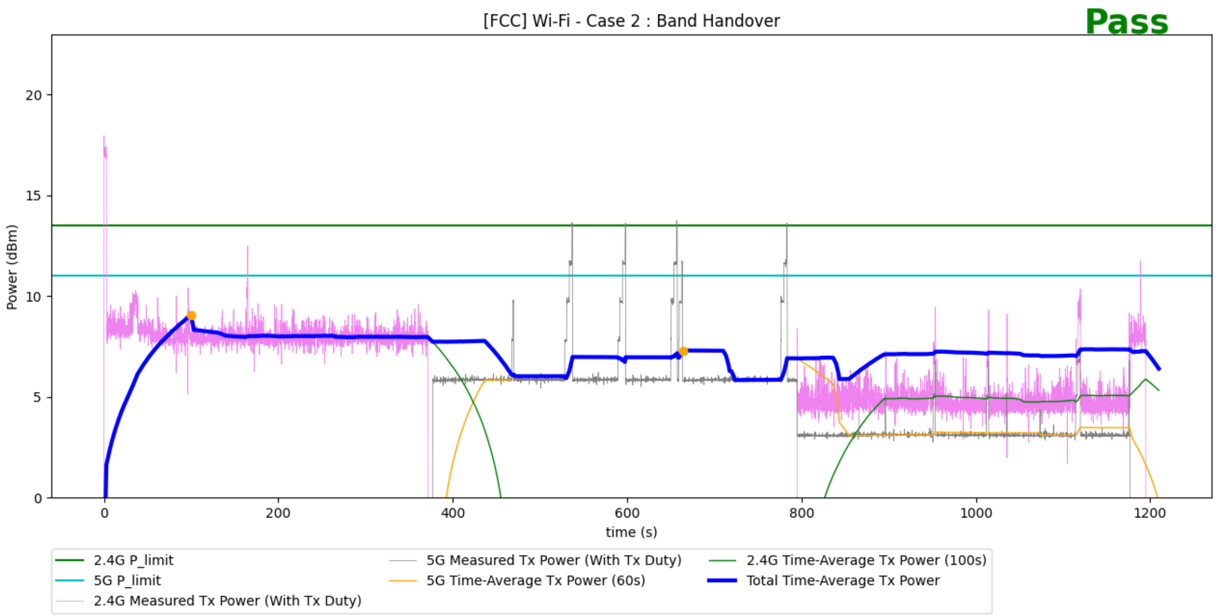


Figure 8-4 Time-averaged conducted TX power over time for test senario 2

8.4 Conducted Power Measurement Results for 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 8-5 demonstrates the DUT’s instantaneous conducted TX power, the time-averaged conducted TX power behavior over time, and the power limit.

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

Test band	Antenna	Switch time	PWF_SAR_limit
2.4GHz	0	0~400s	14dBm
2.4GHz	1	400s~800s	14dBm

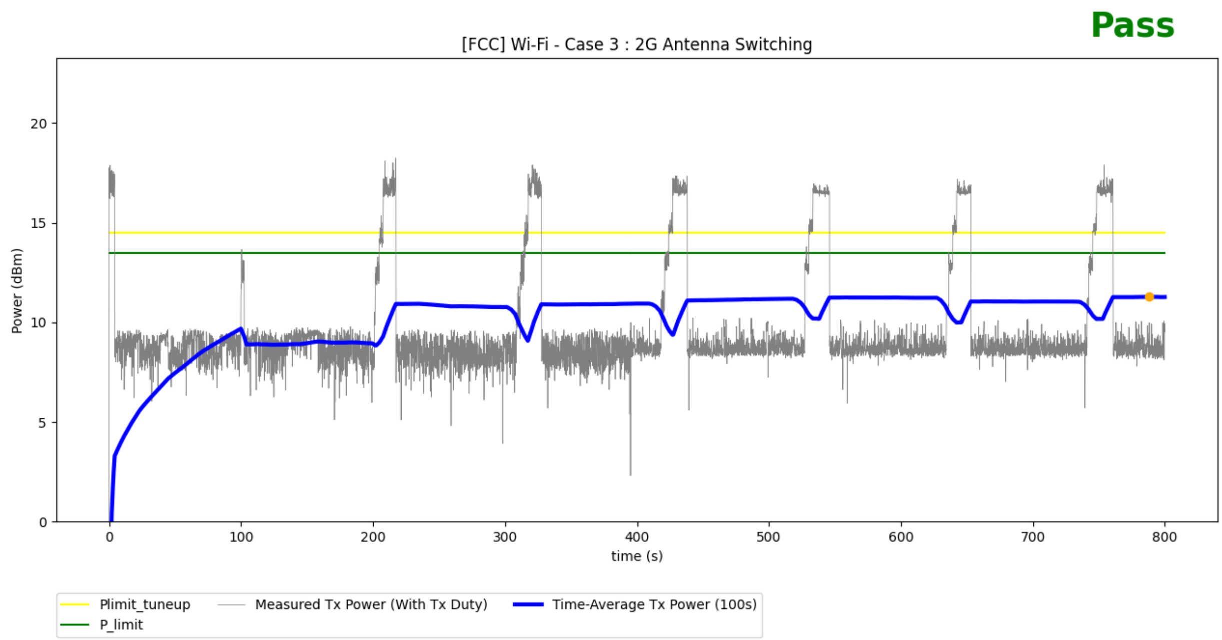


Figure 8-5 Time-averaged conducted TX power over time for test senario 3

8.5 Conducted Power Measurement Results for 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 8-6 demonstrates the DUT's instantaneous conducted TX power, the time-averaged conducted TX power behavior over time, and the power limit.

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

Test band	ECI	Switch time	PWF_SAR_limit
2.4GHz	1	0~400s	14dBm
2.4GHz	2	400s~800s	12dBm

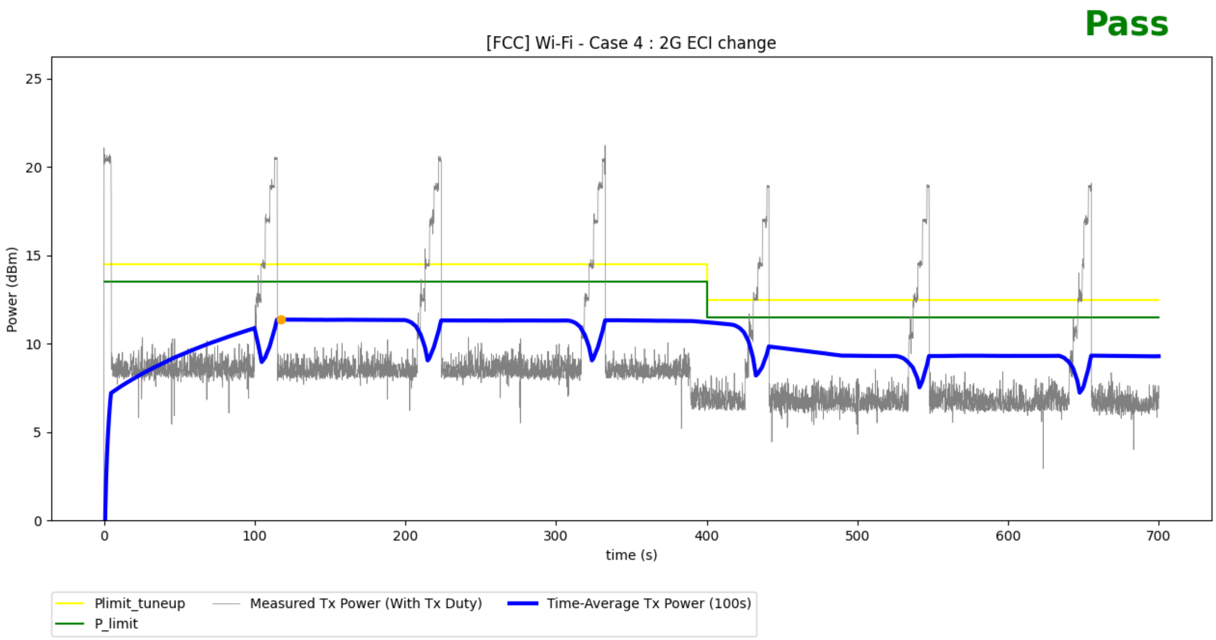


Figure 8-6 Time-averaged conducted TX power over time for test senario 4

8.6 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 7.6, 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 8-7 shows the conducted power measurement result for 2.4GHz TA-SAR and 6GHz TA-PD.

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

Test band	Test band	Switch time	PWF_SAR_limit
SAR	2.4GHz	0~800s	14dBm
SAR	6GHz	0~800s	6dBm
PD	6GHz	0~800s	6dBm

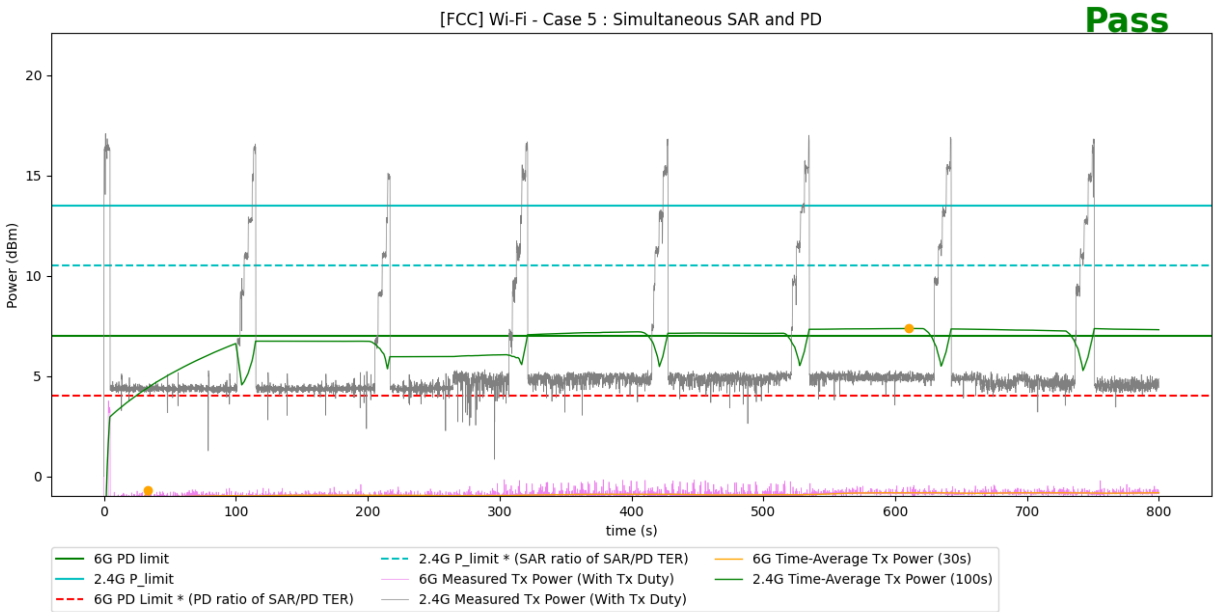


Figure 8-6 Time-averaged conducted TX power over time for test senario 5

9 TA-SAR Validation via SAR Measurements(WWAN)

9.1 Measurement Setup

The measurement setup is similar to normal fixed power SAR measurement. The difference in SAR measurement setup for time averaging feature validation is that the call box operates under the close loop power control mode and is connected to the PC, so that the PC can control the call box based on the test sequence to configure EUT's TX target power. The same test procedure used in conducted power setup for time-varying TX power measurement is also used in this section for time-averaging SAR measurements. Since the SAR chamber is an uncontrolled environment, the path loss between call box antenna and the EUT are well calibrated. The test setup is illustrated in Figure 9-1.

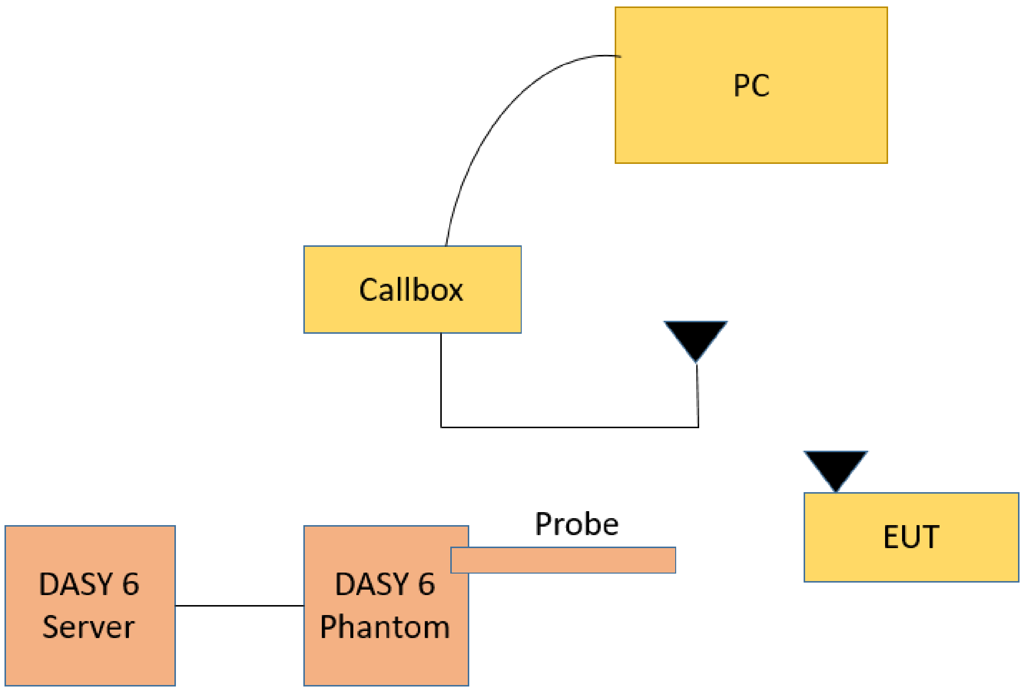


Figure 9-1 TA-SAR wireless test environment

9.2 SAR Measurement Results for Scenario 2: Time-Varying TX power

In this scenario, Mediatek's TA-SAR algorithm is tested under more dynamic power test sequences. The test sequence #1 is shown in section 5.1 and test sequence #2 is tabulated in table 5.4. All of the test cases for this scenario are relegated in Table 9-1, and the test procedure follows section 5.10.2. The measurement setup is shown in Figure 9-1. All of the measurements are conduct by using DASY6. The high-level summary of the final validation results is given in the last column of the table, which concludes that Mediatek's TA-SAR algorithm can maintain the time-averaged SAR is always below the FCC requirement for all test cases. The following sections will demonstrate case-by-case to show how Mediatek's TA-SAR algorithm behaves for each RAT.

Table 9-1 Operating parameters for TA-SAR parameters setting

Test case	RAT	Test band	Test seq.	ECI	Max power (dBm)	P_{sub6_limit} (dBm)	$P_{LowThresh}$ (dBm)	$P_{UE\_backoff}$ (dBm)	$P_{UE\_max\_cust}$ (dBm)	Pass /Fail SAR limit
1	Sub6 NR	5	1	3	24.1	22.2	21.7	19.2	24.1	Pass
2	Sub6 NR	5	2	3	24.1	22.2	21.7	19.2	24.1	Pass
3	Sub6 NR	7	1	5	21.2	10.1	9.6	7.1	13.1	Pass
4	Sub6 NR	7	2	5	21.2	10.1	9.6	7.1	13.1	Pass
5	LTE	26	1	2	23.8	22.8	22.3	19.8	23.8	Pass
6	LTE	26	2	2	23.8	22.8	22.3	19.8	23.8	Pass
7	LTE	41	1	6	23.8	10.8	10.3	7.8	13.8	Pass
8	LTE	41	2	6	23.8	10.8	10.3	7.8	13.8	Pass
9	WCDMA	5	1	3	23.6	22.2	21.7	19.2	23.6	Pass
10	WCDMA	5	2	3	23.6	22.2	21.7	19.2	23.6	Pass
11	WCDMA	4	1	6	24.2	12	11.5	9	15	Pass
12	WCDMA	4	2	6	24.2	12	11.5	9	15	Pass
13	GSM	850	1	6	32.6	28.8	28.3	25.8	31.8	Pass
14	GSM	850	2	6	32.6	28.8	28.3	25.8	31.8	Pass
15	GSM	1900	1	3	30	28.2	27.7	25.2	30	Pass
16	GSM	1900	2	3	30	28.2	27.7	25.2	30	Pass

9.2.1 SAR Measurement results for NR

- **Case 1 in table 9-1: NR n5 result for test sequence 1**

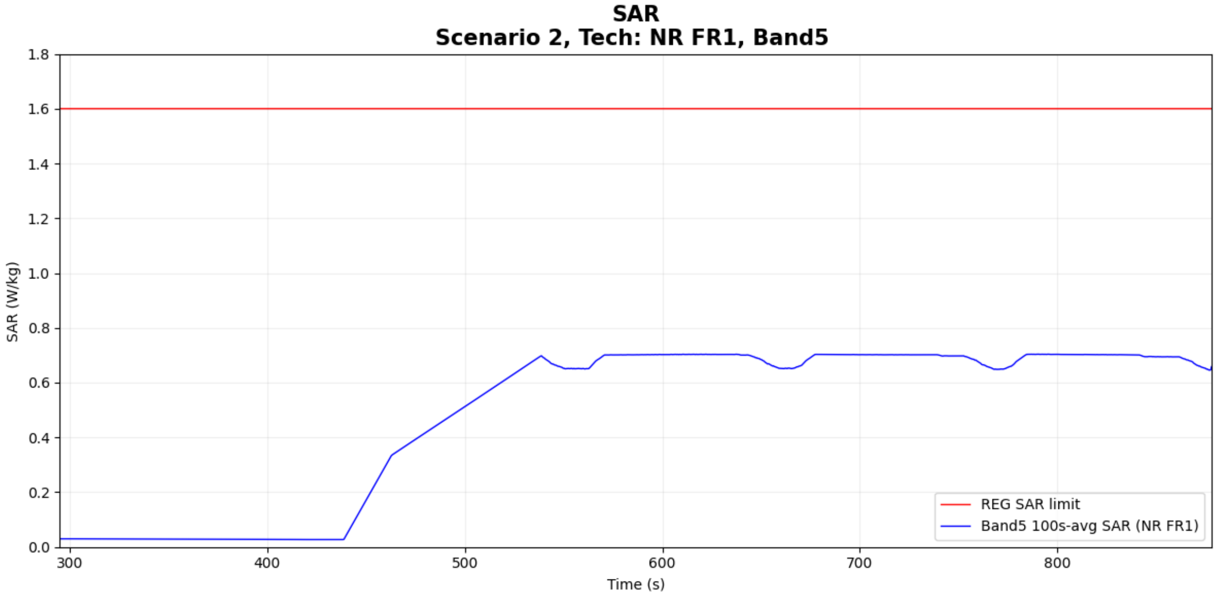


Figure 9-2 Time-averaged SAR for case 1 in table 9-1 (sub NR n5)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.704 W/kg
Validation result: Pass	

- **Case 2 in table 9-1: NR n5 result for test sequence 2**

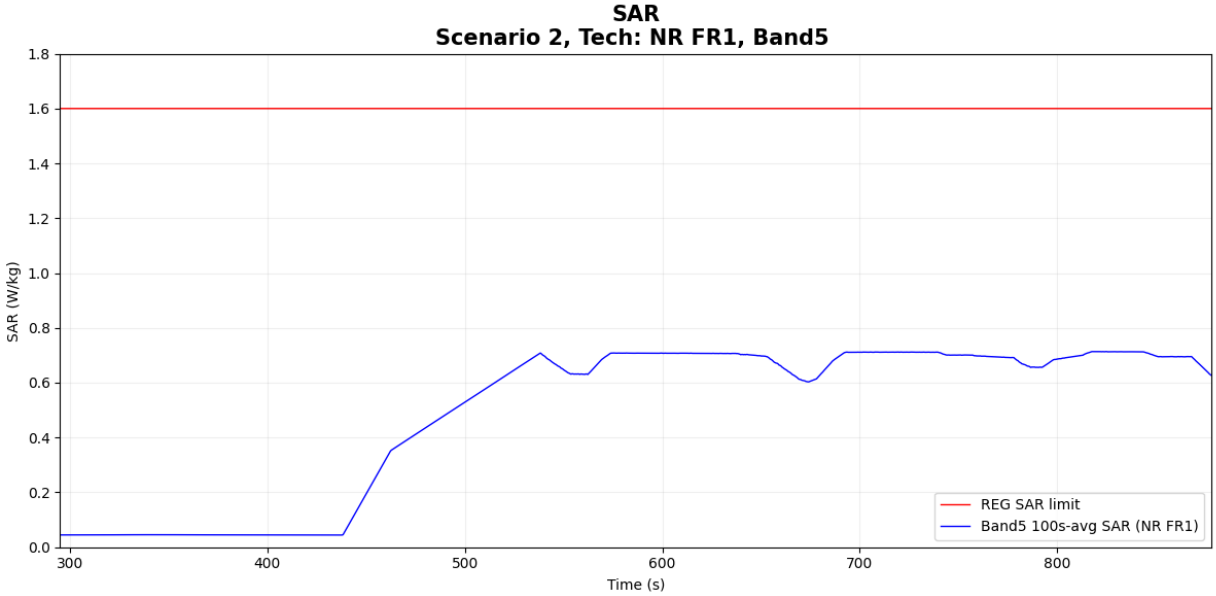


Figure 9-3 Time-averaged SAR for case 2 in table 9-1 (sub NR n5)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.714 W/kg
Validation result: Pass	

- **Case 3 in table 9-1: NR n7 result for test sequence 1**

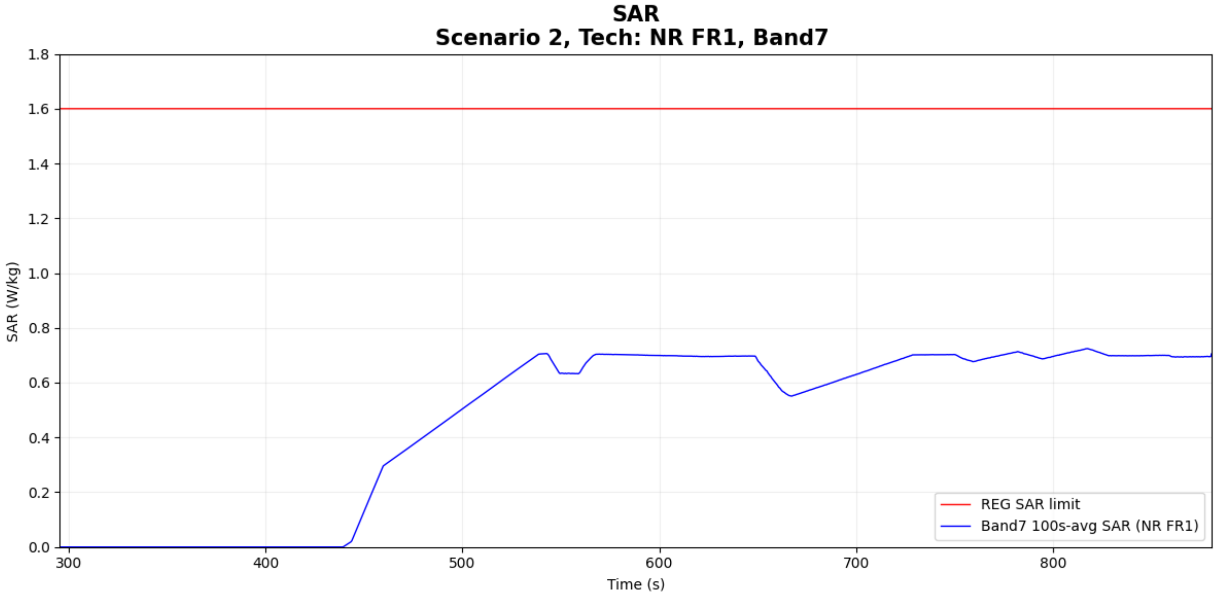


Figure 9-4 Time-averaged SAR for case 3 in table 9-1 (sub NR n7)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.724 W/kg
Validation result: Pass	

- **Case 4 in table 9-1: NR n7 result for test sequence 2**

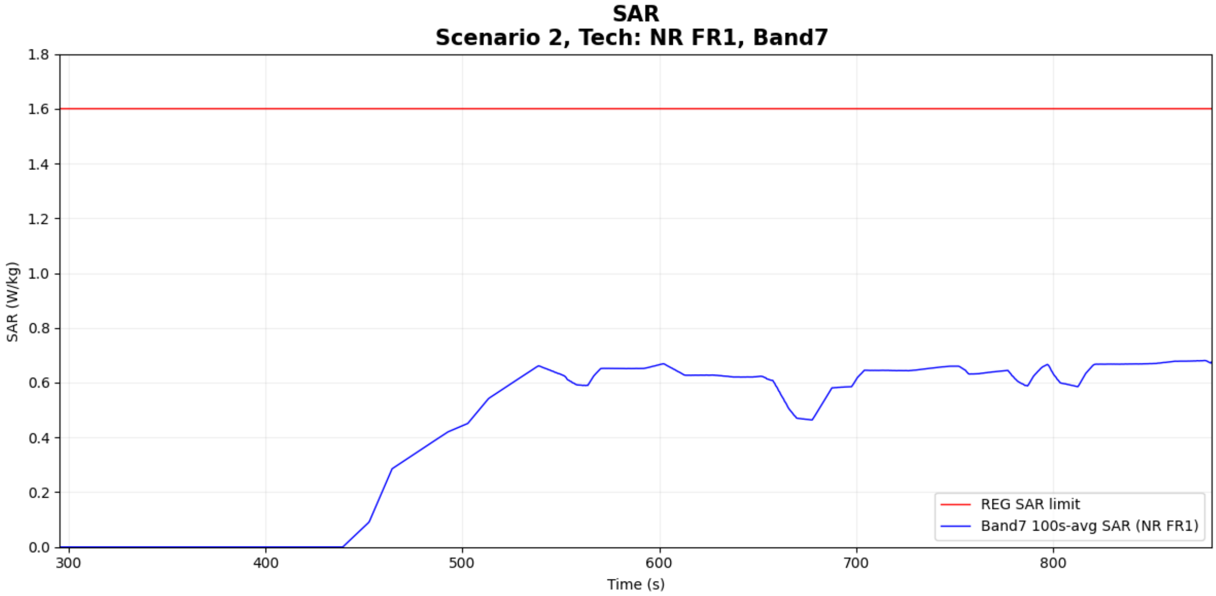


Figure 9-5 Time-averaged SAR for case 4 in table 9-1 (sub NR n7)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.681 W/kg
Validation result: Pass	

9.2.2 SAR Measurement results for 4G LTE

- **Case 5 in table 9-1: 4G LTE B26 result for test sequence 1**

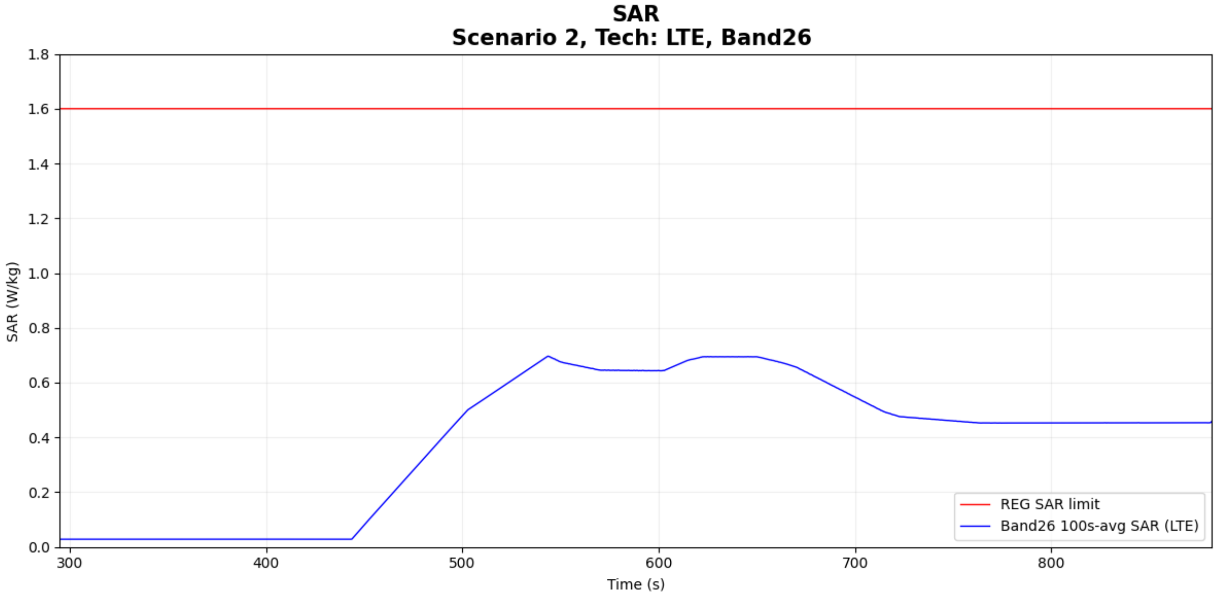


Figure 9-6 Time-averaged SAR for case 5 in table 9-1 (4G LTE B26)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.697 W/kg
Validation result: Pass	

- **Case 6 in table 9-1: 4G LTE B26 result for test sequence 2**

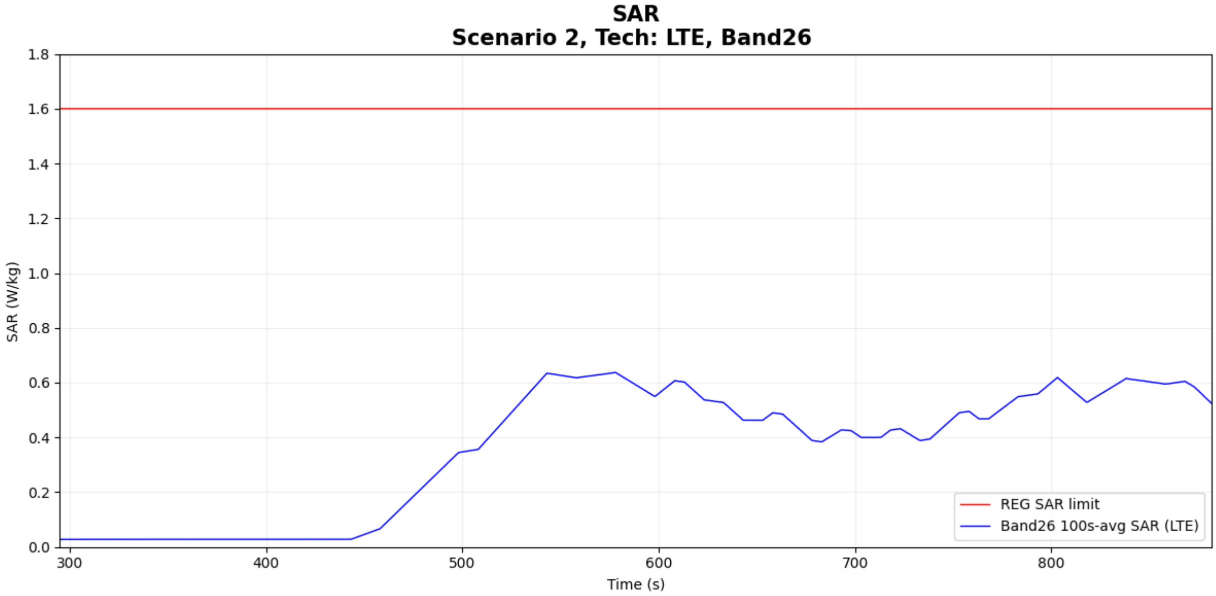


Figure 9-7 Time-averaged SAR for case 6 in table 9-1 (4G LTE B26)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.637 W/kg
Validation result: Pass	

- **Case 7 in table 9-1: 4G LTE B41 result for test sequence 1**

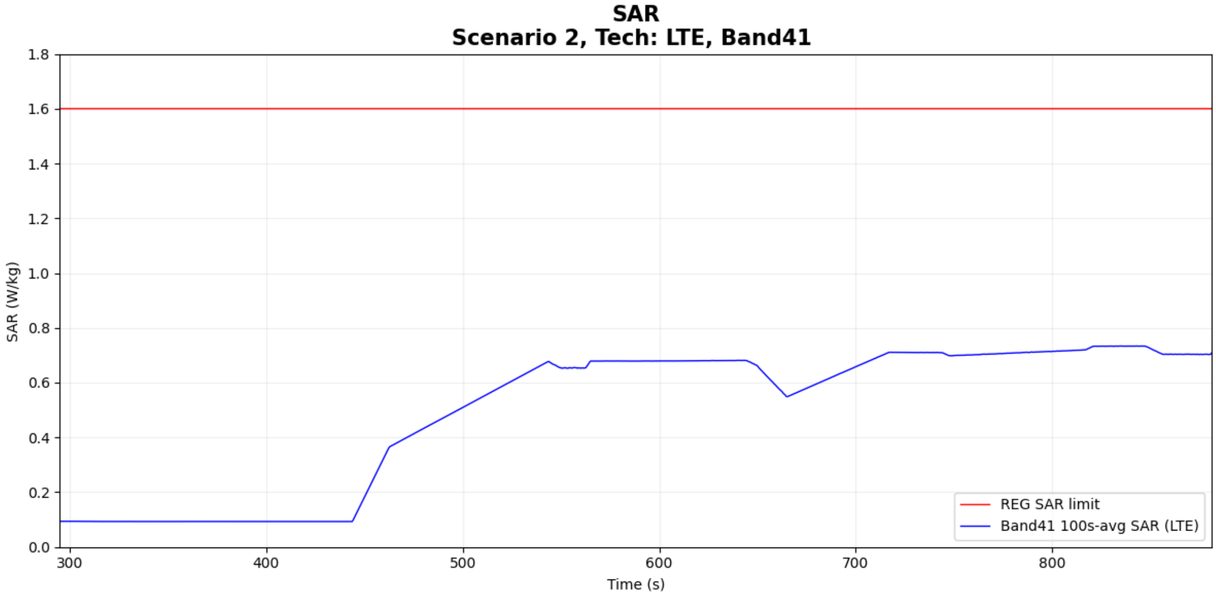


Figure 9-8 Time-averaged SAR for case 7 in table 9-1 (4G LTE B41)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.734 W/kg
Validation result: Pass	

- **Case 8 in table 9-1: 4G LTE B41 result for test sequence 2**

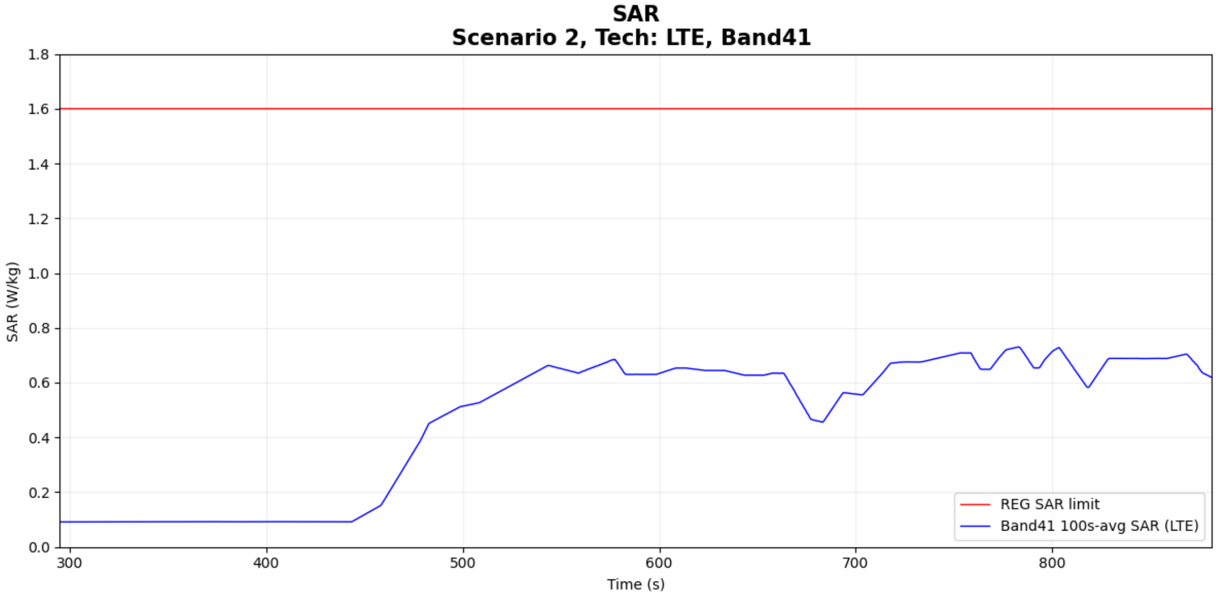


Figure 9-9 Time-averaged SAR for case 8 in table 9-1 (4G LTE B41)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.730 W/kg
Validation result: Pass	

9.2.3 SAR Measurement results for 3G WCDMA

- **Case 9 in table 9-1: 3G WCDMA B5 result for test sequence 1**

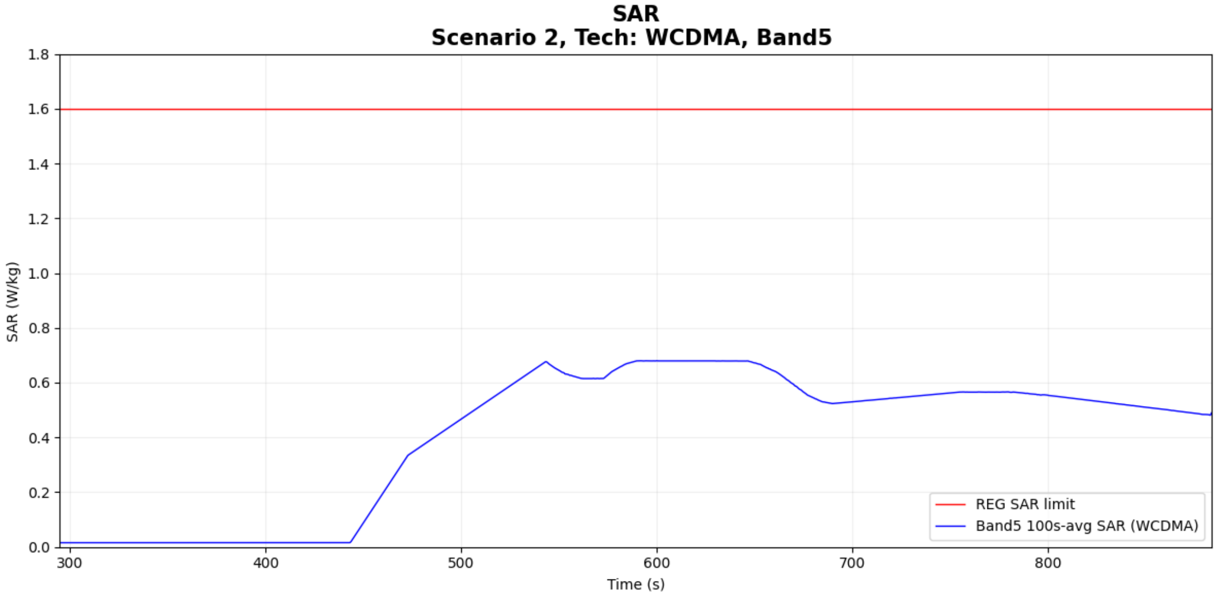


Figure 9-10 Time-averaged SAR for case 9 in table 9-1 (3G WCDMA B5)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.680 W/kg
Validation result: Pass	

- **Case 10 in table 9-1: 3G WCDMA B5 result for test sequence 2**

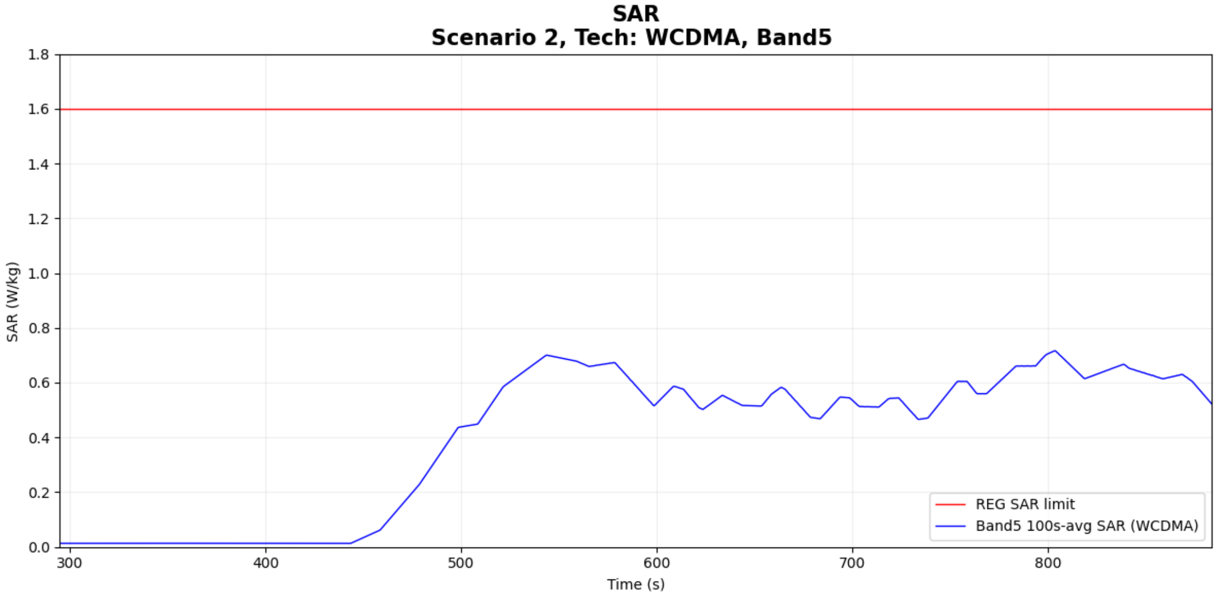


Figure 9-11 Time-averaged SAR for case 10 in table 9-1 (3G WCDMA B5)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.716 W/kg
Validation result: Pass	

- **Case 11 in table 9-1: 3G WCDMA B4 result for test sequence 1**

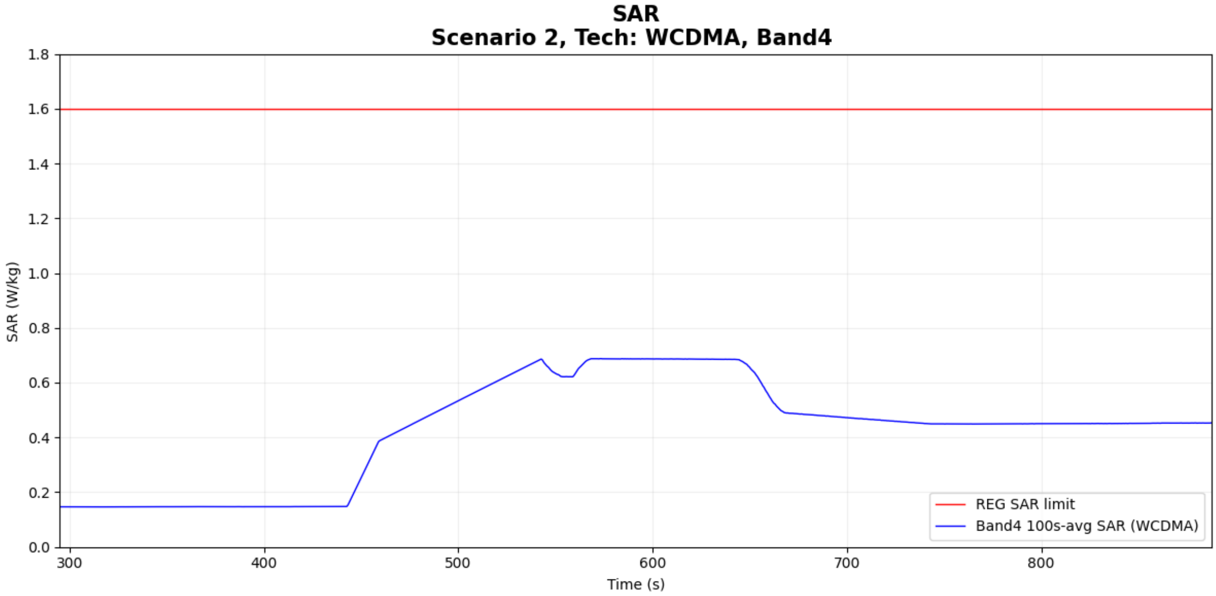


Figure 9-12 Time-averaged SAR for case 11 in table 9-1 (3G WCDMA B4)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.688 W/kg
Validation result: Pass	

- **Case 12 in table 9-1: 3G WCDMA B4 result for test sequence 2**

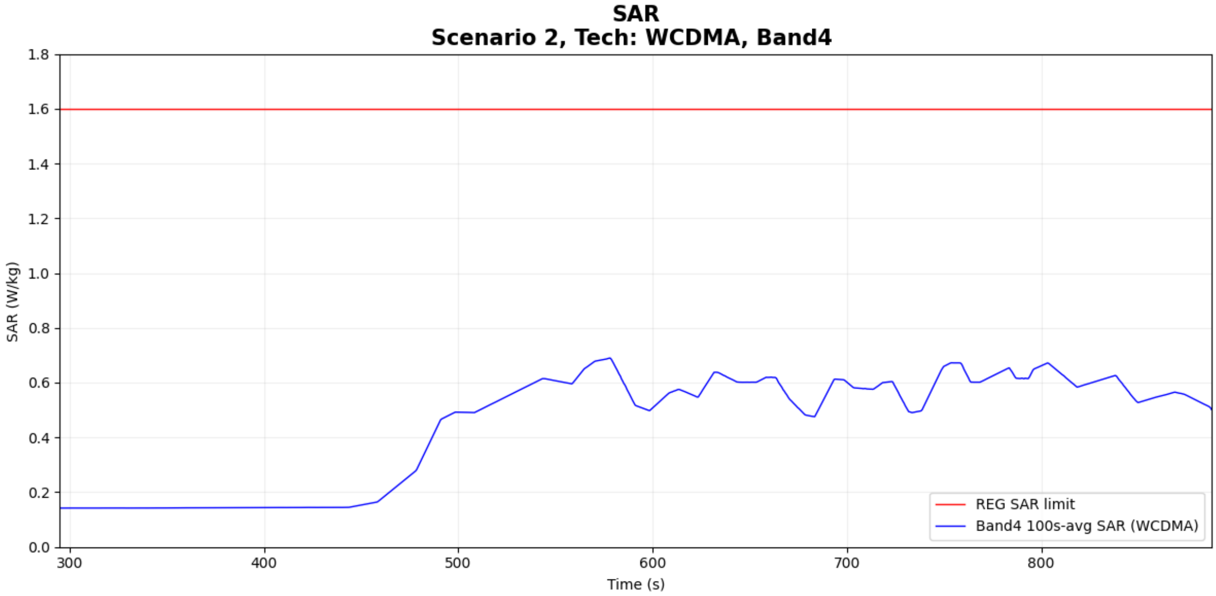


Figure 9-13 Time-averaged SAR for case 12 in table 9-1 (3G WCDMA B4)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.690 W/kg
Validation result: Pass	

9.2.4 SAR Measurement results for 2G GSM

- **Case 13 in table 9-1: 2G GSM 850 result for test sequence 1**

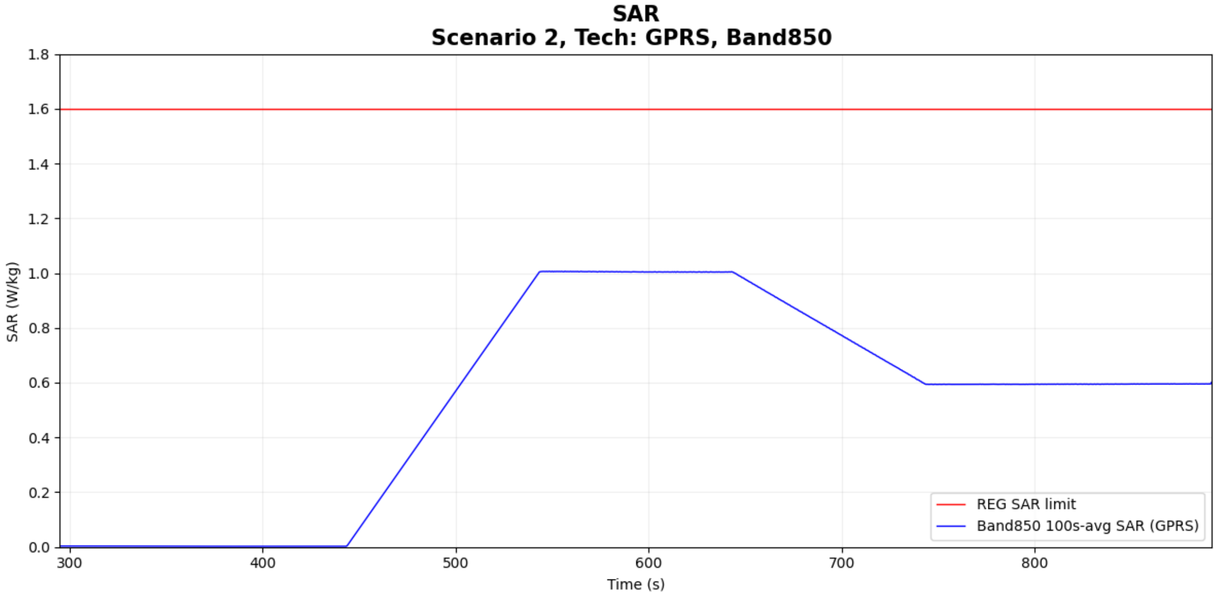


Figure 9-14 Time-averaged SAR for case 13 in table 9-1 (2G GSM 850)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	1.01 W/kg
Validation result: Pass	

- **Case 14 in table 9-1: 2G GSM 850 result for test sequence 2**

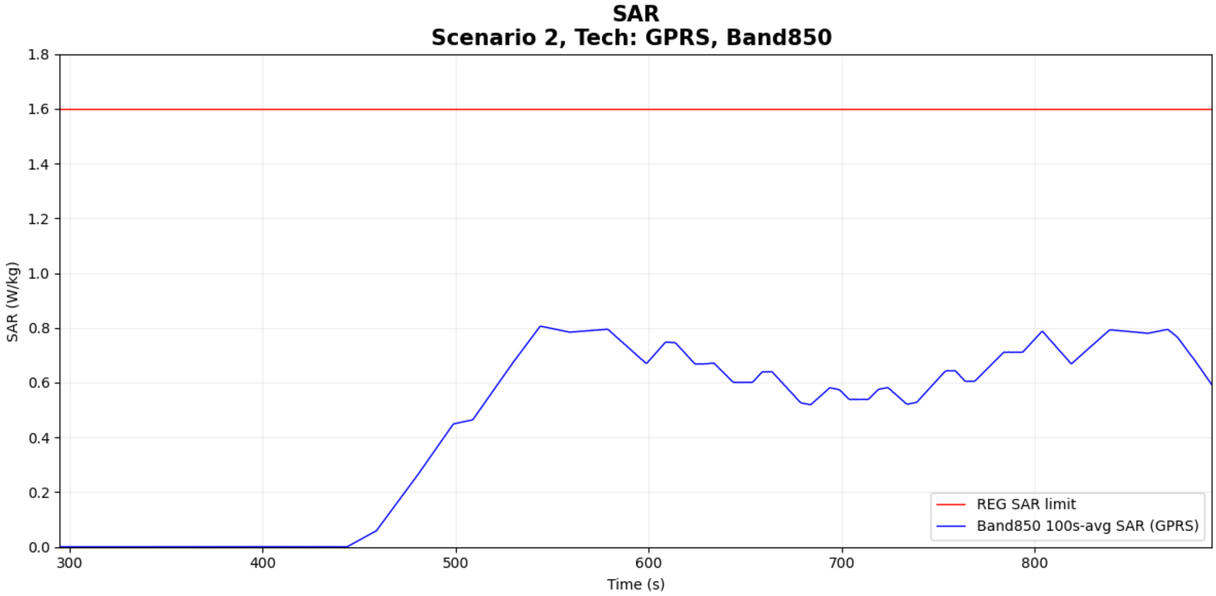


Figure 9-15 Time-averaged SAR for case 14 in table 9-1 (2G GSM 850)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	1.01 W/kg
Validation result: Pass	

- **Case 15 in table 9-1: 2G GSM 1900 result for test sequence 1**

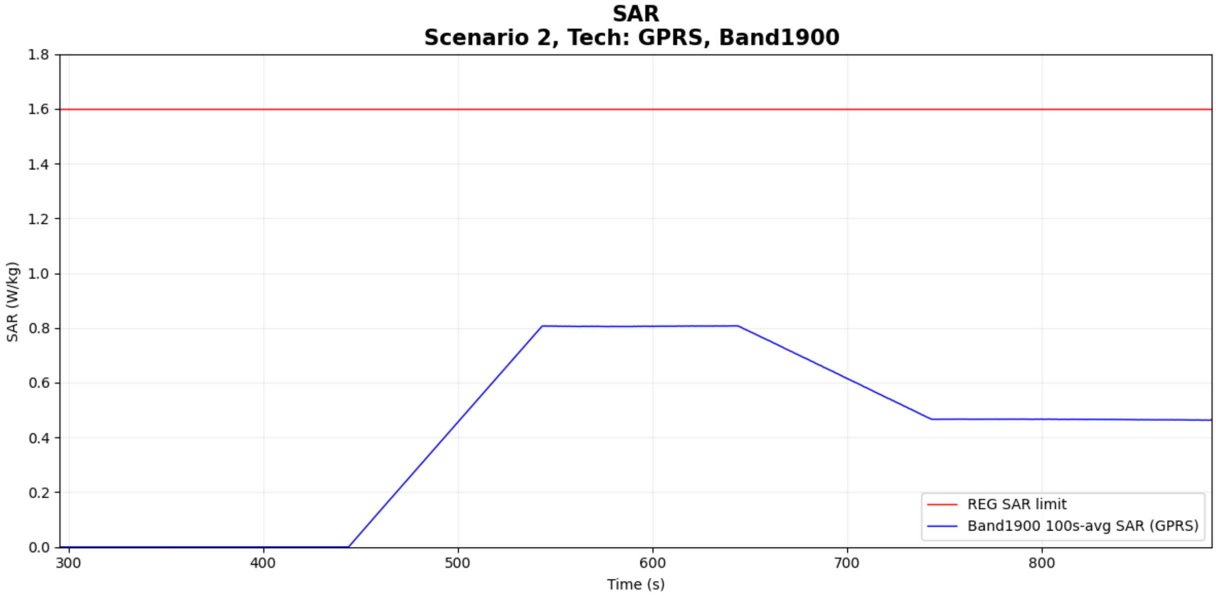


Figure 9-16 Time-averaged SAR for case 15 in table 9-1 (2G GSM 1900)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.807 W/kg
Validation result: Pass	

- **Case 16 in table 9-1: 2G GSM 1900 result for test sequence 2**

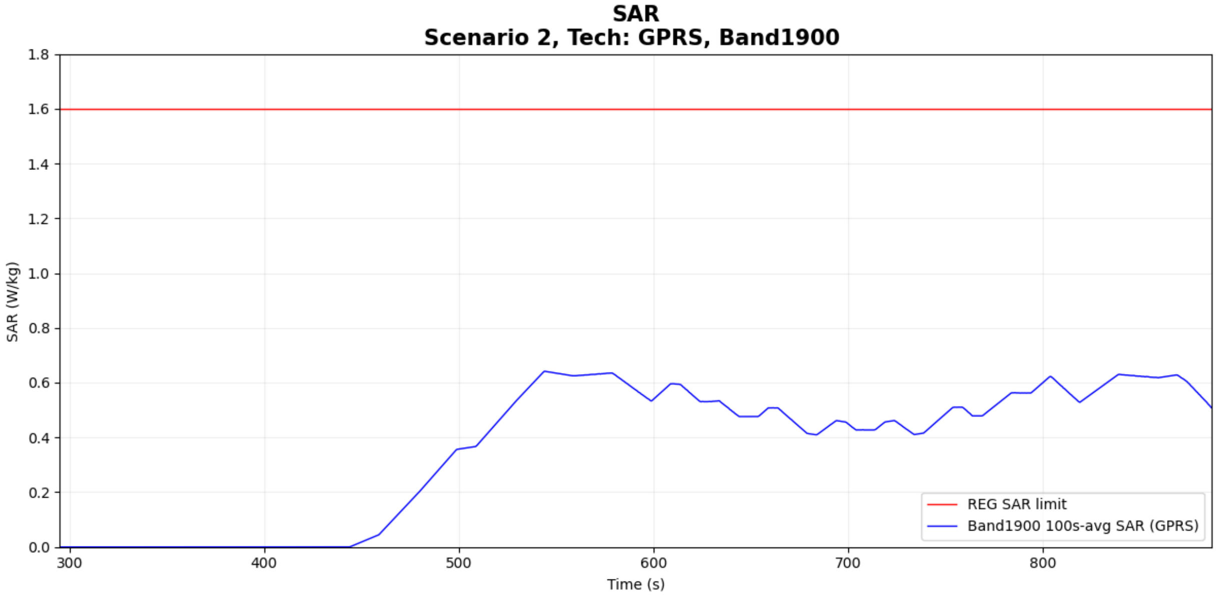


Figure 9-17 Time-averaged SAR for case 16 in table 9-1 (2G GSM 1900)

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.642 W/kg
Validation result: Pass	

10 TA-SAR/TA-PD Validation via SAR Measurements(WLAN)

10.1 Measurement Setup

The measurement setup is illustrated in section 8.1 and the lab SAR measurement photos are shown in Figure 9-1,9-2 and 9-3.

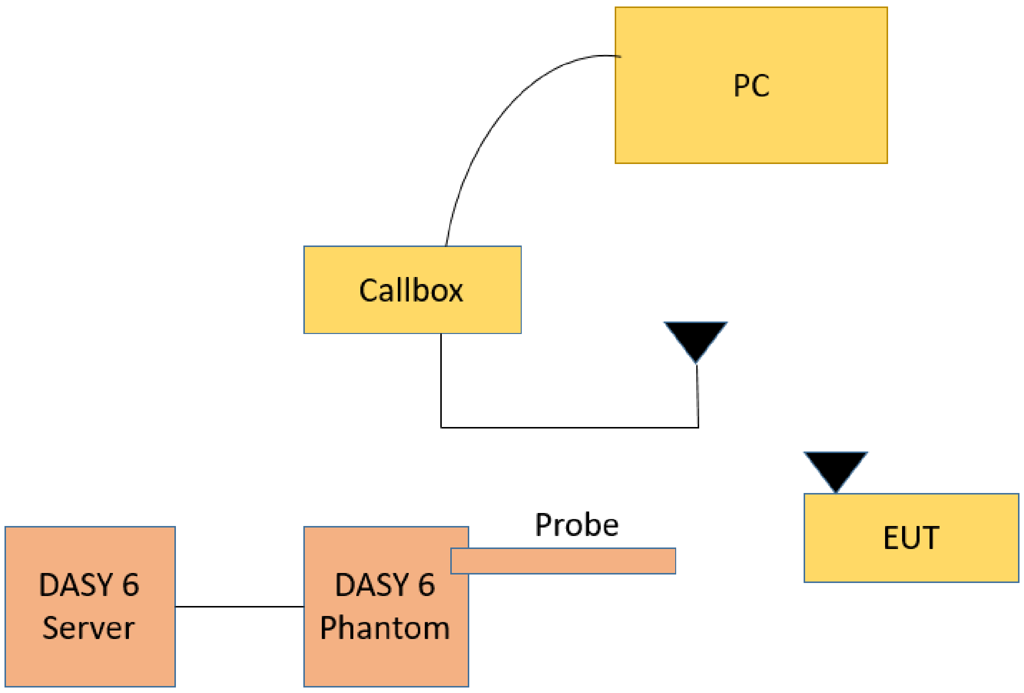


Figure 9-1 TA-SAR wireless test environment

10.2 SAR Measurement Results for Scenario 1: TX Mode Change between Nomal Mode and Sleep Mode

All of the measurements are conduct by using DASY6. The detailed setting is listed in Table 10-1, Figure 10-2 demonstrates scenario 1-1 of 2.4GHz band TA-SAR measurement result, Figure 10-3 demonstrates scenario 1-2-1 of 6GHz band TA-SAR measurement result.

Due to the small PD value, the DASY system is unable to perform TA-PD testing.

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

Test band	PWF_SAR_limit
2.4GHz	14Bm

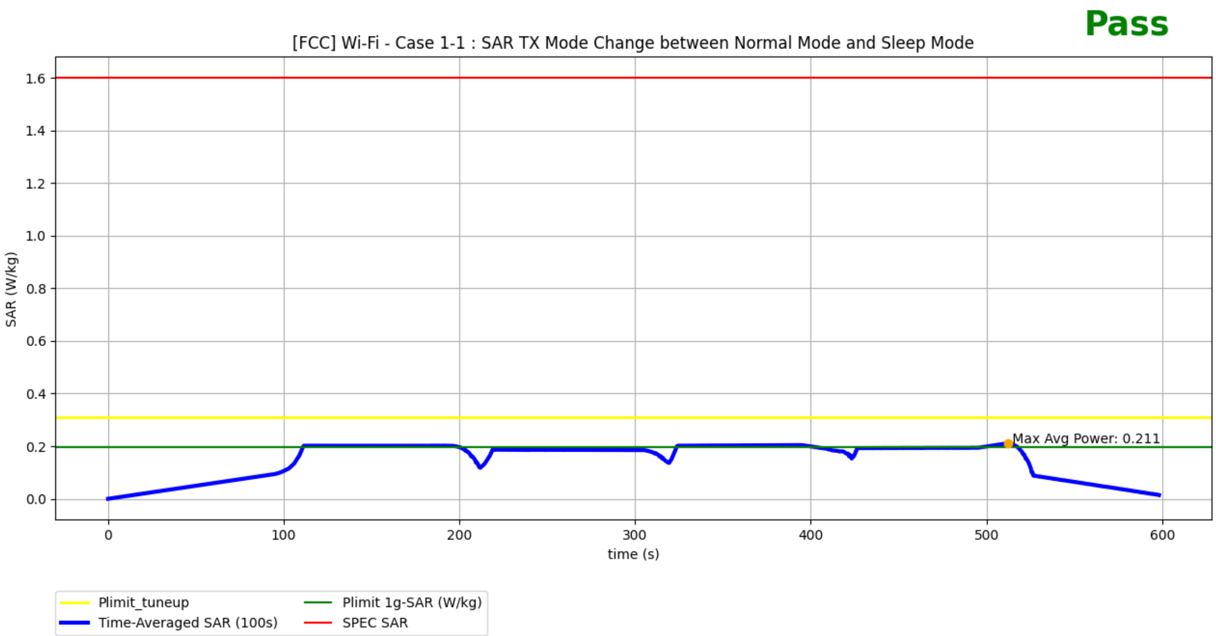


Figure 10-2 Time-averaged SAR measurement for scenario 1-1

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.211 W/kg
Validation result: Pass	

Table 10-2 TA-SAR parameters setting for test scenario 1-2-2

Test band	PWF_SAR_limit
6GHz	6dBm

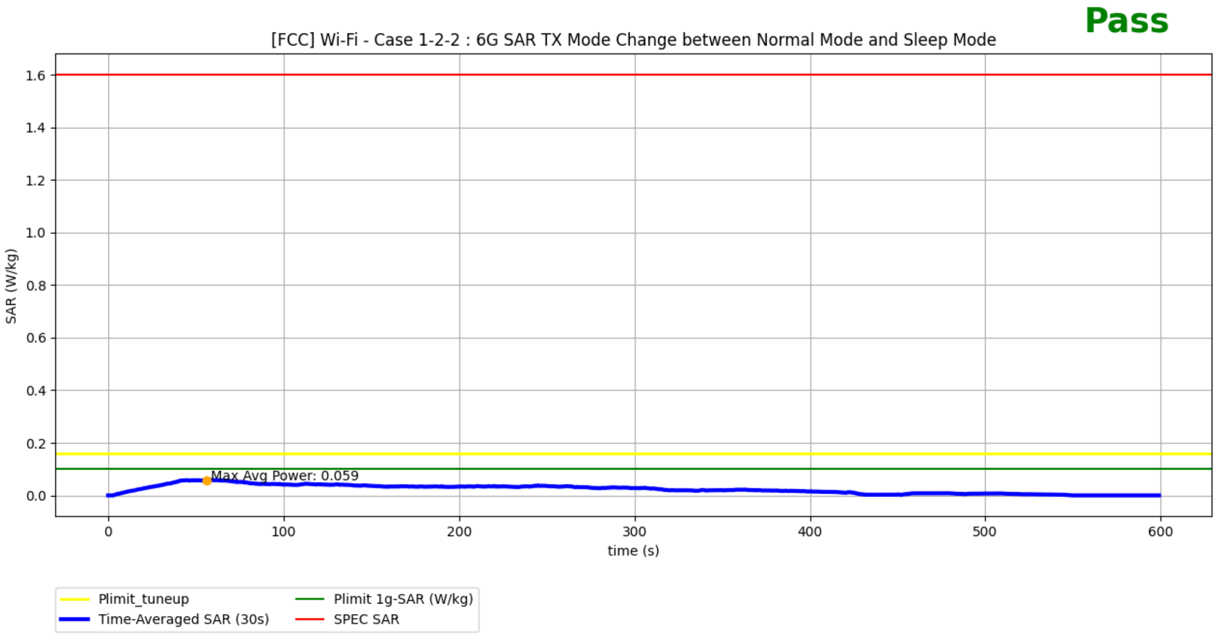


Figure 10-2 Time-averaged SAR measurement for scenario 1-1

FCC 1gSAR limit	1.6 W/kg
Max 100s-time averaged 1gSAR	0.059 W/kg
Validation result: Pass	

11 Conclusions

This document proposes TA-SAR/TA-PD test scenarios and procedures, and further proves Mediatek’s TA-SAR/TA-PD algorithms can meet the FCC SAR regulations with the proposed test scenarios and procedures. Mediatek’s TA-SAR/TA-PD algorithms are able to maintain SAR over time below the FCC regulatory limits (based on the agreed TX-power-to-SAR translation). Furthermore, the near-field measurements are also done in an FCC certified lab to further validate the proposed test methodologies, and the results shown in Chapters 9 and 10 demonstrate that Mediatek’s TA-SAR/TA-PD algorithms really can maintain SAR over time below the FCC regulatory limits under the proposed test procedures. Based on the provided measurement evidences, it is concluded that Mediatek’s TA-SAR/TA-PD algorithms can be tested by using the proposed test methodology for FCC compliance.

Appendix A Main Test Instruments

Table B-1 List of Main Instruments

	Name	Type	Serial Number	Calibration Date	Valid Period
01	Network analyzer	N5239A	MY55491241	May 21, 2024	One year
02	Power sensor	NRP50S	101488	June 5, 2024	One year
03	Power sensor	NRP50S	101489		
04	Signal Generator	MG3700A	6201052605	June 12 2024	One Year
05	Amplifier	60S1G4	0331848	No Calibration Requested	
06	Dual directional coupler	778D	MY48220216	No Calibration Requested	
07	Dual directional coupler	772D	MY46151265	No Calibration Requested	
08	BTS	CMW500	172116	April 9, 2024	One year
09	5G Wireless Test Platform	E7515B	MY60192696	August 23,2024	One year
10	DAE	SPEAG DAE4	1525	September 13,2024	One year
11	DAE	SPEAG DAE4	1556	January 3,2024	One year
12	E-field Probe	SPEAG EX3DV4	7464	January 22,2024	One year
13	EummWV Probe	EummWV4	9492	May 28, 2024	One year
14	Dipole Validation Kit	SPEAG D835V2	4d069	July 9,2024	One year
15	Dipole Validation Kit	SPEAG D1750V2	1003	July 11,2024	One year
16	Dipole Validation Kit	SPEAG D1900V2	5d101	July 8,2024	One year
17	Dipole Validation Kit	SPEAG D2600V2	1012	July 10,2024	One year
18	Dipole Validation Kit	SPEAG D2450V2	853	July 10,2024	One year
19	Dipole Validation Kit	SPEAG D6.5GHzV2	1059	December 01,2021	Three year
20	5G Verification Source	10 GHz	1005	January 18，2024	One year

Appendix B Tissue Simulating Liquids

Table B-1 List of Main Instruments

Measurement Date (yyyy-mm-dd)	Type	Frequency	Permittivity ε	Drift (%)	Conductivity σ (S/m)	Drift (%)
2024/10/15	Head	835 MHz	41.16	-0.82	0.889	-1.22
2024/10/16	Head	1750 MHz	41.2	2.79	1.378	0.58
2024/10/16	Head	1900 MHz	40.2	0.50	1.377	-1.64
2024/10/16	Head	2600 MHz	38.68	-0.85	1.955	-0.26
2024/11/16	Head	2450 MHz	38.68	-1.33	1.805	0.28
2024/11/16	Head	6.5 GHz	33.6	-2.61	6.15	1.32

Appendix C System Validation (SAR)

Measurement Date (yyyy-mm-dd)	Frequency	Target value (W/kg)		Measured value(W/kg)		Deviation	
		10 g Average	1 g Average	10 g Average	1 g Average	10 g Average	1 g Average
2024/10/15	835 MHz	6.09	9.47	6.20	9.56	1.81%	0.95%
2024/10/16	1750 MHz	19.8	37.2	19.2	36.0	-2.83%	-3.12%
2024/10/16	1900 MHz	20.6	39.1	20.3	39.2	-1.36%	0.15%
2024/10/16	2600 MHz	24.8	54.9	25.0	55.6	0.65%	1.28%
2024/11/16	2450 MHz	24.5	52.2	23.6	52.4	-3.51%	0.38%
2024/11/16	6.5 GHz	53.3	289.0	51.6	286.0	-3.19%	-1.04%

Appendix D System Validation (PD)

Date	Frequency (GHz)	5G Verification Source	Probe S/N	Distance (mm)	Measured 4cm^2 (W/m^2)	Targeted 4cm^2 (W/m^2)	Deviation (db)
2024/11/20	10	10GHz_1005	9492	10	57.1	55.5	0.12

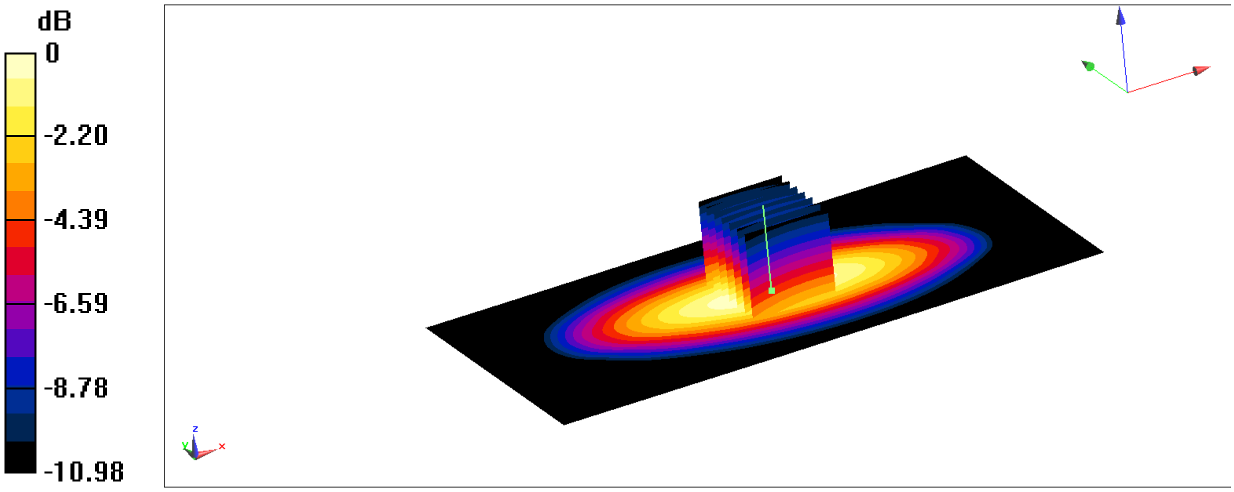
Appendix E System Validation Results

835MHz

Date: 10/15/2024
Electronics: DAE4 Sn1525
Medium: H700-6000M
Medium parameters used: f = 835 MHz; σ = 0.889 S/m; εr = 41.16; ρ = 1000 kg/m3
Ambient Temperature:23.3ºC Liquid Temperature: 22.5ºC
Communication System: UID 0, CW (0) Frequency: 835 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN7464 ConvF(8.69, 9.48, 9.34)

Area Scan (131x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 3.21 W/kg

Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 59.61 V/m; Power Drift = -0.09 dB
Peak SAR (extrapolated) = 3.61 W/kg
SAR(1 g) = 2.39 W/kg; SAR(10 g) = 1.55 W/kg
Maximum value of SAR (measured) = 3.19 W/kg



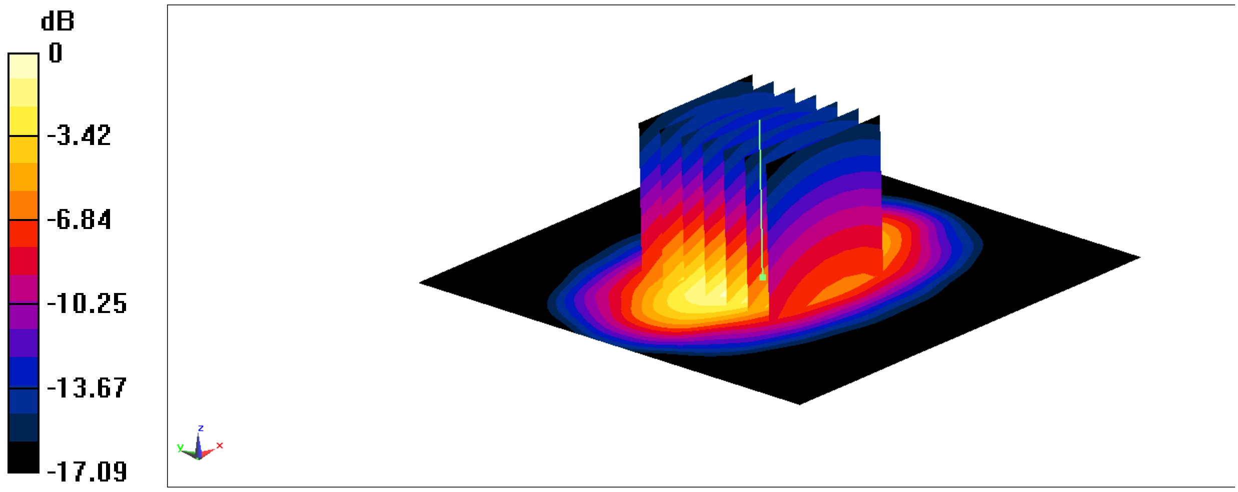
0 dB = 3.19 W/kg = 5.04 dBW/kg

1750MHz

Date: 10/16/2024
Electronics: DAE4 Sn1525
Medium: H700-6000M
Medium parameters used: f = 1750 MHz; σ = 1.378 S/m; εr = 41.2; ρ = 1000 kg/m3
Ambient Temperature:23.3ºC Liquid Temperature: 22.5ºC
Communication System: UID 0, CW (0) Frequency: 1750 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN7464 ConvF(7.99, 8.13, 8.29)

Area Scan (61x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 14.3 W/kg

Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 98.17 V/m; Power Drift = -0.15 dB
Peak SAR (extrapolated) = 16.8 W/kg
SAR(1 g) = 9.01 W/kg; SAR(10 g) = 4.81 W/kg
Maximum value of SAR (measured) = 13.9 W/kg



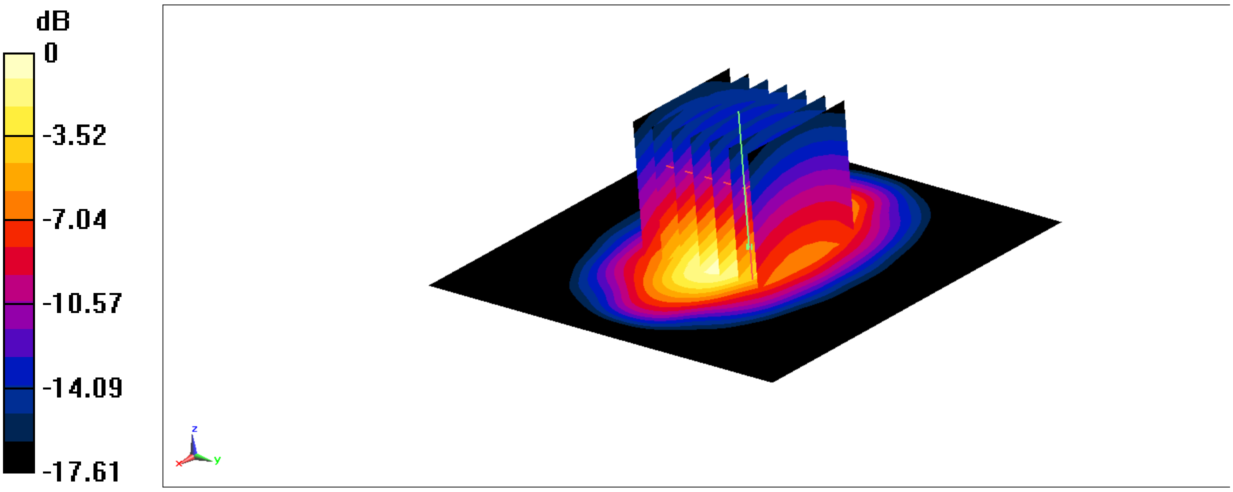
0 dB = 13.9 W/kg = 11.43 dBW/kg

1900MHz

Date: 10/16/2024
Electronics: DAE4 Sn1525
Medium: H700-6000M
Medium parameters used: f = 1900 MHz; σ = 1.377 S/m; εr = 40.2; ρ = 1000 kg/m3
Ambient Temperature:23.3°C Liquid Temperature: 22.5°C
Communication System: UID 0, CW (0) Frequency: 1900 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN7464 ConvF(7.64, 7.81, 7.99)

Area Scan (61x61x1): Interpolated grid: dx=1.500 mm, dy=1.500 mm
Maximum value of SAR (interpolated) = 15.4 W/kg

Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 101.2 V/m; Power Drift = 0.17 dB
Peak SAR (extrapolated) = 18.5 W/kg
SAR(1 g) = 9.79 W/kg; SAR(10 g) = 5.08 W/kg
Maximum value of SAR (measured) = 15.4 W/kg



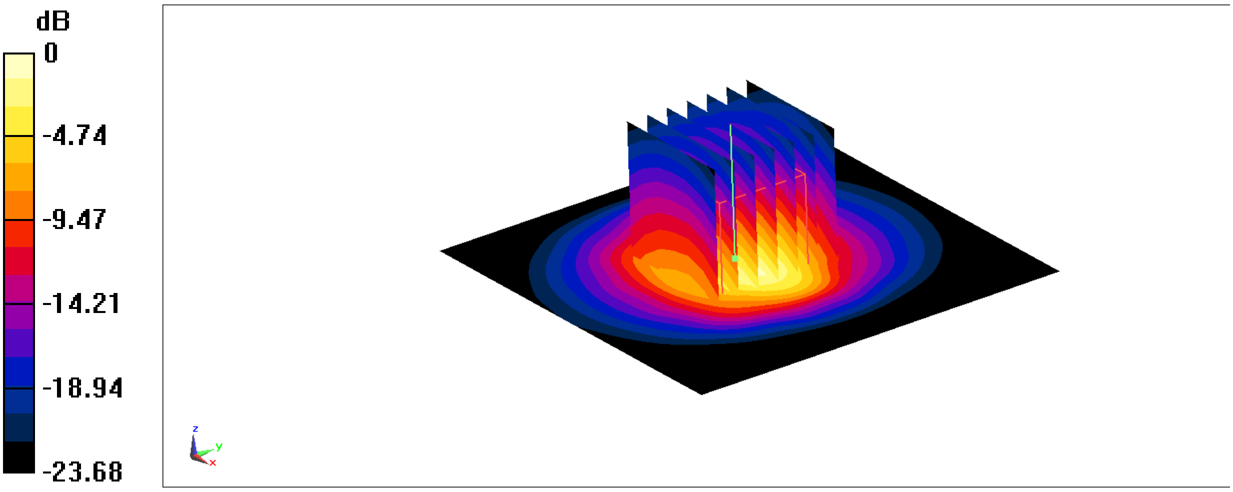
0 dB = 15.4 W/kg = 11.88 dBW/kg

2600MHz

Date: 10/16/2024
Electronics: DAE4 Sn1525
Medium: H700-6000M
Medium parameters used: f = 2600 MHz; σ = 1.955 S/m; εr = 38.68; ρ = 1000 kg/m3
Ambient Temperature:23.3ºC Liquid Temperature: 22.5ºC
Communication System: UID 0, CW (0) Frequency: 2600 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN7464 ConvF(7.34, 7.45, 7.58)

Area Scan (61x61x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 23.3 W/kg

Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 106.1 V/m; Power Drift = 0.07 dB
Peak SAR (extrapolated) = 29.8 W/kg
SAR(1 g) = 13.9 W/kg; SAR(10 g) = 6.24 W/kg
Maximum value of SAR (measured) = 23.8 W/kg



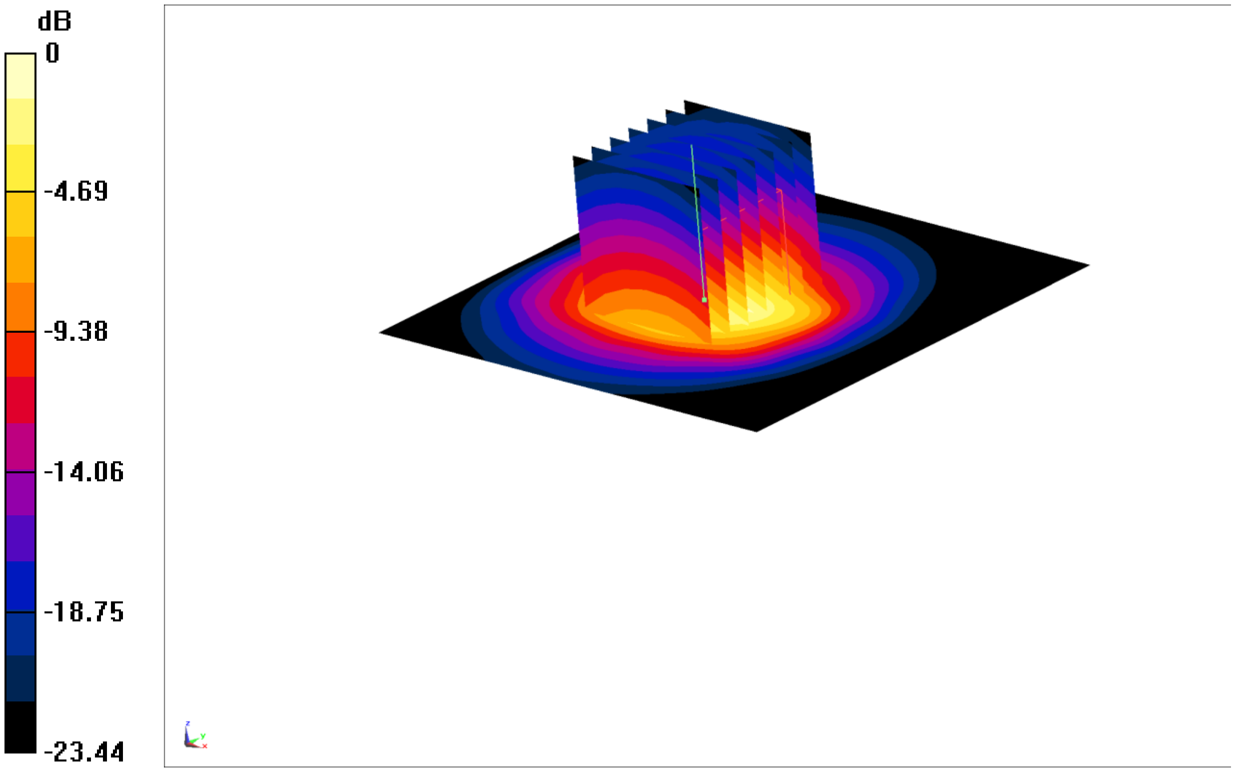
0 dB = 23.8 W/kg = 13.77 dBW/kg

2450MHz

Date: 11/16/2024
Electronics: DAE4 Sn1525
Medium: H700-6000M
Medium parameters used: f = 2450 MHz; σ = 1.805 S/m; εr = 38.68; ρ = 1000 kg/m3
Ambient Temperature:23.3ºC   Liquid Temperature: 22.5ºC
Communication System: UID 0, CW (0) Frequency: 2450 MHz Duty Cycle: 1:1
Probe: EX3DV4 – SN7464 ConvF(7.63, 7.75, 7.92)

Area Scan (61x61x1): Interpolated grid: dx=1.200 mm, dy=1.200 mm
Maximum value of SAR (interpolated) = 21.9 W/kg

Zoom Scan (7x7x7) (7x7x7)/Cube 0: Measurement grid: dx=5mm, dy=5mm, dz=5mm
Reference Value = 100.7 V/m; Power Drift = -0.05 dB
Peak SAR (extrapolated) = 28.6 W/kg
SAR(1 g) = 13.1 W/kg; SAR(10 g) = 5.91 W/kg
Maximum value of SAR (measured) = 22.5 W/kg



0 dB = 22.5 W/kg = 13.52 dBW/kg

6.5GHz

Device Under Test Properties

Model, Manufacturer	Dimensions [mm]	IMEI	DUT Type
Device,	80.0 x 80.0 x 8.0		Phone

Exposure Conditions

Phantom Section, TSL	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz], Channel Number	Conversion Factor	TSL Conductivity [S/m]	TSL Permittivity
Flat, Head Simulating Liquid	FRONT, 5.00	D6.5GHz	CW, 0--	6500.000, 50	5.18	6.15	33.6

Hardware Setup

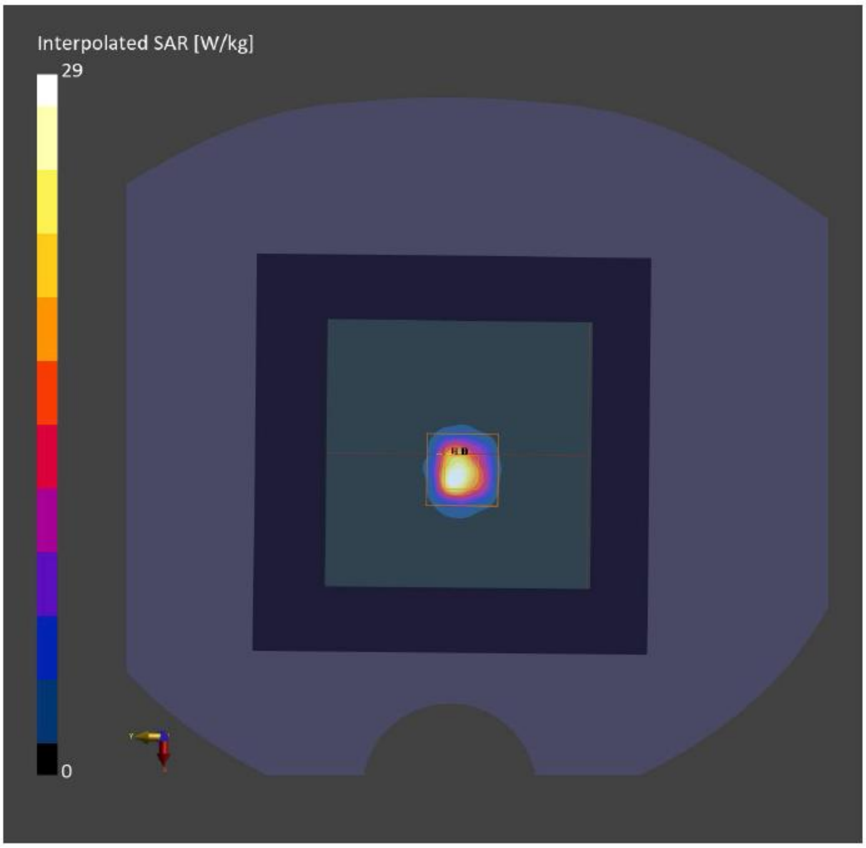
Phantom	TSL, Measured Date	Probe, Calibration Date	DAE, Calibration Date
Twin-SAM V4.0 (30deg probe tilt) - 1456	HBBL-600-10000 Charge:xxxx, --	EX3DV4 - SN7464, 2024-01-22	DAE4 Sn1556, 2024-01-03

Scans Setup

	Area Scan	Zoom Scan
Grid Extents [mm]	119.0 x 119.0	22.0 x 22.0 x 22.0
Grid Steps [mm]	8.5 x 8.5	3.4 x 3.4 x 1.4
Sensor Surface [mm]	3.0	1.4
Graded Grid	N/A	Yes
Grading Ratio	N/A	1.4
MAIA	N/A	N/A
Surface Detection	VMS + 6p	VMS + 6p
Scan Method	Measured	Measured

Measurement Results

	Area Scan	Zoom Scan
Date	2024-11-16, 13:47	2024-11-16, 14:02
psSAR1g [W/Kg]	19.9	29.8
psSAR10g [W/Kg]	4.75	5.86
Power Drift [dB]	0.02	0.03
Power Scaling	Disabled	Disabled
Scaling Factor [dB]		
TSL Correction	No correction	No correction
M2/M1 [%]		51.5
Dist 3dB Peak [mm]		4.9



10GHz

Device Under Test Properties

Model, Manufacturer	Dimensions [mm]	IMEI	DUT Type
Device,	100.0 x 100.0 x 100.0		Phone

Exposure Conditions

Phantom Section	Position, Test Distance [mm]	Band	Group, UID	Frequency [MHz], Channel Number	Conversion Factor
5G	FRONT, 2.00	Validation band	CW, 0--	10000.0, 10000	1.0

Hardware Setup

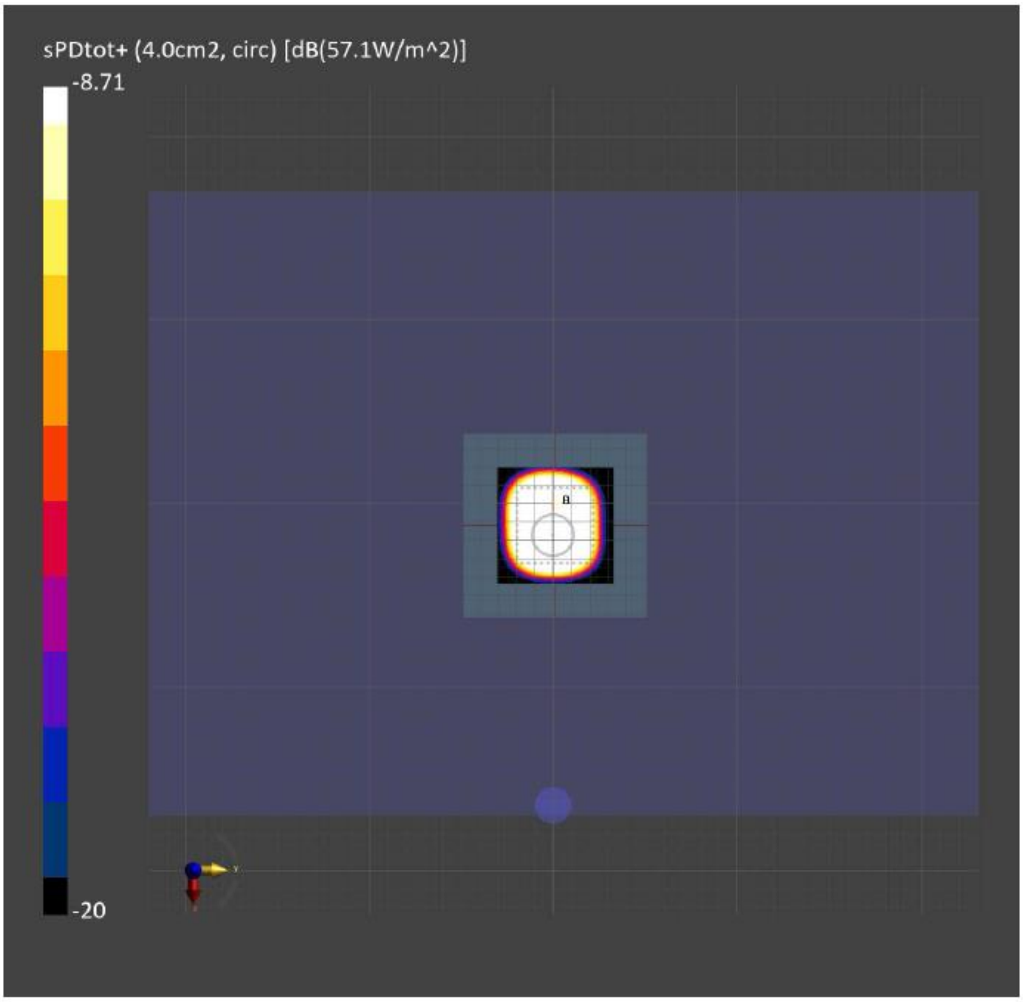
Phantom	Medium	Probe, Calibration Date	DAE, Calibration Date
mmWave - xxxx	Air -	EUmmWV4 - SN9492_F1-55GHz, 2024-05-28	DAE4 Sn1556, 2024-01-03

Scans Setup

Scan Type	5G Scan
Grid Extents [mm]	60.0 x 60.0
Grid Steps [lambda]	0.06808848581238543 x 0.06808848581238543
Sensor Surface [mm]	2.0
MAIA	N/A

Measurement Results

Scan Type	5G Scan
Date	2024-11-20, 14:27
Avg. Area [cm2]	4.00
psPDn+ [W/m2]	56.8
psPDtot+ [W/m2]	57.1
psPDmod+ [W/m2]	57.3
E_{max} [V/m]	155
Power Drift [dB]	0.01



ANNEX F Probe Calibration Certificate

Probe 7464 Calibration Certificate

Calibration Laboratory of
Schmid & Partner
Engineering AG
Zeughausstrasse 43, 8004 Zurich, Switzerland

S Schweizerischer Kalibrierdienst
C Service suisse d'étalonnage
Servizio svizzero di taratura
S Swiss Calibration Service

Accredited by the Swiss Accreditation Service (SAS)
The Swiss Accreditation Service is one of the signatories to the EA Multilateral Agreement for the recognition of calibration certificates

Accreditation No.: **SCS 0108**

Client **CTTL**
Beijing

Certificate No. **EX-7464_Jan24**

CALIBRATION CERTIFICATE

Object	EX3DV4 - SN:7464
Calibration procedure(s)	QA CAL-01.v10, QA CAL-12.v10, QA CAL-14.v7, QA CAL-23.v6, QA CAL-25.v8 Calibration procedure for dosimetric E-field probes
Calibration date	January 22, 2024

This calibration certificate documents the traceability to national standards, which realize the physical units of measurements (SI).
The measurements and the uncertainties with confidence probability are given on the following pages and are part of the certificate.

All calibrations have been conducted in the closed laboratory facility: environment temperature (22 ± 3)℃ and humidity < 70%.

Calibration Equipment used (M&TE critical for calibration)

Primary Standards	ID	Cal Date (Certificate No.)	Scheduled Calibration
Power meter NRP2	SN: 104778	30-Mar-23 (No. 217-03804/03805)	Mar-24
Power sensor NRP-Z91	SN: 103244	30-Mar-23 (No. 217-03804)	Mar-24
OCP DAK-3.5 (weighted)	SN: 1249	05-Oct-23 (OCP-DAK3.5-1249_Oct23)	Oct-24
OCP DAK-12	SN: 1016	05-Oct-23 (OCP-DAK12-1016_Oct23)	Oct-24
Reference 20 dB Attenuator	SN: CC2552 (20x)	30-Mar-23 (No. 217-03809)	Mar-24
DAE4	SN: 660	16-Mar-23 (No. DAE4-660_Mar23)	Mar-24
Reference Probe EX3DV4	SN: 7349	03-Nov-23 (No. EX3-7349_Nov23)	Nov-24

Secondary Standards	ID	Check Date (in house)	Scheduled Check
Power meter E4419B	SN: GB41293874	06-Apr-16 (in house check Jun-22)	In house check: Jun-24
Power sensor E4412A	SN: MY41498087	06-Apr-16 (in house check Jun-22)	In house check: Jun-24
Power sensor E4412A	SN: 000110210	06-Apr-16 (in house check Jun-22)	In house check: Jun-24
RF generator HP 8648C	SN: US3642U01700	04-Aug-99 (in house check Jun-22)	In house check: Jun-24
Network Analyzer E8358A	SN: US41080477	31-Mar-14 (in house check Oct-22)	In house check: Oct-24

	Name	Function	Signature
Calibrated by	Joanna Lleshaj	Laboratory Technician	
Approved by	Sven Kühn	Technical Manager	

Issued: January 24, 2024

This calibration certificate shall not be reproduced except in full without written approval of the laboratory.

Certificate No: EX-7464_Jan24 Page 1 of 23

Calibration Laboratory of
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Engineering AG
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Accreditation No.: **SCS 0108**

Glossary

TSL	tissue simulating liquid
NORMx,y,z	sensitivity in free space
ConvF	sensitivity in TSL / NORMx,y,z
DCP	diode compression point
CF	crest factor (1/duty_cycle) of the RF signal
A, B, C, D	modulation dependent linearization parameters
Polarization φ	φ rotation around probe axis
Polarization ϑ	ϑ rotation around an axis that is in the plane normal to probe axis (at measurement center), i.e., $\vartheta = 0$ is normal to probe axis
Connector Angle	information used in DASY system to align probe sensor X to the robot coordinate system

Calibration is Performed According to the Following Standards:

a) IEC/IEEE 62209-1528, "Measurement Procedure For The Assessment Of Specific Absorption Rate Of Human Exposure To Radio Frequency Fields From Hand-Held And Body-Worn Wireless Communication Devices – Part 1528: Human Models, Instrumentation And Procedures (Frequency Range of 4 MHz to 10 GHz)", October 2020.
b) KDB 865664, "SAR Measurement Requirements for 100 MHz to 6 GHz"

Methods Applied and Interpretation of Parameters:

- *NORMx,y,z*: Assessed for E-field polarization $\vartheta = 0$ ($f \leq 900$ MHz in TEM-cell; $f > 1800$ MHz: R22 waveguide). NORMx,y,z are only intermediate values, i.e., the uncertainties of NORMx,y,z does not affect the E^2-field uncertainty inside TSL (see below *ConvF*).
- *NORM(f)x,y,z = NORMx,y,z * frequency_response* (see Frequency Response Chart). This linearization is implemented in DASY4 software versions later than 4.2. The uncertainty of the frequency response is included in the stated uncertainty of ConvF.
- *DCPx,y,z*: DCP are numerical linearization parameters assessed based on the data of power sweep with CW signal. DCP does not depend on frequency nor media.
- *PAR*: PAR is the Peak to Average Ratio that is not calibrated but determined based on the signal characteristics
- *Ax,y,z; Bx,y,z; Cx,y,z; Dx,y,z; VRx,y,z: A, B, C, D* are numerical linearization parameters assessed based on the data of power sweep for specific modulation signal. The parameters do not depend on frequency nor media. VR is the maximum calibration range expressed in RMS voltage across the diode.
- *ConvF and Boundary Effect Parameters*: Assessed in flat phantom using E-field (or Temperature Transfer Standard for $f \leq 800$ MHz) and inside waveguide using analytical field distributions based on power measurements for $f > 800$ MHz. The same setups are used for assessment of the parameters applied for boundary compensation (alpha, depth) of which typical uncertainty values are given. These parameters are used in DASY4 software to improve probe accuracy close to the boundary. The sensitivity in TSL corresponds to *NORMx,y,z * ConvF* whereby the uncertainty corresponds to that given for *ConvF*. A frequency dependent *ConvF* is used in DASY version 4.4 and higher which allows extending the validity from ± 50 MHz to ± 100 MHz.
- *Spherical isotropy (3D deviation from isotropy)*: in a field of low gradients realized using a flat phantom exposed by a patch antenna.
- *Sensor Offset*: The sensor offset corresponds to the offset of virtual measurement center from the probe tip (on probe axis). No tolerance required.
- *Connector Angle*: The angle is assessed using the information gained by determining the *NORMx* (no uncertainty required).

Parameters of Probe: EX3DV4 - SN:7464

Basic Calibration Parameters

	Sensor X	Sensor Y	Sensor Z	Unc ($k = 2$)
Norm (μV/(V/m)^2) [A]	0.47	0.45	0.46	±10.1%
DCP (mV) [B]	99.7	100.5	100.4	±4.7%

Calibration Results for Modulation Response

UID	Communication System Name		A dB	B dB$\sqrt{\mu V}$	C	D dB	VR mV	Max dev.	Max Unc[E] $k = 2$
0	CW	X	0.00	0.00	1.00	0.00	119.1	±2.0%	±4.7%
		Y	0.00	0.00	1.00		137.6		
		Z	0.00	0.00	1.00		116.5		
10352	Pulse Waveform (200Hz, 10%)	X	18.57	89.69	20.49	10.00	60.0	±2.7%	±9.6%
		Y	20.00	93.91	22.75		60.0		
		Z	20.00	92.74	22.54		60.0		
10353	Pulse Waveform (200Hz, 20%)	X	20.00	90.77	19.55	6.99	80.0	±1.4%	±9.6%
		Y	20.00	98.49	24.17		80.0		
		Z	20.00	92.95	21.35		80.0		
10354	Pulse Waveform (200Hz, 40%)	X	20.00	93.60	19.50	3.98	95.0	±1.6%	±9.6%
		Y	20.00	110.50	28.77		95.0		
		Z	20.00	95.00	20.85		95.0		
10355	Pulse Waveform (200Hz, 60%)	X	20.00	96.22	19.51	2.22	120.0	±1.6%	±9.6%
		Y	20.00	133.23	37.93		120.0		
		Z	20.00	99.33	21.57		120.0		
10387	QPSK Waveform, 1 MHz	X	1.90	66.53	15.71	1.00	150.0	±1.6%	±9.6%
		Y	2.23	69.84	17.98		150.0		
		Z	1.96	66.48	15.85		150.0		
10388	QPSK Waveform, 10 MHz	X	2.56	69.56	16.46	0.00	150.0	±0.9%	±9.6%
		Y	3.31	74.50	19.22		150.0		
		Z	2.65	69.90	16.61		150.0		
10396	64-QAM Waveform, 100 kHz	X	3.42	71.74	19.12	3.01	150.0	±0.7%	±9.6%
		Y	4.98	79.46	22.89		150.0		
		Z	4.16	74.48	20.31		150.0		
10399	64-QAM Waveform, 40 MHz	X	3.59	67.28	15.89	0.00	150.0	±1.0%	±9.6%
		Y	3.96	69.24	17.20		150.0		
		Z	3.64	67.41	15.98		150.0		
10414	WLAN CCDF, 64-QAM, 40 MHz	X	5.01	65.58	15.52	0.00	150.0	±1.9%	±9.6%
		Y	5.19	66.39	16.16		150.0		
		Z	5.06	65.58	15.53		150.0		

Note: For details on UID parameters see Appendix

The reported uncertainty of measurement is stated as the standard uncertainty of measurement multiplied by the coverage factor k=2, which for a normal distribution corresponds to a coverage probability of approximately 95%.

[A] The uncertainties of Norm X,Y,Z do not affect the E^2-field uncertainty inside TSL (see Pages 5 to 7).
[B] Linearization parameter uncertainty for maximum specified field strength.
[E] Uncertainty is determined using the max. deviation from linear response applying rectangular distribution and is expressed for the square of the field value.

