

ISED TAS validation – Part 2:

Tests under dynamic transmit power scenarios

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

Equipment Under Test	SAMSUNG Mobile Phone
Brand Name	Galaxy A Series
Model No.	SM-A156W
Applicant	SAMSUNG Electronics Co., Ltd. 129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Rep. of Korea
ISED ID	649E-SMA156W
Date of Receipt	Oct. 05, 2023
Date of Test(s)	Oct. 24, 2023 ~ Oct. 29, 2023
Date of Issue	Nov. 21, 2023

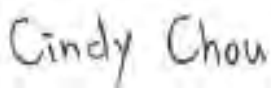
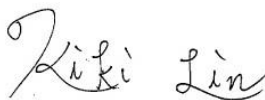
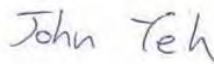
In the configuration tested, the EUT complied with the standards specified above.

Remarks:

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Signed on behalf of SGS

Clerk / Cindy Chou	PM / Kiki Lin	Approved By / John Yeh
		

Date: Nov. 21, 2023

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Note:

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

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1. General Information

1.1 Testing Laboratory

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

Note: Test site name is remarked on the equipment list in each section of this report as an indication where measurements occurred in specific test site and address.

1.2 Details of Applicant

Company Name	SAMSUNG Electronics Co., Ltd.
Company Address	129, Samsung-ro, Yeongtong-gu, Suwon-si, Gyeonggi-do, 16677, Rep. of Korea

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2. Overview

This report define the test plan, test procedures and measurement setup for the validation of the proposed TA-SAR (time-averaged specific absorption rate) algorithm. The measurement results are provided as well to show that the requirements defined by ISED can be all met. The algorithm introduction and its operating parameters, the overview of the test scenarios defined in SPR-004 is given in Chapter 2/3. The test procedures for conducted power measurements and single point SAR measurements are described in Chapter 4. For the TA-SAR algorithm validation, the conducted power measurement setup and the corresponding measurement results are included in Chapter 5, while the single point SAR measurement setup and the measurement results SAR are included in Chapter 6. It is concluded in Chapter 7 that the proposed TA-SAR algorithm can realize dynamic power control to ensure ISED compliance in real-time.

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3. Operating Parameters for Algorithm Validation

Mediatek developed a TA-SAR algorithm to control instantaneous TX power for operating frequencies less than 6GHz, so that the total time-averaged RF exposures (i.e., SAR) are less than the ISED requirements.

3.1 Algorithm Description

The proposed TA-SAR algorithm uses intelligent TX power control to accomplish RF exposure compliance. The basic concept of algorithm is, if time-averaged TX power approaches a predefined TX power limit which is mapped from SAR limit, the instantaneous TX power will be constrained to ensure that the time-averaged TX power is always less than the predefined TX limit. To ease the explanation of the algorithm, the algorithm parameters, based on SPR-004, are summarized in Table 3-1.

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Table 3-1 TA-SAR operating parameters

Algorithm parameters	Description
$P_{limit,nom}$ (dBm)	<p>The nominal time-averaged maximum power level limit for the algorithm operations.</p> <ul style="list-style-type: none"> • $P_{limit,nom}$ corresponds to $SAR_{target,nom}$, which is the nominal maximum 1g or 10g peak spatial-averaged SAR(psSAR) target ($SAR_{target,nom}$ is obtained by scaling down from SAR_{target} with uncertainty). • According to SPR-004, SAR_{target} is the maximum 1g or 10g psSAR target to ensure SAR compliance and corresponds to P_{limit} or P_{max}, whichever is lower. • According to SPR-004, P_{limit} is the maximum time-averaged output power specified to ensure SAR compliance (P_{limit} is obtained by scaling up $P_{limit,nom}$ with uncertainty). <p>According to SPR-004, P_{max} is the maximum instantaneous output power that the transmitter can produce and can be obtained by scaling up $P_{max,nom}$ with uncertainty, where $P_{max,nom}$ is the nominal maximum instantaneous output power associated with the EUT.</p>

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$P_{UE_max_cust}$ (dBm)	Customized maximum instantaneous TX power limit, which is less than or equal to maximum TX power, at which the EUT can possibly transmit with TA-SAR enabled. <ul style="list-style-type: none"> • $P_{UE_max_cust} = \min (P_{max,nom}, P_{limit,nom} + P_{UE_max_cust_offset})$ • $P_{max,nom}$ is nominal maximum TX power at which the EUT can possibly transmit. • $P_{UE_max_cust_offset}$ is a TA-SAR operating parameter adjusted by an OEM and defined in Table 3-2.
$P_{LowThresh}$ (dBm)	Reference threshold for deactivating power backoff.
$P_{UE_backoff}$ (dBm)	Max instantaneous TX power limit when power backoff is activated.

A typical behavior of the TA-SAR algorithm is shown in Figure 3-1.

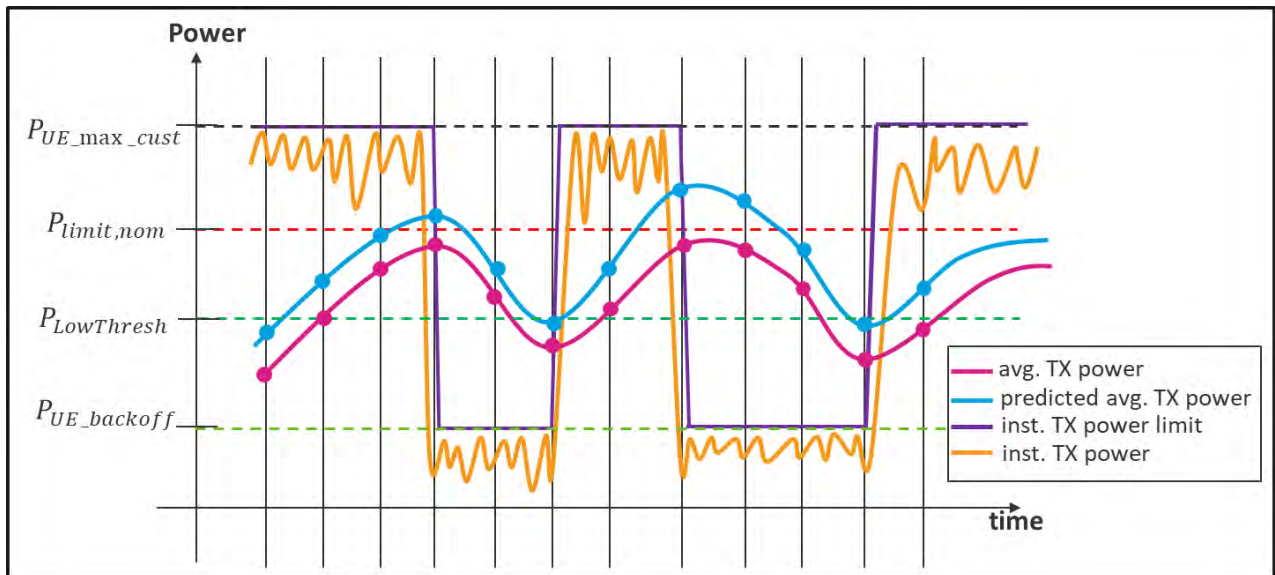


Figure 3-1 Dynamic power control of TA-SAR algorithm

Below are the itemized descriptions to detail the algorithm operations.

- The current time-averaged TX power is guaranteed to be lower than the predefined nominal

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TX power limit ($P_{limit,nom}$) which corresponds to the nominal max psSAR target ($SAR_{target,nom}$).

- $SAR_{target,nom}$ is obtained by scaling down from SAR_{target} with uncertainty
- If the predicted time-averaged TX power tends to be larger than the predefined nominal TX power limit ($P_{limit,nom}$), TA-SAR algorithm enables TX power constraint ($P_{UE_backoff}$) to limit instantaneous TX power.
 - The predicted time-averaged TX power is calculated, according to the current time- averaged TX power with the assumption that the EUT's maximum TX power is reached at the next time period, to get the maximum time-averaged TX power.
- If the predicted time-averaged TX power and the current time-averaged TX power are smaller than the predefined nominal TX power limit ($P_{limit,nom}$) and the lower threshold ($P_{LowThresh}$) respectively, the EUT can transmit higher TX power and exceed the predefined nominal TX power limit during a time period determined by the TA-SAR algorithm.
- The TA-SAR algorithm switches between two states of TX power constraint to improve the transmit performance and ensure the wireless device does not exceed the corresponding SAR_{target} at the same time.
- At any time period, the TA-SAR algorithm satisfies the following equation:

$$\frac{1}{T_{SAR}} \int_{t-T_{SAR}}^t inst_TX_power(t) dt \leq P_{limit,nom}$$

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where $inst_TX_power(t)$ denotes the instantaneous TX power at time t , where T_{SAR} is the time averaging window defined by ISED for assessing time-averaged SAR.

No matter a wireless device has a proximity sensor or not, the TA-SAR algorithm should always be enabled and maintain the TX averaged power below the corresponding power limit. The only difference is that the TA-SAR algorithm operates under different power limit values for different operating states.

TA-SAR algorithm validation has been performed for 2G, 3G, LTE, NR FR1 according to cases with different combinations of the operating parameters listed in Table 3-2.

Table 3-2 TA-SAR operating parameters

Operating parameters	Description
$P_{limit,nom}$ (dBm)	See definition in Table 3-1
$P_{LowThresh_offset}$ (dB)	Parameter for adjusting the value of $P_{LowThresh}$. <ul style="list-style-type: none"> $P_{LowThresh} = P_{limit,nom} - P_{LowThresh_offset}$
$P_{UE_backoff_offset}$ (dB)	Parameter for adjusting the value of $P_{UE_backoff}$. <ul style="list-style-type: none"> $P_{UE_backoff} = P_{limit,nom} - P_{UE_backoff_offset}$
$P_{UE_max_cust_offset}$ (dB)	Parameter for adjusting the value of $P_{UE_max_cust}$. <ul style="list-style-type: none"> $P_{UE_max_cust} = \min(P_{max,nom}, P_{limit,nom} + P_{UE_max_cust_offset})$ <p>$P_{max,nom}$ is nominal maximum TX power that the EUT can produce.</p>

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3.2 Overview of TA-SAR Test Scenarios

For the completeness of verifying that the proposed TA-SAR algorithm can realize ISED compliance regarding RF exposure, several test scenarios are constructed according to SPR-004:

- **Scenario 1:** test under time-varying TX power to verify that the TA-SAR algorithm ensures SAR compliance through dynamic TX power.
- **Scenario 2:** test under different transmission antenna to ensure the TA-SAR algorithm control works correctly during antenna switching from one antenna to another.
- **Scenario 3:** test under different operating states (operating states are also called ECIs (Exposure Condition Index) in this document) to ensure the TA-SAR algorithm control behaves as expected during ECI switching from one ECI to another. (e.g., head body worn)
- **Scenario 4:** test under band handover to ensure the TA-SAR algorithm control continuity and correctness.
- **Scenario 5.1:** test under RAT handover to ensure the TA-SAR algorithm control continuity and correctness.
- **Scenario 5.2, 5.3:** test under SAR exposure switch switching between two active radios (radio 1 only, radio 1+radio 2, and radio 2 only) to ensure the TA-SAR algorithm control continuity and correctness. Scenario 5.2 and scenario 5.3 are for ENDC and ULCA validation respectively.
- **Scenario 6:** test under time division duplexing (TDD) and frequency division duplexing (FDD) configurations to ensure the TA-SAR algorithm control works correctly during configuration switching from one division duplexing to another.
- **Scenario 7:** test under different modulation scheme (MCS) to ensure the TA-SAR algorithm control continuity and correctness.
- **Scenario 8:** test under call drop and re-establishment conditions to ensure the TA-SAR algorithm control continuity and SAR compliance.

For TA-SAR validation, the description of the conducted power measurement test procedures is included in sections 4.2~4.10, and the description of the single point SAR measurement test procedure is included in section 4.11. In each of the test scenarios, certain test sequences, described in section 4.1, are applied.

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4. TA-SAR Test Scenarios and Test Procedures

In order to demonstrate that TA-SAR algorithm performs as expected under various operating scenarios, Table 4-1 lists the test scenarios and expected test sequences to validate TA-SAR algorithm in these scenarios. The test sequences 0, 1, 2, 3 are defined in section 4.1. The details of each test procedures via conducted power and single point SAR measurements are described in sections 4.2~4.10 and section 4.11, respectively.

Table 4-1 Test scenario list of TA-SAR validation

Test scenario		Test sequences	Description
1	Change in requested power	1, 2, 3	Test under time-varying TX power
2	Antenna switching	0	Test with change antenna
3	Change in operating state	0	Test with operating state transition
4	Frequency band hand-off or redirect	0	Test with band change
5.1	Technology hand-off	0	Test with technology change
5.2	SAR exposure switch (ENDC)	0	Test under transition with ENDC
5.3	SAR exposure switch (ULCA)	0	Test under transition with ULCA
6	Switching between TDD and FDD configurations	0	Test with TDD/FDD transition
7	Change in modulation scheme	0	Test with modulation scheme change (e.g., 16QAM→QPSK)
8	Dropped connection	0	Test with call drop and re-establishment

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4.1 Test Sequences for All Scenarios

According to SPR-004, test sequence is generated based on the below parameters (see section 2.1 for the detailed descriptions):

- $P_{max,nom}$: a certain nominal maximum instantaneous TX power limit with a given operating state of EUT (P_{max} is obtained by $P_{max,nom}$ scaling up with uncertainty)
- $P_{limit,nom}$: a certain nominal time-averaged TX power limit which corresponding to $SAR_{target,nom}$ with a given operating state of EUT (P_{limit} is obtained by $P_{limit,nom}$ scaling up with uncertainty)
 - $SAR_{target,nom}$: a certain nominal maximum 1g or 10g peak spatial-averaged SAR (psSAR) target with a given operating state of EUT ($SAR_{target,nom}$ is obtained by scaling down from SAR_{target} with uncertainty)

Accordingly, four test sequences are predefined for TA-SAR algorithm 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 maximum ($P_{max,nom}$) until 400 seconds, then at ($0.5 \times P_{limit,nom}$) for the following 400 seconds.
- **Test sequence 2**: EUT's TX power is requested to be at 1 mW (0dBm) until 400 seconds, then at maximum ($P_{max,nom}$) for the following 400 seconds.
- **Test sequence 3**: EUT's TX power is requested to vary with time. A unique pseudo-random sequence with 150 independent power requests according to SPR-004 is obtained based on the following formula:

$$P_{req} = P_{max,nom} \left(\frac{P_{limit,nom}}{P_{max,nom}} \right)^x$$

- P_{req} is the requested power in watts.
- x is a random value drawn from the Weibull distribution with shape and scale parameters of 2.0 and 0.8 respectively.
- The corresponding request durations are given by:

$$T_{req} = 2(1 + 2y)$$

- T_{req} is the duration of the power request in seconds.
- y is a uniform distributed random value between 0 and 1.

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The test sequence 0, 1, and 2 are illustrated in Figure 4-1, Figure 4-2, and Figure 4-3, respectively. The waveforms of the three test sequences are listed in Table 4-2, Table 4-3, and Table 4-4. The test sequence 3 is listed and illustrated in Appendix-B. Note that all test sequences are illustrated as frame-averaged level.

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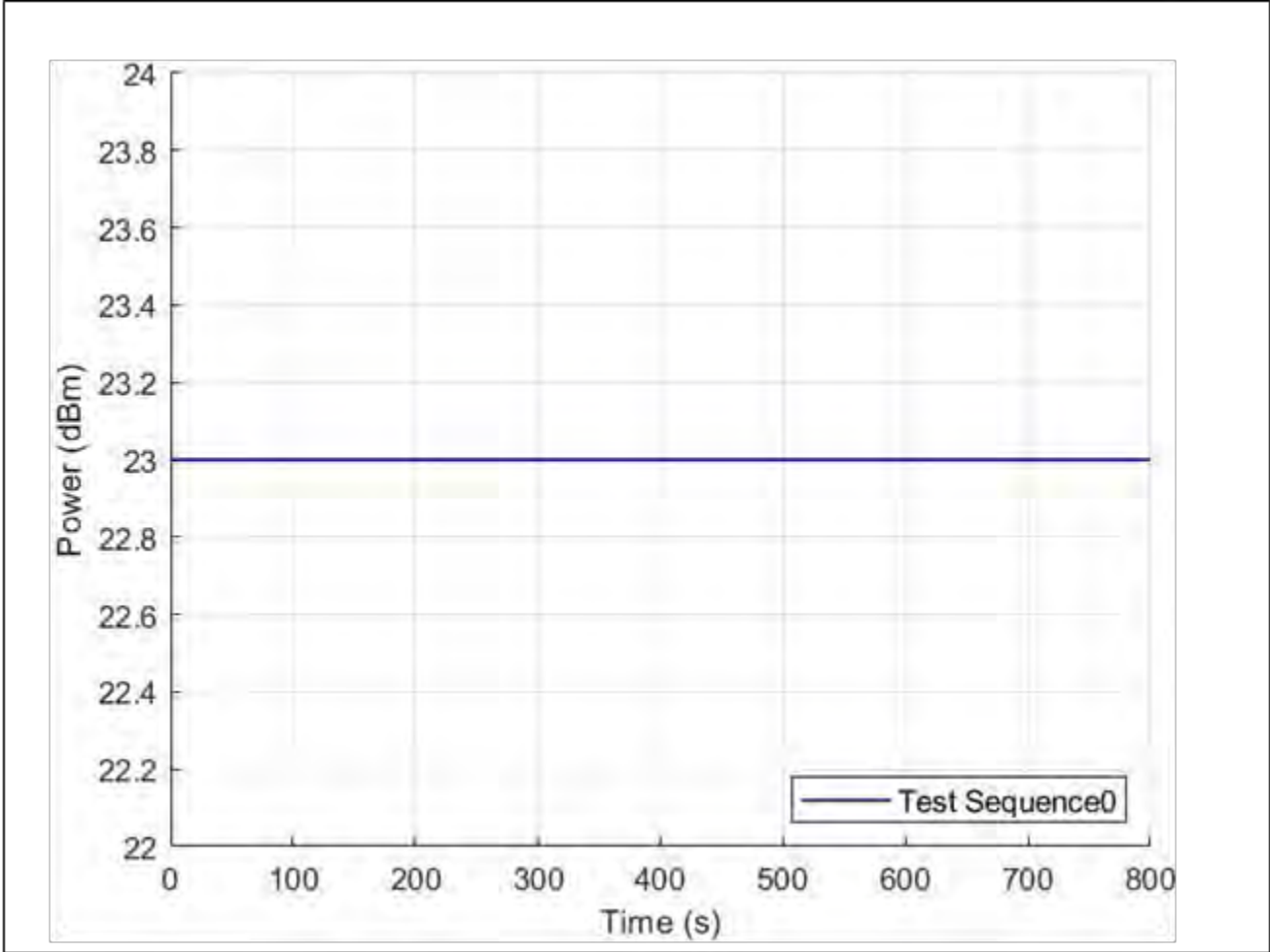


Figure 4-1 Test sequence 0

Table 4-2 Test sequence 0

Time	Duration	Power (dBm)	Note
800	800	23	$P_{max,nom}$

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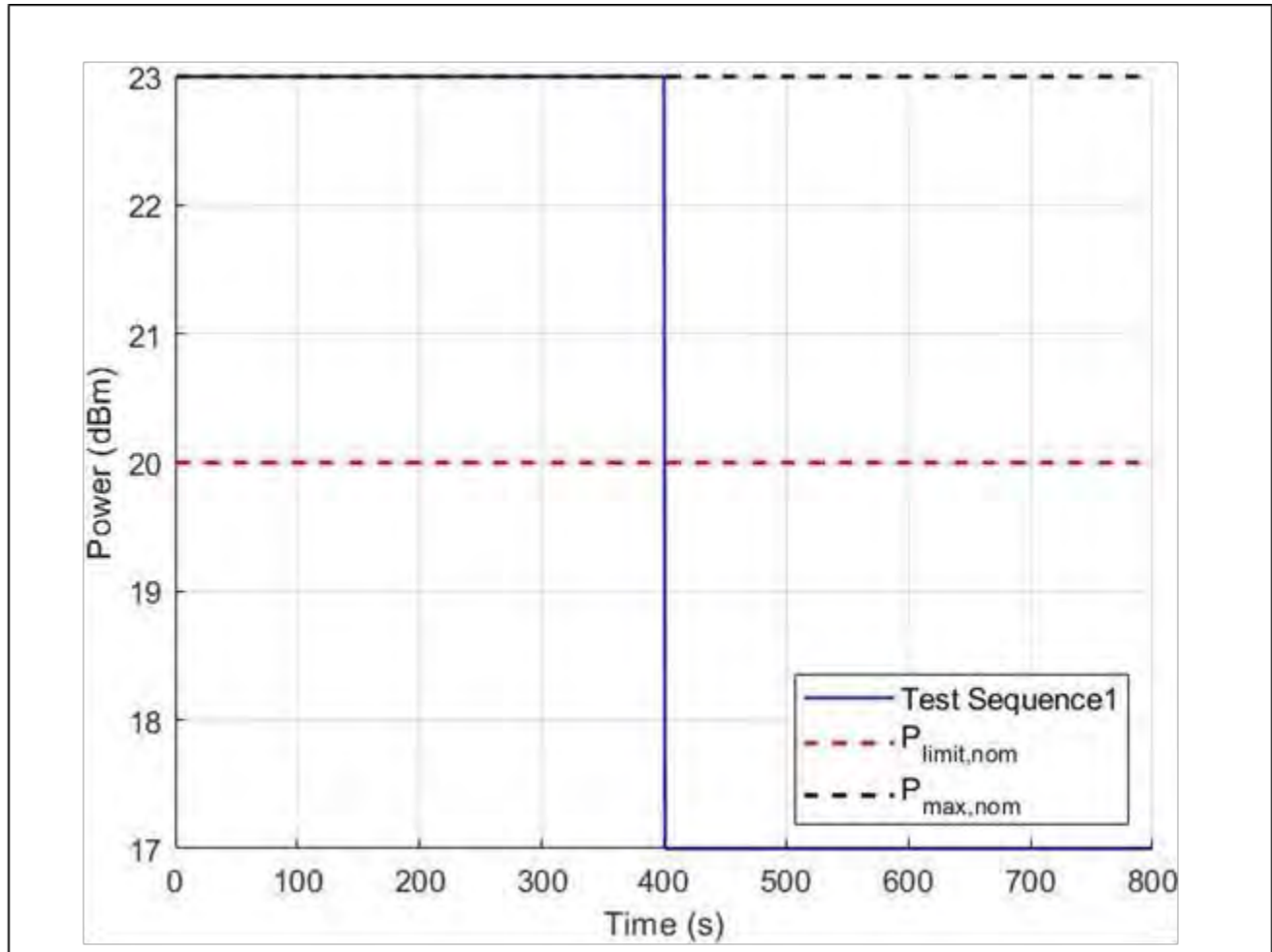


Figure 4-2 Test sequence 1

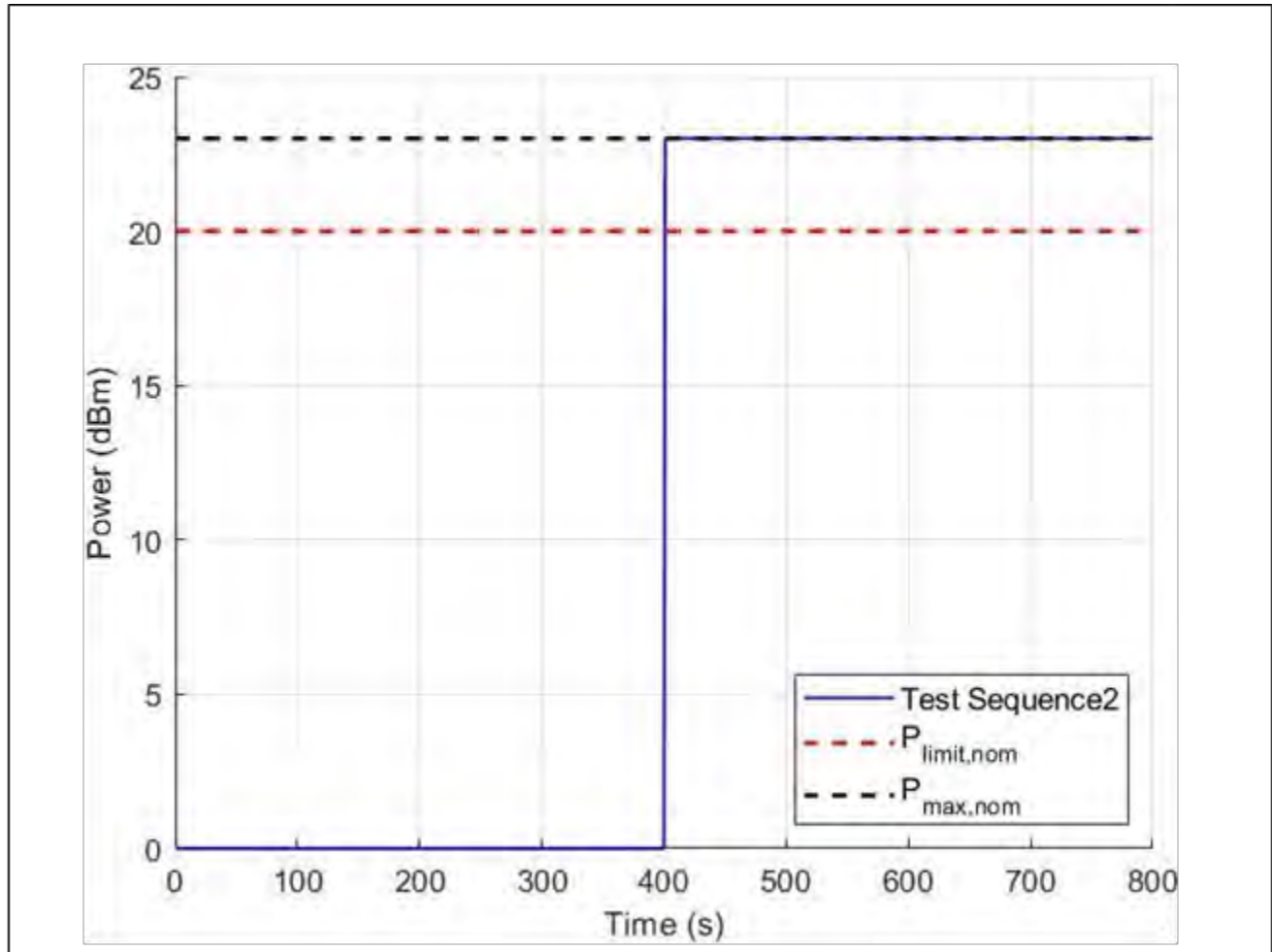
Table 4-3 Test sequence 1

Time	Duration	Power (dBm)	Note
400	400	23	$P_{max,nom}$
800	400	17	$P_{limit,nom} -3dB$

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Figure 4-3 Test sequence 2
Table 4-4 Test sequence 2

Time	Duration	Power (dBm)	Note
400	400	0	0dBm
800	400	23	$P_{max,nom}$

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4.2 Test Configuration and Procedure for Scenario 1: Changes in Requested Power via Conducted Power Measurements

4.2.1 Configuration

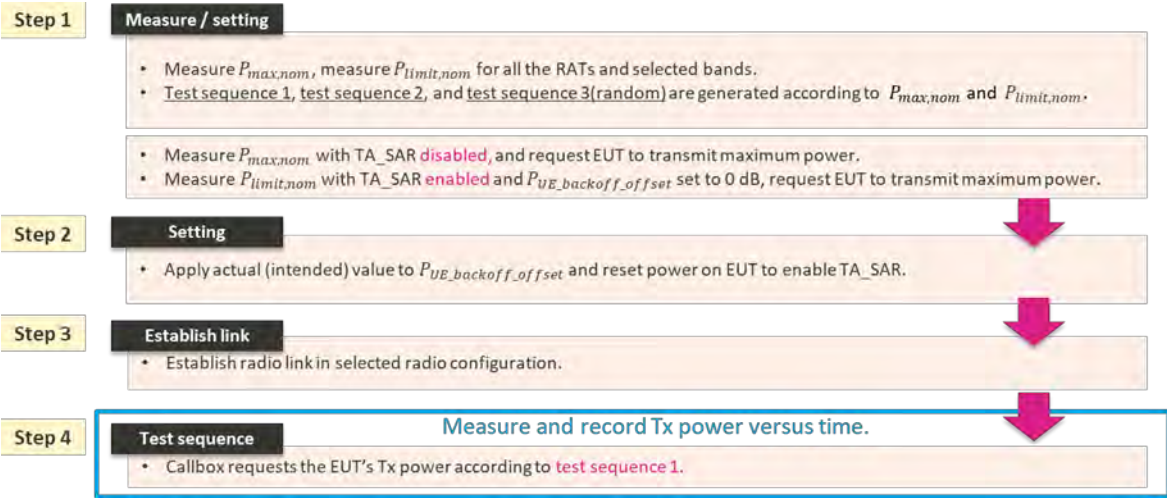
According to SPR-004, conducted power measurements shall be performed for at least one band per technology. The P_{limit} value associated with the chosen band should be several dB lower than the corresponding value of P_{max} . Whenever possible, the same band should not be repeated for different technologies. FDD and TDD configurations shall be treated as separate technologies.

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.

4.2.2 Procedure

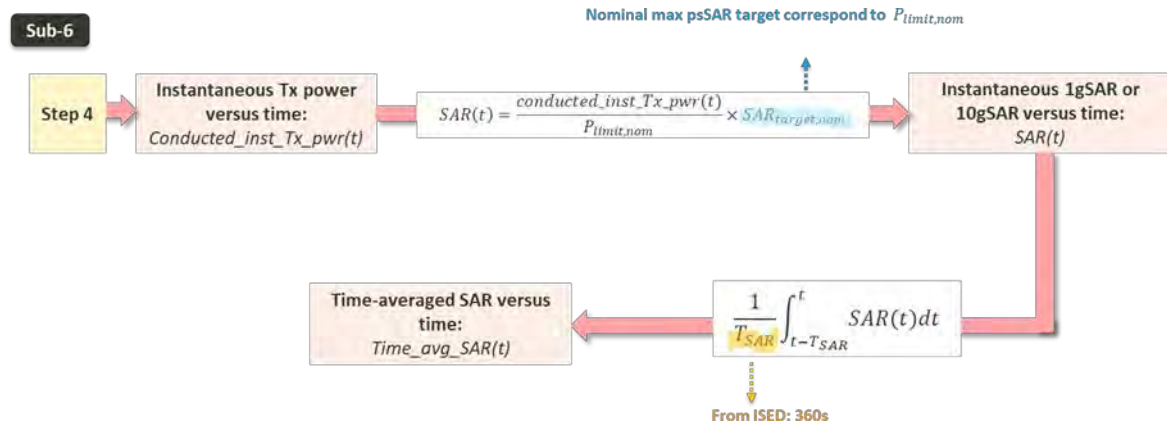
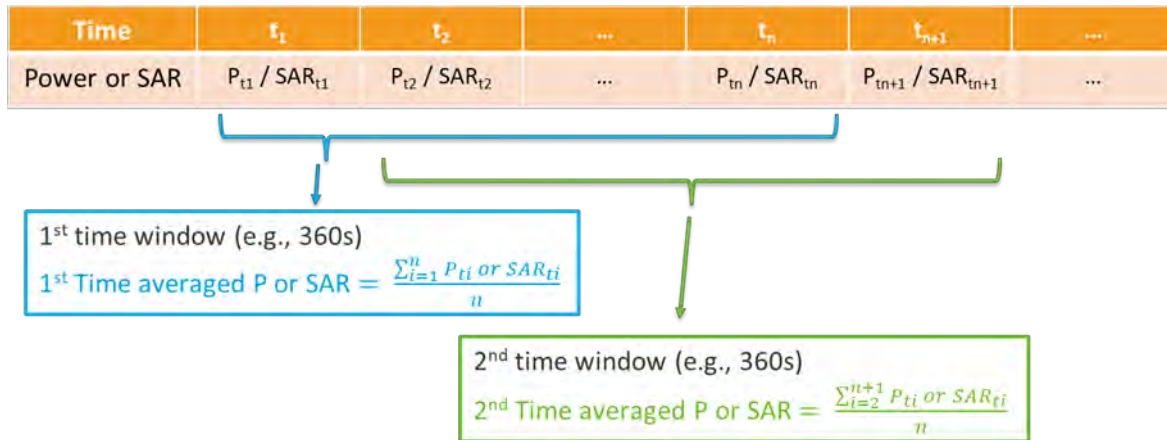
TX power is measured, recorded, and processed by the following steps:

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



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- Step 5: convert the measured conducted TX power into SAR
Convert the measured conducted TX power from step 4 into 1gSAR or 10gSAR value using the following equation. Perform the running time average to power and 1gSAR or 10g SAR to determine time-averaged value versus time as below:



- Step 6: plot results (note: All items of A. and B. are illustrated as frame-averaged level)
 - Make one power perspective plot containing
 - Requested power (test sequence 1)
 - Measured instantaneous conducted TX power
 - Calculated time-averaged conducted TX power over time
 - Power limit $P_{limit, nom}$ and P_{limit} in dBm ($P_{limit} = P_{limit, nom} + 1dB \text{ uncertainty}$)
 - Capable maximum TX power P_{max} in dBm ($P_{max} = P_{max, nom} + 1dB \text{ uncertainty}$)
 - Maximum time-averaged conducted TX power value

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- B. Make one SAR perspective plot containing
1. Calculated time-averaged 1gSAR or 10gSAR over time
 2. $SAR_{target,nom}$ and SAR_{target}
 $(SAR_{target} = SAR_{target,nom} \times 10^{1dB\ uncertainty/10})$
 3. ISED limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)
 4. Maximum time-averaged 1gSAR or 10gSAR value

• 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 and Step 6.A with test sequence 2.

• Step 8: repeat steps 2~6 for test sequence 3

Repeat steps 2 ~ 6 for (pseudo-random) test sequence 3 and replace test sequence 1 in step 4 and Step 6.A with test sequence 3.

• Step 9: repeat steps 2~8 for different bands

The validation criteria are, at all times, the calculated time-averaged 1gSAR or 10gSAR versus time shall not exceed SAR_{target} .

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4.3 Test Configuration and Procedure for Scenario 2: Antenna Switching via Conducted Power Measurements

4.3.1 Configuration

According to SPR-004, when different P_{limit} and P_{max} values are associated with each transmitting antenna, consideration shall be given to the combinations of antennas and operating state(s) for which the P_{limit} values are several dB below the corresponding P_{max} values. Of these combinations, the performance of the TAS algorithm shall be validated when the EUT switches from the antenna with the highest P_{limit} value to that with the lowest.

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

4.3.2 Procedure

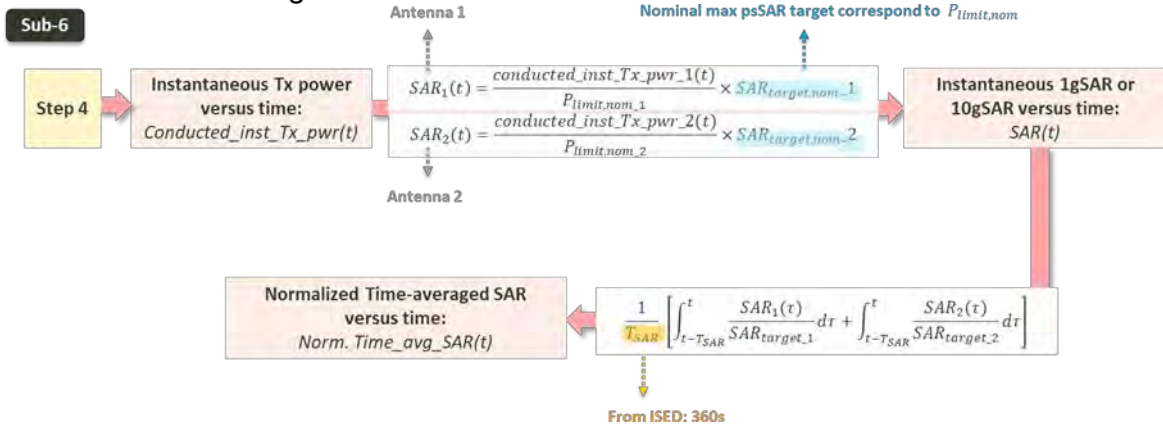
TX power is measured, recorded, and processed by the following steps:

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

Step 1	Measure / setting	<ul style="list-style-type: none"> • Measure $P_{max,nom}$ and measure $P_{limit,nom}$ for both the selected antennas. • Measure $P_{max,nom}$ with TA_SAR disabled, and request EUT to transmit maximum power. • Measure $P_{limit,nom}$ with TA_SAR enabled and $P_{UE_backoff_offset}$ set to 0 dB, request EUT to transmit maximum power.
Step 2		<ul style="list-style-type: none"> • Apply actual (intended) value to $P_{UE_backoff_offset}$ and reset power on EUT to enable TA-SAR.
Step 3		<ul style="list-style-type: none"> • Establish radio link in first selected antenna with callbox .
Measure and record the conducted Tx power versus time for the full duration of this test		
Step 4	Initial request	<ul style="list-style-type: none"> • Request EUT's Tx power at 0 dBm for at least one time window specified for the selected technology/band. • Then request EUT's Tx power to be at maximum power for at least one time window.
	Antenna switch	<ul style="list-style-type: none"> • Switch the radio link to second antenna selected. • For the remaining time, continue callbox requesting EUT's TX power to be at maximum power at least one time window.

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- Step 5: convert the measured conducted TX power into SAR
 Convert the measured conducted TX power from step 4 into 1gSAR or 10gSAR value using the following equation. Perform the running time average to power and 1gSAR or 10g SAR to determine time-averaged value versus time as below:



- Step 6: plot results (note: All items of A. and B. are illustrated as f-time-averaged level)
 - A. Make one power perspective plot containing
 1. Requested power (test sequence 0)
 2. Measured instantaneous conducted TX power
 3. Calculated time-averaged conducted TX power over time
 4. Power limit $P_{limit,nom}$ and P_{limit} in dBm ($P_{limit} = P_{limit,nom} + 1dB\ uncertainty$)
 5. Capable maximum TX power P_{max} in dBm ($P_{max} = P_{max,nom} + 1dB\ uncertainty$)
 6. Maximum time-averaged conducted TX power value
 - B. Make one SAR perspective plot containing (note: 1.~5. are normalized with SAR_{target})
 1. Normalized time-averaged 1gSAR or 10gSAR over time
 2. Normalized total time-averaged 1gSAR or 10gSAR over time
 3. Normalized $SAR_{target,nom}$ and Normalized SAR_{target}
 ($SAR_{target} = SAR_{target,nom} \times 10^{1dB\ uncertainty/10}$)
 4. Normalized ISED limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)
 5. Maximum normalized time-averaged 1gSAR or 10gSAR value
- The validation criteria are, at all times, the normalized time-averaged 1gSAR or 10gSAR versus time shall not exceed normalized SAR_{target} .

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4.4 Test Configuration and Procedure for Scenario 3: Change in Operating State via Conducted Power Measurements

4.4.1 Configuration

According to SPR-004, conducted power measurements shall be performed to validate the TAS algorithm when the EUT changes between operating states with different P_{limit} values.

The TAS algorithm shall be validated for the following changes in operating state:

- Among the operating states for which the P_{limit} values are several dB below the corresponding P_{max} values, changing from one operating state to another with a lower P_{limit} value
- If applicable, changing from an operating state for which the TAS algorithm is transparent, i.e.

$P_{limit} \geq P_{max}$, to one for which P_{limit} is several dB below P_{max}

4.4.2 Procedure

The test procedure is identical to section 4.3.2 except the following 3 changes:

1. Replace two antennas in Step 1 with two operating states.
2. Replace antenna switch operation with operating state switch.
3. No normalized total time-averaged 1gSAR or 10gSAR plot in Step 6

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

- The correct power control is controlled by TA-SAR during operating state switches from one operating state to another.
- The validation criteria are, at all times, the normalized time-averaged 1gSAR or 10gSAR versus time shall not exceed normalized SAR_{target} .

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4.5 Test Configuration and Procedure for Scenario 4: Frequency Band Hand-Off or Redirect via Conducted Power Measurements

4.5.1 Configuration

According to SPR-004, conducted power measurements shall be performed to validate the TAS algorithm when the EUT switches between frequency bands with different P_{limit} values.

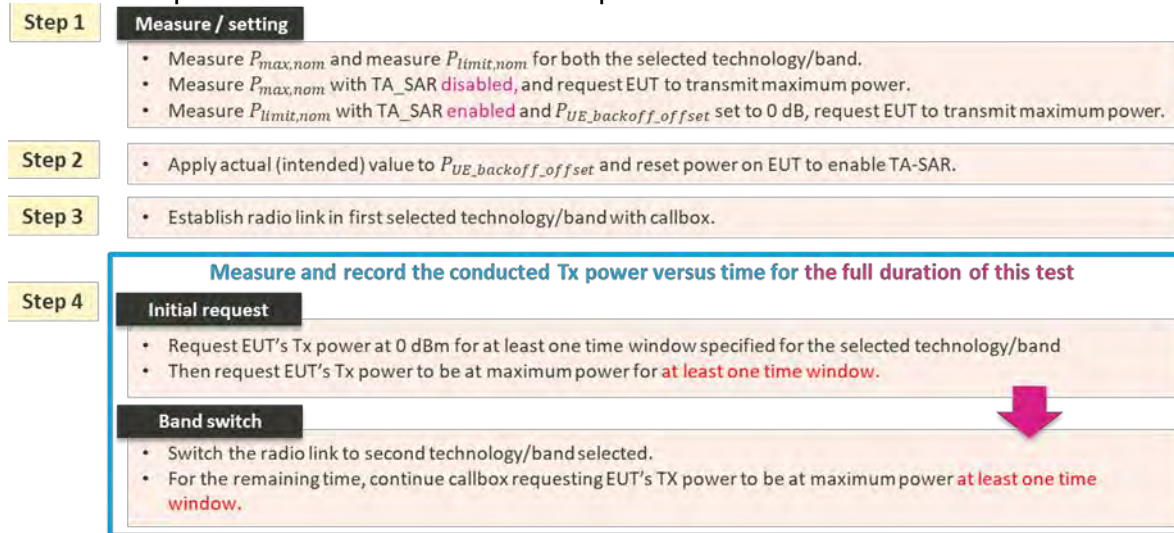
The TAS algorithm shall be validated for the following changes in frequency band:

- Among the frequency band configuration for which the P_{limit} values are several dB below the corresponding P_{max} values, changing from one frequency band to another with a lower P_{limit} value
- If applicable, changing from a frequency band for which the TAS algorithm is transparent, i.e. $P_{limit} \geq P_{max}$, to one for which P_{limit} is several dB below P_{max}

4.5.2 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

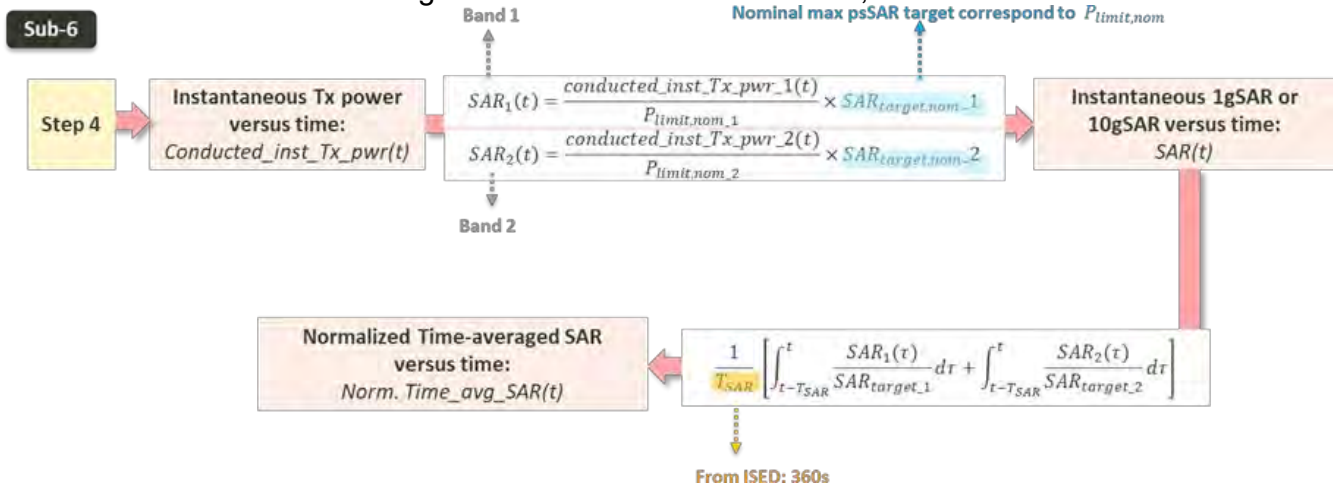


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- Step 5: convert the measured conducted TX power into SAR
 Convert the measured conducted TX power from step 4 into 1gSAR or 10gSAR value using the following equation. Perform the running time average to power and 1gSAR or 10g SAR to determine time-averaged value versus time as follows,



- Step 6: plot results (note: All items of A. and B. are illustrated as frame-averaged level)
 - A. Make one power perspective plot containing
 1. Requested power (test sequence 0)
 2. Measured instantaneous conducted TX power
 3. Calculated time-averaged conducted TX power over time
 4. Power limit $P_{limit,nom}$ and P_{limit} in dBm ($P_{limit} = P_{limit,nom} + 1dB\ uncertainty$)
 5. Capable maximum TX power P_{max} in dBm ($P_{max} = P_{max,nom} + 1dB\ uncertainty$)
 6. Maximum time-averaged conducted TX power value
 - B. Make one SAR perspective plot containing (note: 1.~5. are normalized with SAR_{target})
 1. Normalized time-averaged 1gSAR or 10gSAR over time
 2. Normalized total time-averaged 1gSAR or 10gSAR over time
 3. Normalized $SAR_{target,nom}$ and Normalized SAR_{target}
 $(SAR_{target} = SAR_{target,nom} \times 10^{1dB\ uncertainty/10})$
 4. Normalized ISED limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)
 5. Maximum normalized time-averaged 1gSAR or 10gSAR value
- The validation criteria are, at all times, the normalized time-averaged 1gSAR or 10gSAR versus time shall not exceed normalized SAR_{target} .

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4.6 Test Configuration and Procedure for Scenario 5.1: Technology Hand-Off or Redirect via Conducted Power Measurements

4.6.1 Configuration


According to SPR-004, conducted power measurements shall be performed to validate the TAS algorithm when the EUT switches between technologies with different P_{limit} values.

Among the technology configurations for which the P_{limit} values are several dB below the corresponding P_{max} values, the test shall consist of changing from one technology to another with a lower P_{limit} value.

4.6.2 Procedure

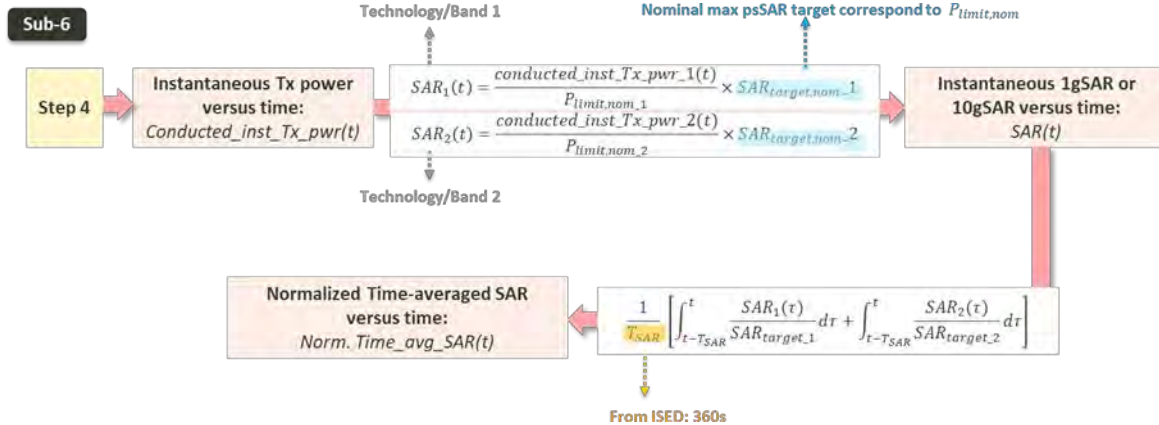
TX power is measured, recorded, and processed by the following steps:

- Steps 1~4: measure and record TX power versus time for test scenario 5.1

Step 1	<p>Measure / setting</p> <ul style="list-style-type: none"> • Measure $P_{max,nom}$ and measure $P_{limit,nom}$ for both the selected technology/band. • Measure $P_{max,nom}$ with TA_SAR disabled, and request EUT to transmit maximum power. • Measure $P_{limit,nom}$ with TA_SAR enabled and $P_{UE_backoff_offset}$ set to 0 dB, request EUT to transmit maximum power.
Step 2	<ul style="list-style-type: none"> • Apply actual (intended) value to $P_{UE_backoff_offset}$ and reset power on EUT to enable TA-SAR.
Step 3	<ul style="list-style-type: none"> • Establish radio link in first selected technology/band with callbox.
Step 4	<p style="text-align: center;">Measure and record the conducted Tx power versus time for the full duration of this test</p> <p>Initial request</p> <ul style="list-style-type: none"> • Request EUT's Tx power at 0 dBm for at least one time window specified for the selected technology/band • Then request EUT's Tx power to be at maximum power for at least one time window. <p style="text-align: right;"></p> <p>Technology / Band switch</p> <ul style="list-style-type: none"> • Switch the radio link to second technology/band selected. • For the remaining time, continue callbox requesting EUT's TX power to be at maximum power 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 10g SAR to determine time-averaged value versus time as follows,

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- Step 6: plot results (note: All items of A. and B. are illustrated as frame-averaged level)
 - A. Make one power perspective plot containing
 1. Requested power (test sequence 0)
 2. Measured instantaneous conducted TX power
 3. Calculated time-averaged conducted TX power over time
 4. Power limit $P_{limit,nom}$ and P_{limit} in dBm ($P_{limit} = P_{limit,nom} + 1dB \text{ uncertainty}$)
 5. Capable maximum TX power P_{max} in dBm ($P_{max} = P_{max,nom} + 1dB \text{ uncertainty}$)
 6. Maximum time-averaged conducted TX power value
 - B. Make one SAR perspective plot containing (note: 1.~5. are normalized with SAR_{target})
 1. Normalized time-averaged 1gSAR or 10gSAR over time
 2. Normalized total time-averaged 1gSAR or 10gSAR over time
 3. Normalized $SAR_{target,nom}$ and Normalized SAR_{target}
 $(SAR_{target} = SAR_{target,nom} \times 10^{1dB \text{ uncertainty}/10})$
 4. Normalized ISED limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)
 5. Maximum normalized time-averaged 1gSAR or 10gSAR value
- The validation criteria are, at all times, the normalized time-averaged 1gSAR or 10g SAR versus time shall not exceed normalized SAR_{target} .

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4.7 Test Configuration and Procedure for Scenario 5.2, 5.3: SAR Exposure Switch via Conducted Power Measurements

4.7.1 Configuration

TA-SAR algorithm operation is independent of the source of SAR exposure (e.g., LTE 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_{limit} values of radio1 and radio2 less than their corresponding P_{max} , and their P_{limit} values are different if possible.
 - If the previous configuration does not exist, at least one radio has its P_{limit} less than P_{max} .
 - If above two cannot be found, select one configuration that has P_{limit} of radio1 and radio2 with the least difference between P_{limit} and P_{max} (i.e., P_{limit} can be greater than P_{max}).
- Two SAR switching scenarios are sufficient because the TA-SAR algorithm operation is the same
 - Select ENDC for scenario 5.2
 - Select ULCA for scenario 5.3

4.7.2 Procedure

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

- Steps 1~3: measure and record TX power versus time for test scenario 5.2
 - 1.A. Measure conducted TX power corresponding to radio1 $P_{limit,nom}$
 - Establish device in call with the callbox for radio1 band.
 - Measure conducted TX power corresponding to radio1 $P_{limit,nom}$ with TA_SAR enabled and $P_{UE_backoff_offset}$ set to 0 dB, request EUT to transmit maximum power.
 - 1.B. measure conducted TX power corresponding to radio2 $P_{limit,nom}$

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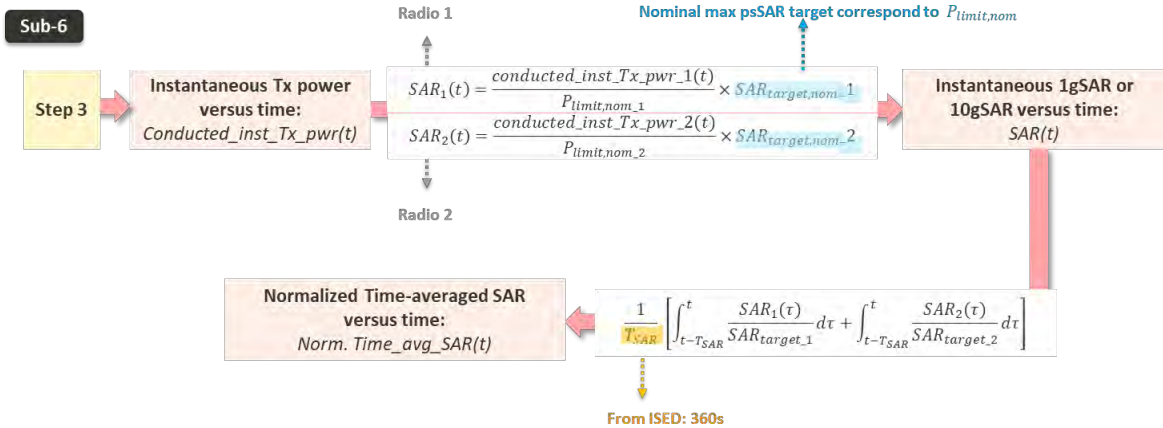
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- Repeat above step to measure conducted TX power corresponding to radio2 $P_{limit,nom}$.
- If radio2 is dependent on radio1 (for example, non-standalone mode of radio 2 NR FR1 requiring radio1 LTE as anchor), then establish radio1 + radio2 call with callbox, and request all down bits for radio1 with callbox requesting maximum power from radio2. Then measure conducted TX power corresponds to radio2 $P_{limit,nom}$

Step 1	Measure / setting	<ul style="list-style-type: none"> Measure $P_{max,nom}$ and measure $P_{limit,nom}$ for radio1 and radio2 in the selected technology/band. Measure $P_{max,nom}$ with TA_SAR disabled, and request EUT to transmit maximum power for both radios. Test condition to measure conducted $P_{limit,nom}$ is in step 1.A and 1.B. Apply actual (intended) value to $P_{UE_backoff_offset}$ and reset power on EUT to enable TA-SAR for radio1 + radio2 call.
Step 2	Establish link	<ul style="list-style-type: none"> Establish device in radio1+radio2 call and request low power (all-down bits) on radio1.
Measure and record the conducted Tx power versus time for the full duration of this test		
Step 3	Radio 2 predominant	<ul style="list-style-type: none"> Let callbox request EUT's Tx power to be at 0 dBm for in radio2 for at least one time window. Then let callbox request EUT's Tx power to be at maximum power in radio2 for at least one time window.
	Radio 1 + Radio2	<ul style="list-style-type: none"> Set callbox to request EUT's Tx power to be at maximum power on radio1, i.e., all-up bits. Continue radio1+radio2 call with both radios at maximum power for at least one time window.
	Radio 1 predominant	<ul style="list-style-type: none"> Drop (or request all-down bits on) radio2. Continue radio1 at maximum power for at least one time window.

- Step 4: convert the measured conducted TX power into SAR
Convert the measured conducted TX power from step 3 into 1gSAR or 10gSAR value using the following equation. Perform the running time average to power and 1gSAR or 10g SAR to determinetime-averaged value versus time as follows,

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- Step 5: plot results (note: All items of A. and B. are illustrated as frame-averaged level)
 - A. Make one power perspective plot containing
 1. Requested power (test sequence 0)
 2. Measured instantaneous conducted TX power
 3. Calculated time-averaged conducted TX power over time
 4. Power limit $P_{limit, nom}$ and P_{limit} in dBm ($P_{limit} = P_{limit, nom} + 1dB$ uncertainty)
 5. Capable maximum TX power P_{max} in dBm ($P_{max} = P_{max, nom} + 1dB$ uncertainty)
 6. Maximum time-averaged conducted TX power value
 - B. Make one SAR perspective plot containing (note: 1.~5. are normalized with SAR_{target})
 1. Normalized time-averaged 1gSAR or 10gSAR over time
 2. Normalized total time-averaged 1gSAR or 10gSAR over time
 3. Normalized $SAR_{target, nom}$ and Normalized SAR_{target}
 ($SAR_{target} = SAR_{target, nom} \times 10^{1dB \text{ uncertainty}/10}$)
 4. Normalized ISED limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)
 5. Maximum normalized time-averaged 1gSAR or 10gSAR value

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- Step 6: repeat steps 1~5 for scenario 5.3
- The validation criteria are, at all times, the normalized time-averaged 1gSAR or 10gSAR versus time shall not exceed normalized SAR_{target} .

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4.8 Test Configuration and Procedure for Scenario 6: Switching between TDD and FDD Configurations via Conducted Power Measurements

4.8.1 Configuration

According to SPR-004, conducted power measurements shall be performed to validate the TAS algorithm when the EUT switches between TDD and FDD configurations with different P_{limit} values, both of which should be several dB lower than the corresponding P_{max} values.

4.8.2 Procedure

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

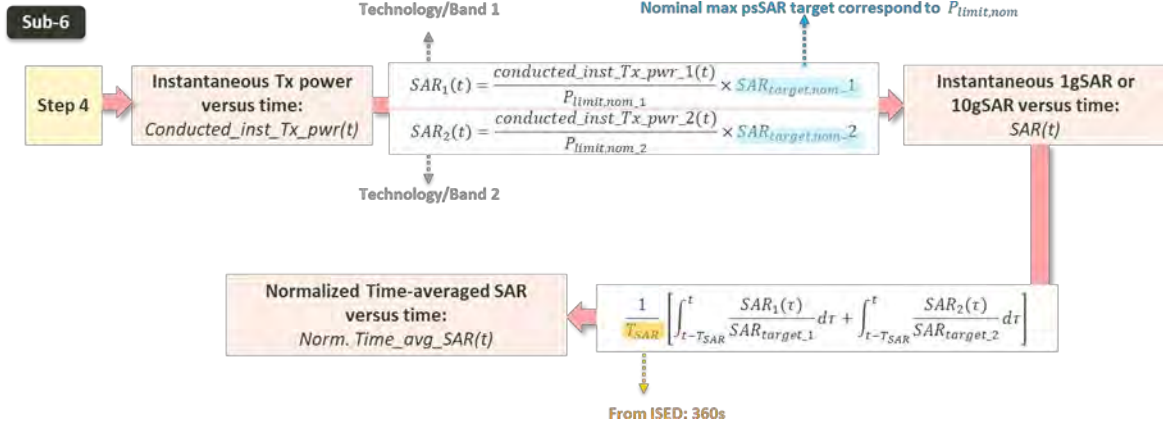
- Step 1~4: measure and record TX power versus time for test scenario 6

Step 1	Measure / setting	<ul style="list-style-type: none"> • Measure $P_{max,nom}$ and measure $P_{limit,nom}$ for both the selected technology/band with TDD and FDD. • Measure $P_{max,nom}$ with TA_SAR disabled and request EUT to transmit maximum power . • Measure $P_{limit,nom}$ with TA_SAR enabled and $P_{UE_backoff_offset}$ set to 0 dB, request EUT to transmit maximum power .
Step 2		<ul style="list-style-type: none"> • Apply actual (intended) value to $P_{UE_backoff_offset}$ and reset power on EUT to enable TA-SAR.
Step 3		<ul style="list-style-type: none"> • Establish radio link in first selected Technology/band with callbox.
Step 4	<p style="text-align: center; color: blue; font-weight: bold;">Measure and record the conducted Tx power versus time for the full duration of this test</p> <div style="background-color: #cccccc; padding: 2px;">Initial request</div> <ul style="list-style-type: none"> • Request EUT's Tx power at 0 dBm for at least one time window specified for the selected technology/band • Then request EUT's Tx power to be at maximum power for at least one time window. <div style="text-align: center; color: magenta; font-size: 2em; margin: 5px 0;">↓</div> <div style="background-color: #cccccc; padding: 2px;">Technology / Band switch</div> <ul style="list-style-type: none"> • Switch the radio link to second Technology/band selected. • For the remaining time, continue callbox requesting EUT's TX power to be at maximum power 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 10g SAR to determinetime-averaged value versus time as follows,

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- Step 6: plot results (note: All items of A. and B. are illustrated as frame-averaged level)
 - A. Make one power perspective plot containing
 1. Requested power (test sequence 0)
 2. Measured instantaneous conducted TX power
 3. Calculated time-averaged conducted TX power over time
 4. Power limit $P_{limit,nom}$ and P_{limit} in dBm ($P_{limit} = P_{limit,nom} + 1dB \text{ uncertainty}$)
 5. Capable maximum TX power P_{max} in dBm ($P_{max} = P_{max,nom} + 1dB \text{ uncertainty}$)
 6. Maximum time-averaged conducted TX power value
 - B. Make one SAR perspective plot containing (note: 1.~5. are normalized with SAR_{target})
 1. Normalized time-averaged 1gSAR or 10gSAR over time
 2. Normalized total time-averaged 1gSAR or 10gSAR over time
 3. Normalized $SAR_{target,nom}$ and Normalized SAR_{target}
 ($SAR_{target} = SAR_{target,nom} \times 10^{1dB \text{ uncertainty}/10}$)
 4. Normalized ISED limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)
 5. Maximum normalized time-averaged 1gSAR or 10gSAR value

- The validation criteria are, at all times, the normalized time-averaged 1gSAR or 10gSAR versus time shall not exceed normalized SAR_{target} .

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4.9 Test Configuration and Procedure for Scenario 7: Change in Modulation Scheme via Conducted Power Measurements

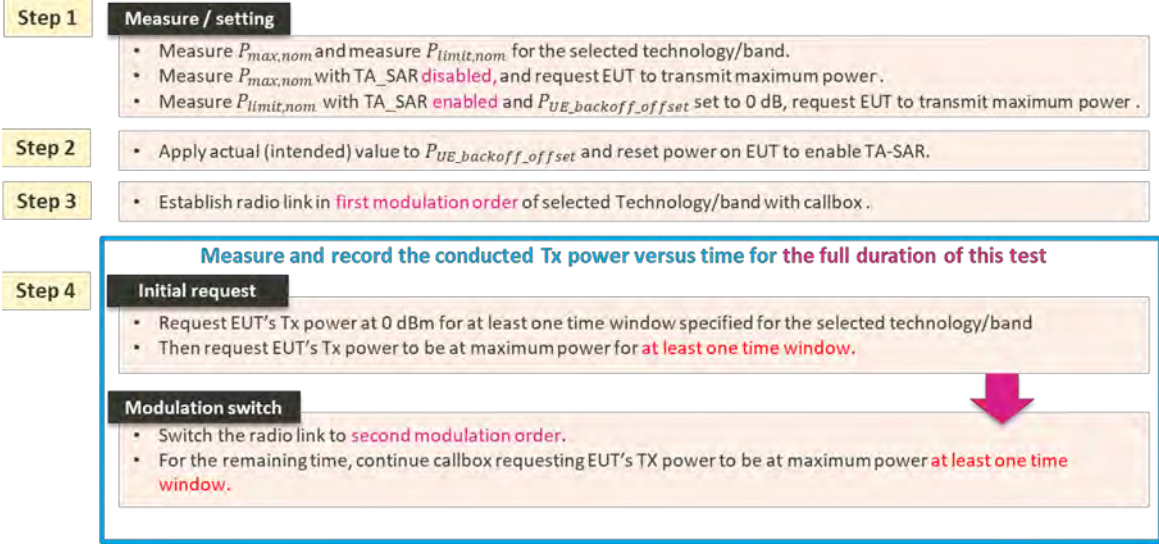
4.9.1 Configuration

Since the algorithm is independent of RAT/band/channel, select any one RAT/band/channel, whose P_{limit} values is below P_{max} . Mediatek’s algorithm uses the same P_{limit} for different modulation schemes of the same band.

4.9.2 Procedure

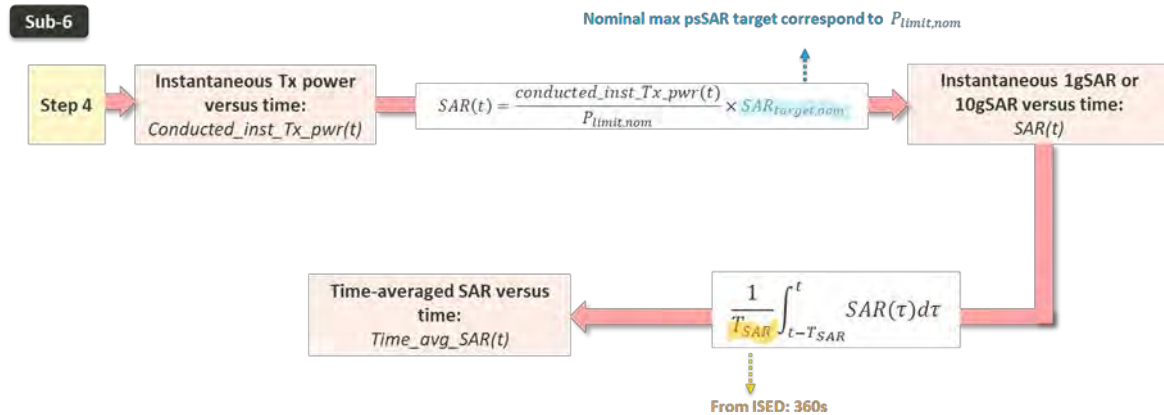
TX power is measured, recorded, and processed by the following steps:

- Steps 1~4: measure and record TX power versus time for test scenario 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 10g SAR to determine time-averaged value versus time as follows,

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- Step 6: plot results (note: All items of A. and B. are illustrated as frame-averaged level)
 - A. Make one power perspective plot containing
 1. Requested power (test sequence 0)
 2. Measured instantaneous conducted TX power
 3. Calculated time-averaged conducted TX power over time
 4. Power limit $P_{limit,nom}$ and P_{limit} in dBm ($P_{limit} = P_{limit,nom} + 1dB \text{ uncertainty}$)
 5. Capable maximum TX power P_{max} in dBm ($P_{max} = P_{max,nom} + 1dB \text{ uncertainty}$)
 6. Maximum time-averaged conducted TX power value
 - B. Make one SAR perspective plot containing
 1. Calculated time-averaged 1gSAR or 10gSAR over time
 2. $SAR_{target,nom}$ and SAR_{target}
($SAR_{target} = SAR_{target,nom} \times 10^{1dB \text{ uncertainty}/10}$)
 3. ISED limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)
 4. Maximum time-averaged 1gSAR or 10gSAR value
- The validation criteria are, at all times, the calculated time-averaged 1gSAR or 10gSAR versus time shall not exceed SAR_{target} .

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4.10 Test Configuration and Procedure for Scenario 8: Dropped Connection via Conducted Power Measurements

4.10.1 Configuration

According to SPR-004, conducted power measurements shall be performed to validate the TAS algorithm during dropped connections to ensure the algorithm is able to account for previous connection states.

Only one test is required with one of the configurations for which P_{limit} is below P_{max} .

4.10.2 Procedure

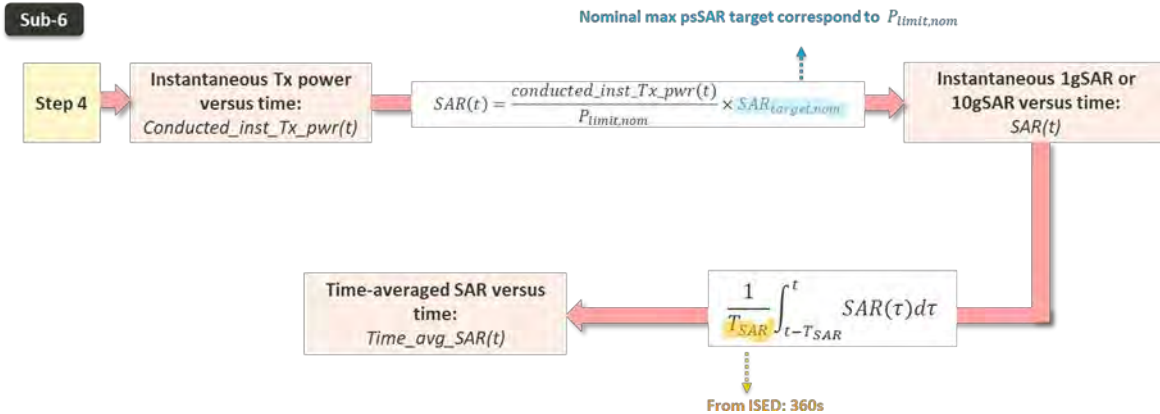
TX power is measured, recorded, and processed by the following steps:

- Steps 1~4: measure and record TX power versus time for test scenario 8

Step 1	Measure / setting	<ul style="list-style-type: none"> • Measure $P_{max,nom}$, measure $P_{limit,nom}$ for the selected technology/band. • Measure $P_{max,nom}$ with TA_SAR disabled, and request EUT to transmit maximum power. • Measure $P_{limit,nom}$ with TA_SAR enabled and $P_{UE_backoff_offset}$ set to 0 dB, request EUT to transmit maximum power. 						
Step 2		<ul style="list-style-type: none"> • Apply actual (intended) value to $P_{UE_backoff_offset}$ and reset power on EUT to enable TA_SAR. 						
Step 3		<ul style="list-style-type: none"> • Establish radio link in selected radio configuration. 						
Step 4	<p style="text-align: center; color: blue; font-weight: bold;">Measure and record the conducted Tx power versus time for the full duration of this test</p> <table border="1" style="width: 100%; border-collapse: collapse;"> <tr> <td style="background-color: #333; color: white;">Initial request</td> <td> <ul style="list-style-type: none"> • Request EUT's Tx power at 0 dBm for at least one time window for the selected technology/band. </td> </tr> <tr> <td style="background-color: #333; color: white;">Drop connection</td> <td> <ul style="list-style-type: none"> • Drop the call for ~10 seconds. </td> </tr> <tr> <td style="background-color: #333; color: white;">Re-establish</td> <td> <ul style="list-style-type: none"> • Re-establish another call in the same radio configuration at first link (i.e., same Technology/band/channel) • For the remaining time, continue callbox requesting EUT's Tx power to be at maximum power at least one time window. </td> </tr> </table>		Initial request	<ul style="list-style-type: none"> • Request EUT's Tx power at 0 dBm for at least one time window for the selected technology/band. 	Drop connection	<ul style="list-style-type: none"> • Drop the call for ~10 seconds. 	Re-establish	<ul style="list-style-type: none"> • Re-establish another call in the same radio configuration at first link (i.e., same Technology/band/channel) • For the remaining time, continue callbox requesting EUT's Tx power to be at maximum power at least one time window.
Initial request	<ul style="list-style-type: none"> • Request EUT's Tx power at 0 dBm for at least one time window for the selected technology/band. 							
Drop connection	<ul style="list-style-type: none"> • Drop the call for ~10 seconds. 							
Re-establish	<ul style="list-style-type: none"> • Re-establish another call in the same radio configuration at first link (i.e., same Technology/band/channel) • For the remaining time, continue callbox requesting EUT's Tx power to be at maximum power 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 10g SAR to determinetime-averaged value versus time as follows,

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- Step 6: plot results (note: All items of A. and B. are illustrated as frame-averaged level)
 - A. Make one power perspective plot containing
 1. Requested power (test sequence 0)
 2. Measured instantaneous conducted TX power
 3. Calculated time-averaged conducted TX power over time
 4. Power limit $P_{limit,nom}$ and P_{limit} in dBm ($P_{limit} = P_{limit,nom} + 1dB \text{ uncertainty}$)
 5. Capable maximum TX power P_{max} in dBm ($P_{max} = P_{max,nom} + 1dB \text{ uncertainty}$)
 6. Maximum time-averaged conducted TX power value
 - B. Make one SAR perspective plot containing
 1. Calculated time-averaged 1gSAR or 10gSAR over time
 2. $SAR_{target,nom}$ and SAR_{target}
($SAR_{target} = SAR_{target,nom} \times 10^{1dB \text{ uncertainty}/10}$)
 3. ISED limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)
 4. Maximum time-averaged 1gSAR or 10gSAR value
- The validation criteria are, at all times, the calculated time-averaged 1gSAR or 10gSAR versus time shall not exceed SAR_{target} .

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4.11 Test Configuration and Procedure for Scenario 1: Changes in Requested Power via Single Point SAR Measurements

4.11.1 Configuration

According to SPR-004, single point SAR measurements shall be performed to validate the TAS algorithm; however, compared with the requirements for conducted power measurements, fewertest cases are required:

- Single point SAR measurements need be performed only for changes in requested power, asdescribed in section 6.2.2 of SPR-004.
- To account for linearity, single point SAR measurements shall be performed on each antennafor at least one frequency. If possible, each antenna should be validated using a different frequency.
- Single point SAR measurements shall be performed only for configurations involving a singletransmitter, i.e. not for simultaneous transmission.

The configurations and operating states selected for single point SAR measurements shall match those selected for conducted power measurements and for SAR compliance assessment. This requirement facilitates the correlation of the single point SAR results with both the conducted power measurements and the $SAR_{target,nom}$ results in the RF exposure technical brief.

4.11.2 Procedure

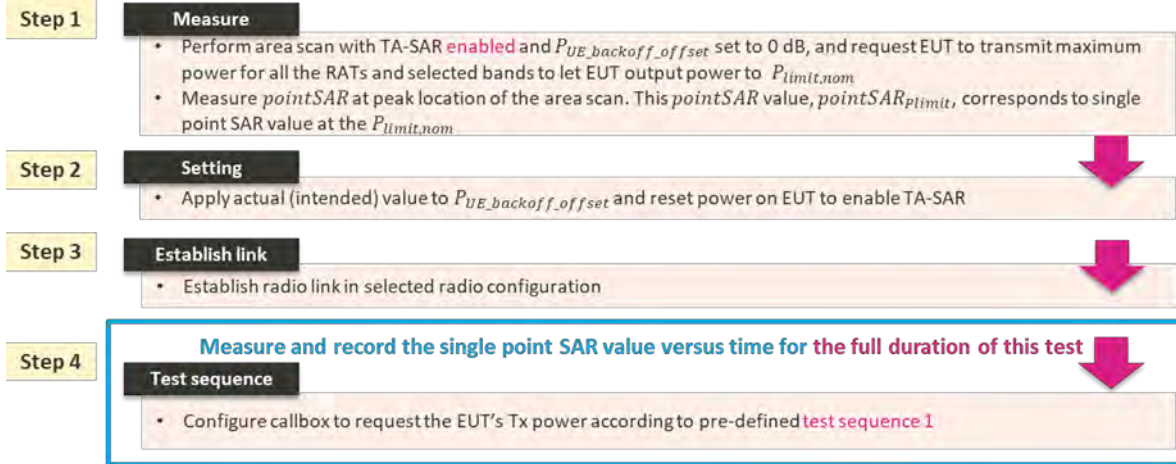
SAR is measured and recorded by the following steps:

- Steps 1~4: measure and record SAR versus time

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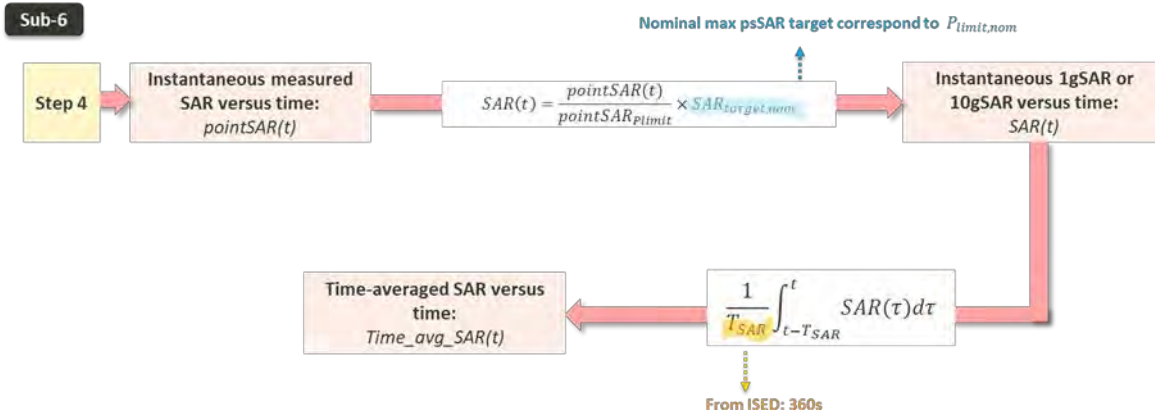
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- Step 5: convert the measured SAR into time-averaged SAR

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



where, $pointSAR_{plimit}$ is the value determined in step 1, and $pointSAR(t)$ is the instantaneous single point SAR measured in step 4.

- Step 6: plot result (note: All items are illustrated as frame-averaged level)
 - Calculated time-averaged 1gSAR or 10gSAR over time
 - $SAR_{target,nom}$ and SAR_{target}
($SAR_{target} = SAR_{target,nom} \times 10^{1dB\ uncertainty/10}$)
 - ISED limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)
 - Maximum time-averaged 1gSAR or 10gSAR value

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5. Measured instantaneous single point SAR

- Step 7: repeat steps 2 ~ 6 with the pre-defined test sequence 2
- Step 8: repeat steps 2 ~ 6 with the pre-defined test sequence 3
- Step 9: repeat steps 2 ~ 8 for all the selected technologies and bands

The validation criteria are, at all times, the calculated time-averaged 1gSAR or 10gSAR versus timeshall not exceed SAR_{target} .

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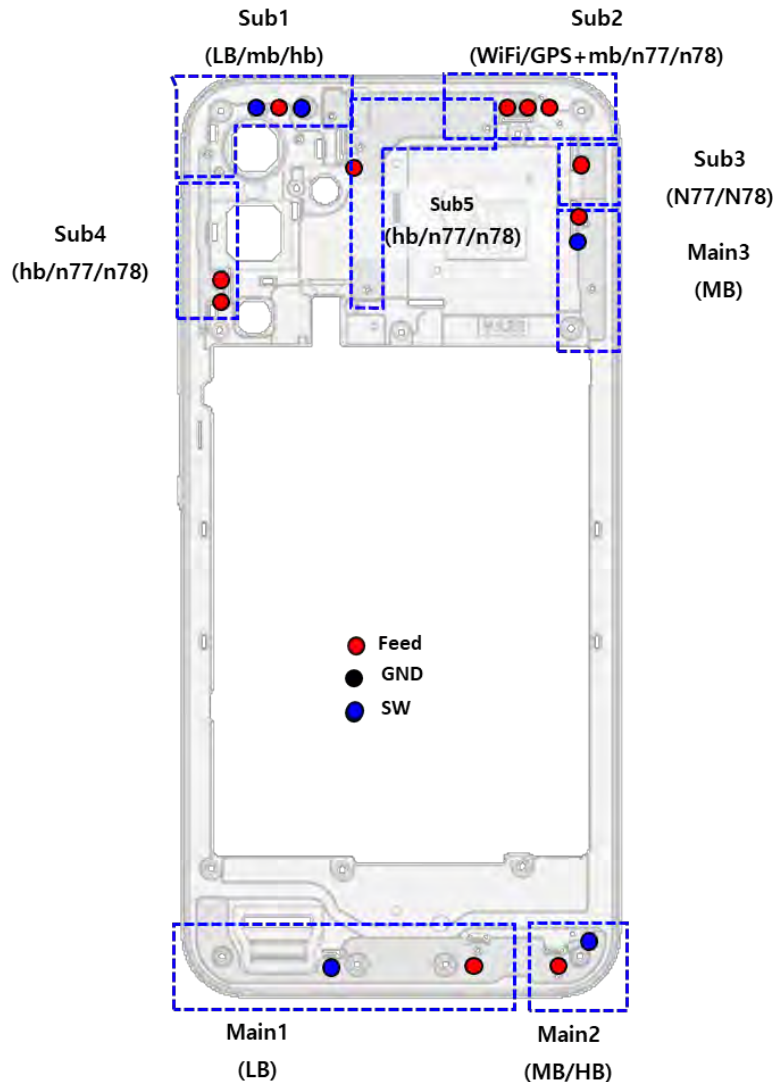
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5. TA-SAR Validation via Conducted Power Measurements

5.1 Measurement Setup

5.1.1 Test Bench Introduction

All of the test cases defined in this chapter are conducted by using the phone, whose antenna placement for each RAT is illustrated in Figure 5-1.



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Ant	Support Band List	Ant	Support Band List
MAIN1 [Ant A]	TX/RX - GSM 850/900 - WCDMA B5/8 - LTE B5/2/13/14/20/26/28/71 - NR N5/29/71	SUB1 [Ant D]	DRX - GSM 850/900/1800/1900 - WCDMA B1/2/4/5/8 DRX - LTE B1/2/3/4/5/7/12/13/14/20/25/26/28/29/30/38/39/40/41/66/71 - NR N2/5/25/26/29/41/66/70/71
MAIN2 [Ant B]	TX/RX - GSM 1800/1900 - WCDMA B1/2/4 - LTE B1/2/3/4/7/25/30/38/39/40/41/66 - NR 2/25/41/66/70 PRX - LTE B29 - NR n29	SUB2 [Ant E]	DRX MIMO - LTE B2/4/25/66 - NR N2/25/66/70 PRX MIMO - LTE B48 - NR N48/77/78 TX SRS - NR N48/77/78(SRS1) GPS L1 WiFi 2.4GHz/5.0GHz
MAIN3 [Ant C]	PRX(MIMO)/TX - LTE B2/4/25/66 NR PRX(MIMO) - NR N2/66/25/70 NR TX - NR N2/66	SUB3 [Ant F]	TRX - LTE LTE B48 - NR N48/77/78 TX SRS - NR N48/77/78(SRS0)
		SUB4 [Ant G]	DRX MIMO - LTE B48 - NR N48/77/78 TX SRS - N48/77/78(SRS3) PRX MIMO - LTE B41 - NR N41
		SUB5 [Ant H]	DRX - LTE B48 - NR N48/77/78 TX SRS NR N48/77/78(SRS2) DRX MIMO - LTE B41 - NR N41

Figure 5- 1 Antenna placement of the phone

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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 5-2 shows the block diagram of the measurement bench, which supports the following test scenarios.

- Test scenario 1: Change in requested power
- Test scenario 3: Change in operating state
- Test scenario 7: Change in modulation scheme
- Test scenario 8: Dropped connection

For these measurements, RF port of the call box is connected to the EUT's antenna port through a directional coupler, whose specification is shown in Table 5-1, 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 5-2 are relegated in Figure A-1 in Appendix A.

Table 5-1 Specification of directional coupler

Woken WCOU-0.4-26.5S-10-01 0.4-26.5GHz 10dB 20W SMA Directional Coupler	
Electrical Specification	
Frequency	0.4 – 26.5 GHz
impedance	50 Ohm
Coupling Accuracy	10+-0.8dB
Insertion Loss	1.7dB Max.
Power	Avg.:20W

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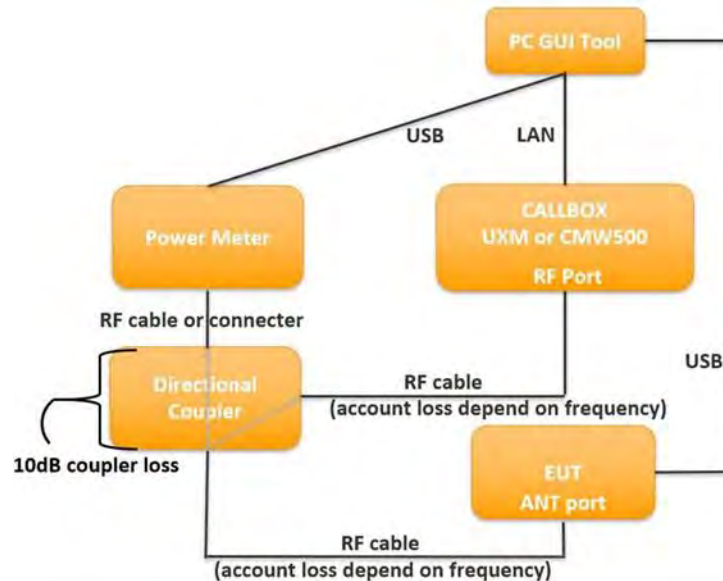


Figure 5- 2 TA-SAR conductive power test setup block diagram for scenarios 1/3/7/8

Figure 5-3 shows the block diagram of the measurement bench, which supports test scenario 2 (antenna switching), scenario 4 (frequency band hand-off or redirect), and scenario 6 (switching between TDD and FDD configurations). 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 three test scenarios. The pictures for these three setups are shown in Figure A-2 in Appendix A.

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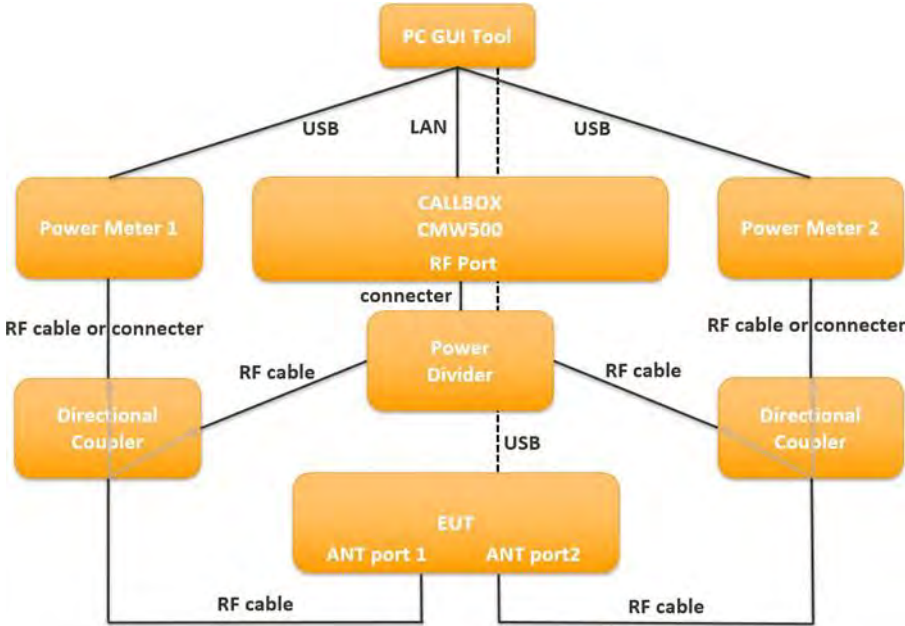


Figure 5-3 TA-SAR conductive power test setup block diagram for scenarios 2/4/6

Figure 5-4 shows the setup for test scenario 5.1 (technology hand-off) and scenario 5.2/5.3 (SAR exposure switch, EN-DC/ULCA). Since two RATs /Bands need to be controlled in this scenario, RF port of RAT/Band 1 and RF port of RAT/Band 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/Bands individually transmit signals through one antenna port. The antenna port assignment of each RAT/Band for these two scenarios is described in Figure 5-1. The pictures of Figure 5-4 are shown in Figures A-3 and A-4 in Appendix A.

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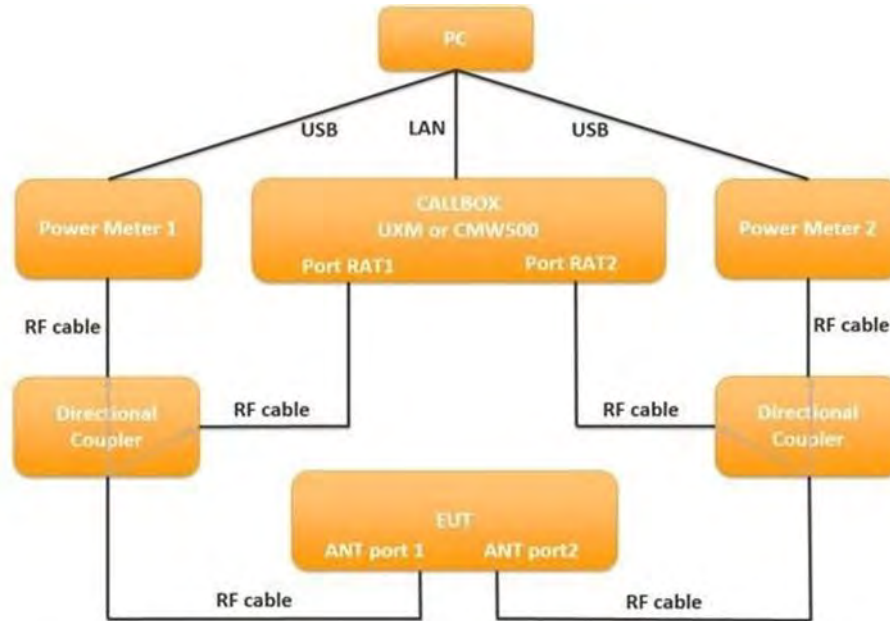


Figure 5-4 TA-SAR conductive power test setup block diagram for scenarios 5.1/5.2/5.3

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5.1.2 Sub6 NR/LTE/WCDMA/2G Power Limit Table and Test Configurations

For the supported bands/antennas/duty cycle/operating states (ECI) of each technology, the nominal time-averaged TX power limit $P_{limit,nom}$, corresponding to $SAR_{target,nom}$, and $P_{max,nom}$ are listed as burst-power and frame-averaged levels in Table 5-2. Note that $SAR_{target,nom}$ is obtained by scaling down from SAR_{target} with uncertainty (see section 2.1). For TDD bands with TX duty cycles less than or equal to 100%, burst-power level does not account for TX duty cycle, in contrast, frame-averaged power level does account for TX duty cycle.

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Table 5-2 Summary table of $P_{limit,nom}$ and $P_{max,nom}$ for all supported RAT

RAT	Band	ANT	Duty cycle (%)	$P_{limit,nom}$ (dBm) Setting								$P_{max,nom}$ (dBm) Setting	
				ECI 1 RCV		ECI 2 HOTSPOT		ECI 3 EarJack		ECI 0 Free			
				burst-power	frame-averaged power	burst-power	frame-averaged power	burst-power	frame-averaged power	burst-power	frame-averaged power	burst-power	frame-averaged power
2G GSM	850	A(M1)	12.5	37.03	28.00	33.33	24.30	33.33	24.30	33.33	24.30	32.50	23.47
2G GPRS	850 1Tx	A(M1)	12.5	37.03	28.00	33.33	24.30	33.33	24.30	33.33	24.30	32.50	23.47
2G GPRS	850 2Tx	A(M1)	25	34.02	28.00	30.32	24.30	30.32	24.30	30.32	24.30	29.50	23.48
2G GPRS	850 3Tx	A(M1)	37.5	32.26	28.00	28.56	24.30	28.56	24.30	28.56	24.30	28.00	23.74
2G GPRS	850 4Tx	A(M1)	50	31.01	28.00	27.31	24.30	27.31	24.30	27.31	24.30	26.50	23.49
2G GSM	1900	B(M2)	12.5	39.03	30.00	30.63	21.60	30.63	21.60	30.63	21.60	29.50	20.47
2G GPRS	1900 1Tx	B(M2)	12.5	39.03	30.00	30.63	21.60	30.63	21.60	30.63	21.60	29.50	20.47
2G GPRS	1900 2Tx	B(M2)	25	36.02	30.00	27.62	21.60	27.62	21.60	27.62	21.60	27.00	20.98
2G GPRS	1900 3Tx	B(M2)	37.5	34.26	30.00	25.86	21.60	25.86	21.60	25.86	21.60	25.00	20.74
2G GPRS	1900 4Tx	B(M2)	50	33.01	30.00	24.61	21.60	24.61	21.60	24.61	21.60	24.00	20.99
3G WCDMA	II	B(M2)	100	22.00	22.00	20.00	20.00	20.00	20.00	20.00	20.00	24.00	24.00
3G WCDMA	IV	B(M2)	100	22.50	22.50	20.00	20.00	20.00	20.00	20.00	20.00	24.00	24.00
3G WCDMA	V	A(M1)	100	23.50	23.50	23.50	23.50	23.50	23.50	23.50	23.50	24.50	24.50
4G LTE	B2	B(M2)	100	29.60	29.60	19.50	19.50	19.50	19.50	19.50	19.50	24.50	24.50
	B2	C(M3)	100	21.50	21.50	20.00	20.00	20.00	20.00	20.00	20.00	24.50	24.50
	B4	B(M2)	100	30.00	30.00	19.50	19.50	19.50	19.50	19.50	19.50	24.50	24.50
	B4	C(M3)	100	21.50	21.50	20.00	20.00	20.00	20.00	20.00	20.00	24.50	24.50
	B5	A(M1)	100	28.90	28.90	23.50	23.50	23.50	23.50	23.50	23.50	24.50	24.50
	B7	B(M2)	100	27.70	27.70	19.00	19.00	19.00	19.00	19.00	19.00	23.00	23.00
	B12	A(M1)	100	31.00	31.00	26.30	26.30	26.30	26.30	26.30	26.30	24.50	24.50
	B13	A(M1)	100	28.70	28.70	20.50	20.50	20.50	20.50	20.50	20.50	23.50	23.50
	B14	A(M1)	100	29.50	29.50	20.50	20.50	20.50	20.50	20.50	20.50	23.50	23.50
	B25	B(M2)	100	29.60	29.60	19.50	19.50	19.50	19.50	19.50	19.50	24.50	24.50
	B25	C(M3)	100	21.50	21.50	20.00	20.00	20.00	20.00	20.00	20.00	24.50	24.50
	B26	A(M1)	100	28.90	28.90	23.50	23.50	23.50	23.50	23.50	23.50	24.50	24.50
	B30	B(M2)	100	29.50	29.50	19.00	19.00	19.00	19.00	19.00	19.00	23.00	23.00
	B38	B(M2)	63.3	28.79	26.80	24.79	22.80	24.79	22.80	24.79	22.80	23.00	21.01
	B41 PC3	B(M2)	63.3	28.79	26.80	24.79	22.80	24.79	22.80	24.79	22.80	24.00	22.01
	B41 PC2	B(M2)	43.3	30.44	26.80	26.44	22.80	26.44	22.80	26.44	22.80	25.50	21.86
	B48	F(S3)	63.3	19.00	17.01	24.39	22.40	24.39	22.40	24.39	22.40	23.00	21.01
	B66	B(M2)	100	30.00	30.00	19.50	19.50	19.50	19.50	19.50	19.50	24.50	24.50
B66	C(M3)	100	21.50	21.50	20.00	20.00	20.00	20.00	20.00	20.00	24.50	24.50	
B71	A(M1)	100	31.40	31.40	27.00	27.00	27.00	27.00	27.00	27.00	24.50	24.50	
5G NR	n2	B(M2)	100	30.20	30.20	19.50	19.50	19.50	19.50	19.50	19.50	24.50	24.50
	n2	C(M3)	100	21.50	21.50	20.00	20.00	20.00	20.00	20.00	20.00	24.50	24.50
	n5	A(M1)	100	28.10	28.10	23.50	23.50	23.50	23.50	23.50	23.50	24.50	24.50
	n25	B(M2)	100	30.20	30.20	19.50	19.50	19.50	19.50	19.50	19.50	24.50	24.50
	n41	B(M2)	100	17.00	17.00	17.00	17.00	17.00	17.00	17.00	17.00	26.00	26.00
	n48	F(S3)	100	13.00	13.00	17.00	17.00	17.00	17.00	17.00	17.00	23.00	23.00
	n66	B(M2)	100	30.20	30.20	19.50	19.50	19.50	19.50	19.50	19.50	24.50	24.50
	n66	C(M3)	100	21.50	21.50	20.00	20.00	20.00	20.00	20.00	20.00	24.00	24.00
	n70	B(M2)	100	29.10	29.10	22.00	22.00	22.00	22.00	22.00	22.00	24.50	24.50
	n71	A(M1)	100	30.60	30.60	27.90	27.90	27.90	27.90	27.90	27.90	24.50	24.50
	n77	F(S3)	100	15.00	15.00	16.00	16.00	16.00	16.00	16.00	16.00	26.00	26.00
n78	F(S3)	100	15.00	15.00	16.00	16.00	16.00	16.00	16.00	16.00	26.00	26.00	

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In this evaluation, 1-dB device uncertainty is considered for Mediatek's internal device. To further verify that, Table 5-3 summarizes the conducted test configurations of all RATs and shows the deviation of nominal and measured power limit or maximum. The table shows that the deviation of $P_{limit,nom}$ and measured $P_{limit,nom}$ (i.e., $Meas. P_{limit,nom} - P_{limit,nom}$) for each configuration is within 1-dB. Likewise, the deviation of $P_{max,nom}$ and measured $P_{max,nom}$ (i.e., $Meas. P_{max,nom} - P_{max,nom}$) for each configuration is within 1-dB as well.

Table 5-3 Conducted Test configurations of radio technologies and measured $P_{limit,nom}$ and $P_{max,nom}$

Test Case	Test Scenario	Test band	Test Sequence	BW (MHz)	Modulation	duty cycle	RB size	RB offset	Test Position	Gap (mm)	ANT	ANT Index	ANT state (TX/RX)	ECI	UL Channel	UL Freq (MHz)	DL Channel	DL Freq (MHz)	Part 1 SAR@P _{limit} 1-5dB (W/kg)	SAR req.	Meas. P _{limit,nom}	Meas. P _{max,nom}	P _{limit,nom}	P _{max,nom}	min power duration	duration 1	drop call	duration 2	duration 3
0		WCDMA Band II	1	N/A	RMC	100.00%	N/A	N/A	Bottom Edge	50	BiMO	1	0/0	2	9400	1880	9800	1860	0.224	1.6	18.72	23.76	20.00	24.00	0	400		400	
1		LTE Band 7	1	20	QPSK	100.00%	50	0	Back Side	50	BiMO	1	0/0	2	20800	3520	2850	2650	0.368	1.6	28.6	32.6	19.00	23.00	0	400		400	
2		LTE Band 13	1	10	QPSK	100.00%	1	40	Back Side	50	BiMO	1	0/0	2	23220	782	5230	751	0.203	1.6	21.04	23.50	20.50	23.50	0	400		400	
3		LTE Band 40	1	20	QPSK	43.30%	1	0	Right Check	0	F133	5	0/1	1	55773	3603	55773	3603	0.299	1.6	17.85	21.78	17.01	21.01	0	400		400	
4		FR1 n25	1	40	QPSK(DFT+OFDM)	100.00%	108	54	Back Side	50	BiMO	1	0/0	2	376500	1882	392500	1862.5	0.277	1.6	19.7	24.58	19.50	24.50	0	400		400	
5		FR1 n48	1	40	QPSK (CP-OFDM)	100.00%	1	1	Right Check	0	F133	5	0/1	1	641666	3624.99	641666	3624.99	0.188	1.6	11.53	21.64	13.00	23.00	0	400		400	
6		WCDMA Band II	2	N/A	RMC	100.00%	N/A	N/A	Bottom Edge	50	BiMO	1	0/0	2	9400	1880	9800	1860	0.224	1.6	18.72	23.76	20.00	24.00	0	400		400	
7		LTE Band 7	2	20	QPSK	100.00%	50	0	Back Side	50	BiMO	1	0/0	2	20800	3520	2850	2650	0.368	1.6	28.6	32.6	19.00	23.00	0	400		400	
8	1. Changes in requested power (constant + near field)	LTE Band 13	2	10	QPSK	100.00%	1	40	Back Side	50	BiMO	1	0/0	2	23220	782	5230	751	0.203	1.6	21.04	23.50	20.50	23.50	0	400		400	
9		LTE Band 40	2	20	QPSK	43.30%	1	0	Right Check	0	F133	5	0/1	1	55773	3603	55773	3603	0.299	1.6	17.85	21.78	17.01	21.01	0	400		400	
10		FR1 n25	2	40	QPSK(DFT+OFDM)	100.00%	108	54	Back Side	50	BiMO	1	0/0	2	376500	1882	392500	1862.5	0.277	1.6	19.7	24.58	19.50	24.50	0	400		400	
11		FR1 n48	2	40	QPSK (CP-OFDM)	100.00%	1	1	Right Check	0	F133	5	0/1	1	641666	3624.99	641666	3624.99	0.188	1.6	11.53	21.64	13.00	23.00	0	400		400	
12		WCDMA Band II	3(4)	N/A	RMC	100.00%	N/A	N/A	Bottom Edge	50	BiMO	1	0/0	2	9400	1880	9800	1860	0.224	1.6	18.72	23.76	20.00	24.00	0	800		800	
13		LTE Band 7	3(4)	20	QPSK	100.00%	50	0	Back Side	50	BiMO	1	0/0	2	20800	3520	2850	2650	0.368	1.6	28.6	32.6	19.00	23.00	0	800		800	
14		LTE Band 13	3(4)	10	QPSK	100.00%	1	40	Back Side	50	BiMO	1	0/0	2	23220	782	5230	751	0.203	1.6	21.04	23.50	20.50	23.50	0	400		400	
15		LTE Band 40	3(4)	20	QPSK	43.30%	1	0	Right Check	0	F133	5	0/1	1	55773	3603	55773	3603	0.299	1.6	17.85	21.78	17.01	21.01	0	400		400	
16		FR1 n25	3(4)	40	QPSK(DFT+OFDM)	100.00%	108	54	Back Side	50	BiMO	1	0/0	2	376500	1882	392500	1862.5	0.277	1.6	19.7	24.58	19.50	24.50	0	800		800	
17		FR1 n48	3(4)	40	QPSK (CP-OFDM)	100.00%	1	1	Right Check	0	F133	5	0/1	1	641666	3624.99	641666	3624.99	0.188	1.6	11.53	21.64	13.00	23.00	0	800		800	
18	1. Change in operating state	FR1 n48	0	40	QPSK (CP-OFDM)	100.00%	1	1	N/A	50	F133	5	0/1	2	641666	3624.99	641666	3624.99	0.188	1.6	15.56	21.62	17.00	23.00	540	720		720	
19		LTE Band 26	0	15	QPSK	100.00%	1	74	N/A	0	BiMO	0	0/0	2	26865	831.5	2475	876.5	0.52	1.6	23.09	23.50	24.50	540	720		720		
20	4. Frequency band hand-off or redirect	LTE Band 25	0	20	QPSK	100.00%	1	0	N/A	50	BiMO	1	0/0	2	24365	1882	8365	1862.5	0.203	1.6	17.82	23.28	19.50	24.50	540	720		720	
21		LTE Band 20	0	20	QPSK	100.00%	1	40	N/A	50	BiMO	1	0/0	2	24365	1882	8365	1862.5	0.203	1.6	17.82	23.28	19.50	24.50	540	720		720	
22	15. Technology hand-off (S.1 handover)	LTE Band 26	0	15	QPSK	100.00%	1	74	N/A	0	BiMO	0	0/0	2	26865	831.5	2475	876.5	0.52	1.6	23.32	23.12	23.50	24.50	540	720		720	
23	1. SAR exposure switch (S.2 ENDC)	FR1 n25	0	40	QPSK(DFT+OFDM)	100.00%	108	54	N/A	50	BiMO	1	0/0	2	37710	1882	392500	1862.5	0.277	1.6	19.01	23.71	19.50	24.50	540	720		720	
24	6. Switching between TDD and FDD configurations	FR1 n48	0	40	QPSK (CP-OFDM)	100.00%	1	1	N/A	50	BiMO	1	0/0	2	641666	3624.99	641666	3624.99	0.188	1.6	15.56	21.62	17.00	23.00	540	720		720	
24	8. Dropped connection	FR1 n25	0	40	QPSK(DFT+OFDM)	100.00%	108	54	N/A	50	BiMO	1	0/0	2	376500	1882	392500	1862.5	0.277	1.6	19.08	23.99	19.50	24.50	540	720	10	720	

NOTE:

* $P_{limit,nom}$, $P_{max,nom}$, measured $P_{limit,nom}$, and measured $P_{max,nom}$ are frame-averaged power values in dBm, which take TX duty cycle into account for TDD bands with TX duty cycle less than or equal to 100%.

** P_{limit} deviation is compared to P_{max} since $P_{limit} > P_{max}$

For convenience, we repeat some information from section 2.1 as below:

- SAR_{target} is the $SAR_{target,nom}$ with 1-dB device uncertainty
- $P_{max,nom}$: a certain nominal maximum instantaneous TX power limit with a given operating state of EUT
- $P_{limit,nom}$: a certain nominal time-averaged TX power limit corresponding to $SAR_{target,nom}$ with a given operating state of EUT

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5.2 Conducted Power Measurement Results for Scenario 1: Change in Requested Power

In this scenario, Mediatek's TA-SAR algorithm is tested under dynamic power test sequences. The test sequence 1 is shown in section 4.1, and test sequences 2 and 3 are tabulated in Table 4-4 and Appendix B, respectively. All of the test cases for this scenario are relegated in Table 5-4, and the test procedure follows section 4.2.2. The measurement setup is shown in Figure 5-2. 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 guarantee the time-averaged SAR is always below the ISED requirement for all test cases. The following details will demonstrate case-by-case to show how Mediatek's TA-SAR algorithm behaves for each RAT.

Table 5-4 TA-SAR parameters setting for scenario 1

Test case	RAT	Test band	Test seq.	ECI	$P_{max,nom}$ (dBm)	$P_{limit,nom}$ (dBm)	$P_{LowThresh}$ (dBm)	$P_{UE_backoff}$ (dBm)	$P_{UE_max_cust}$ (dBm)	Pass or Fail SAR limit
0	WCDMA	Band 2	1	2	24.00	20.00	19.50	17.00	24.00	Pass
1	LTE	Band 7	1	2	23.00	19.00	18.50	16.00	23.00	Pass
2	LTE	Band 13	1	2	23.50	20.50	20.00	17.50	23.50	Pass
3	LTE	Band 48	1	1	21.01	17.01	16.51	14.01	21.01	Pass
4	FR1	n25	1	2	24.50	19.50	19.00	16.50	24.50	Pass
5	FR1	n48	1	1	23.00	13.00	12.50	10.00	23.00	Pass
6	WCDMA	Band 2	2	2	24.00	20.00	19.50	17.00	24.00	Pass
7	LTE	Band 7	2	2	23.00	19.00	18.50	16.00	23.00	Pass
8	LTE	Band 13	1	2	24.50	28.10	27.60	25.10	24.50	Pass
9	LTE	Band 48	2	1	23.50	20.50	20.00	17.50	23.50	Pass
10	FR1	n25	2	2	24.50	19.50	19.00	16.50	24.50	Pass
11	FR1	n48	2	1	23.00	13.00	12.50	10.00	23.00	Pass
12	WCDMA	Band 2	3(4)	2	24.00	20.00	19.50	17.00	24.00	Pass
13	LTE	Band 7	3(4)	2	23.00	19.00	18.50	16.00	23.00	Pass
14	LTE	Band 13	1	2	23.50	20.50	20.00	17.50	23.50	Pass
15	LTE	Band 48	3(4)	1	21.01	17.01	16.51	14.01	21.01	Pass
16	FR1	n25	3(4)	2	24.50	19.50	19.00	16.50	24.50	Pass

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17	FR1	n48	3(4)	1	23.00	13.00	12.50	10.00	23.00	Pass
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Note: All power items in above table are frame-averaged level

For the two figures of each test case, the first figure demonstrates ($P_{limit,nom}$, P_{limit} , and P_{max} are defined in section 2.1):

- Test sequence: requested power (test sequence for each case is defined in Table 5-4)
- inst. TX power: measured instantaneous conducted TX power
- time averaged TX power: calculated time-averaged conducted TX power over time
- $P_{limit,nom}$ and P_{limit} : power limit in dBm ($P_{limit} = P_{limit,nom} + 1dB \text{ uncertainty}$)
- P_{max} : capable maximum TX power in dBm ($P_{max} = P_{max,nom} + 1dB \text{ uncertainty}$)
- max time averaged TX power: maximum time-averaged conducted TX power value

The second figure demonstrates ($SAR_{target,nom}$ and SAR_{target} are defined in section 2.1):

- calculated 360s-avg SAR: calculated time-averaged 1gSAR or 10gSAR over time
 - Converted from calculated time-averaged conducted TX power following section 4.2.2
- $SAR_{target,nom}$ and SAR_{target} : $SAR_{target} = SAR_{target,nom} \times 10^{1dB \text{ uncertainty}/10}$
- REG SAR limit: ISED limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)
 - Larger than or equal to SAR_{target}
- max 360s-avg SAR: maximum time-averaged 1gSAR or 10gSAR value

According to the illustrations of each case, maximum time-averaged conducted TX power value $\leq P_{limit}$, showing that calculated time-averaged conducted TX power does not exceed P_{limit} at all times. Furthermore, maximum time-averaged SAR value $\leq SAR_{target}$, proving that the calculated time-averaged SAR does not exceed SAR_{target} at all times. In conclusion, all test cases of the scenario meet ISED requirement.

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5.2.1 Measurement results for NR

The corresponding detailed test procedure is described in section 4.2.2. All items in the below figures are illustrated as frame-averaged level.

According to the illustrations of each case, maximum time-averaged conducted TX power value $\leq P_{limit}$, showing that calculated time-averaged conducted TX power does not exceed P_{limit} at all times. Furthermore, maximum time-averaged SAR value $\leq SAR_{target}$, proving that the calculated time-averaged SAR does not exceed SAR_{target} at all times. In conclusion, all test cases of the scenario meet ISED requirement.

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- Case 4 in Table 5-4

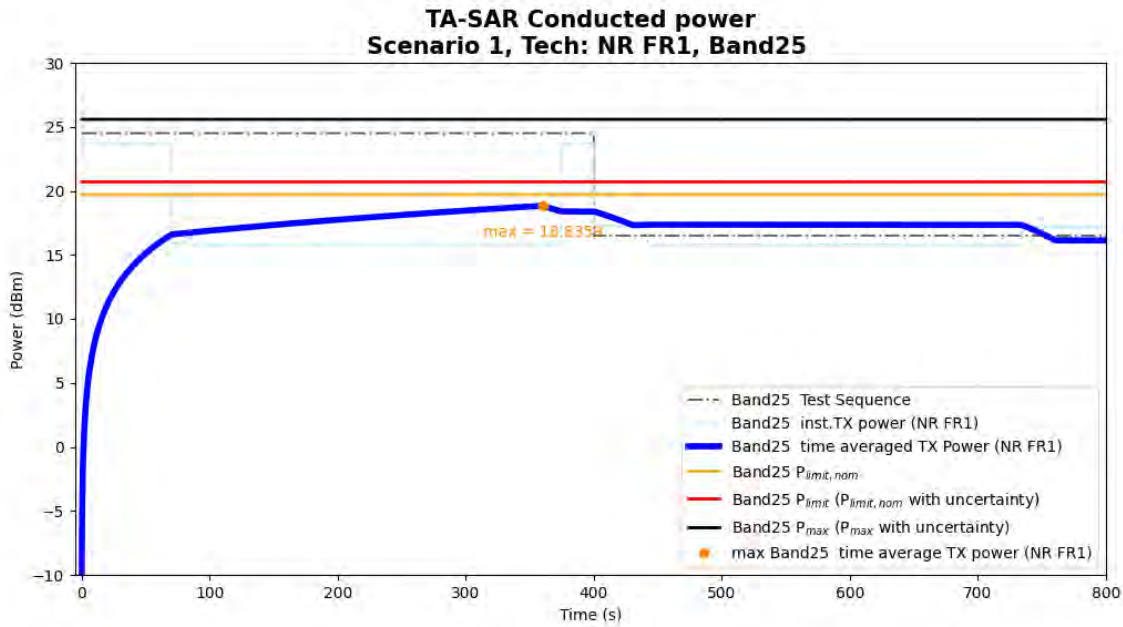


Figure 5-5 Time-averaged conducted TX power over time for case 4 (sub6 NR n25)

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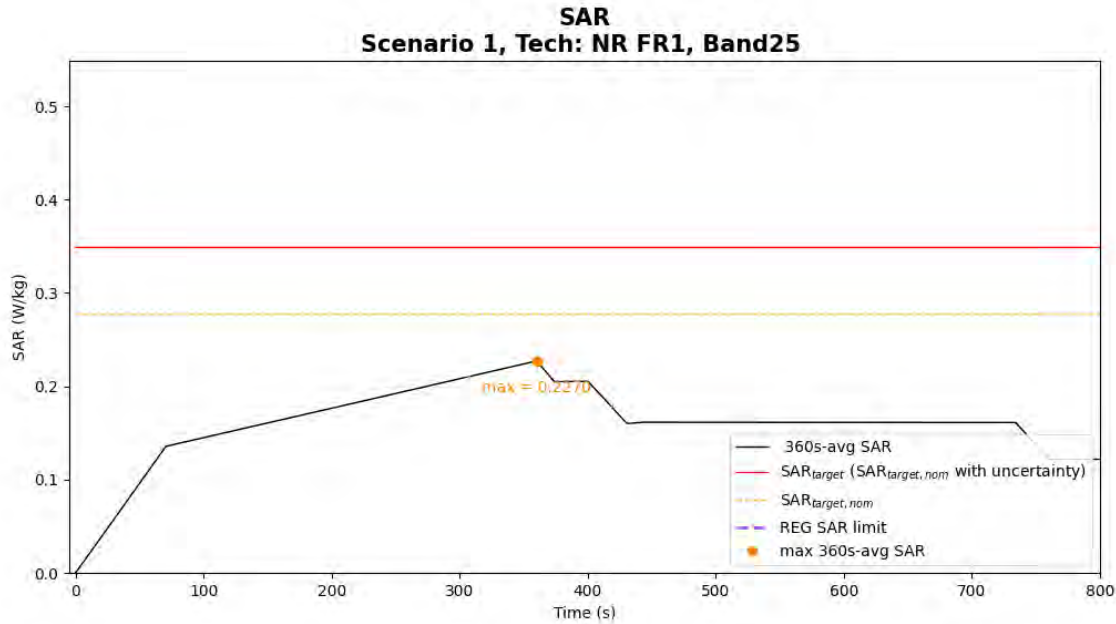


Figure 5-6 Time-averaged SAR for case 4 (sub6 NR n25)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.2270 W/kg
Validation result: pass	

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● Case 5 in Table 5-4

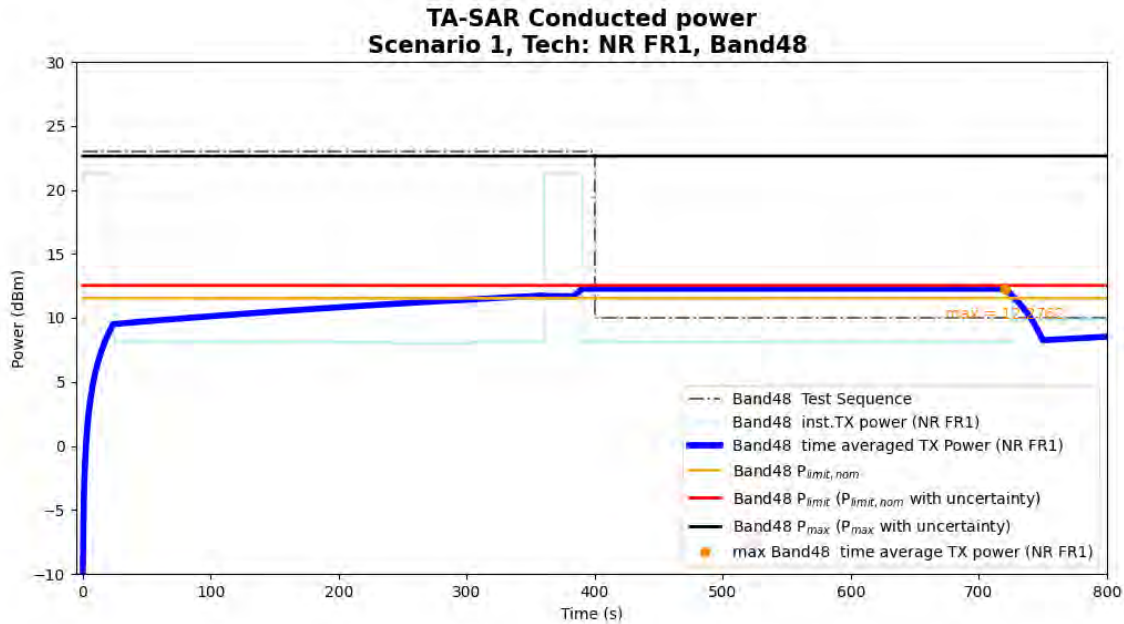


Figure 5-7 Time-averaged conducted TX power over time for case 5 (sub6 NR n48)

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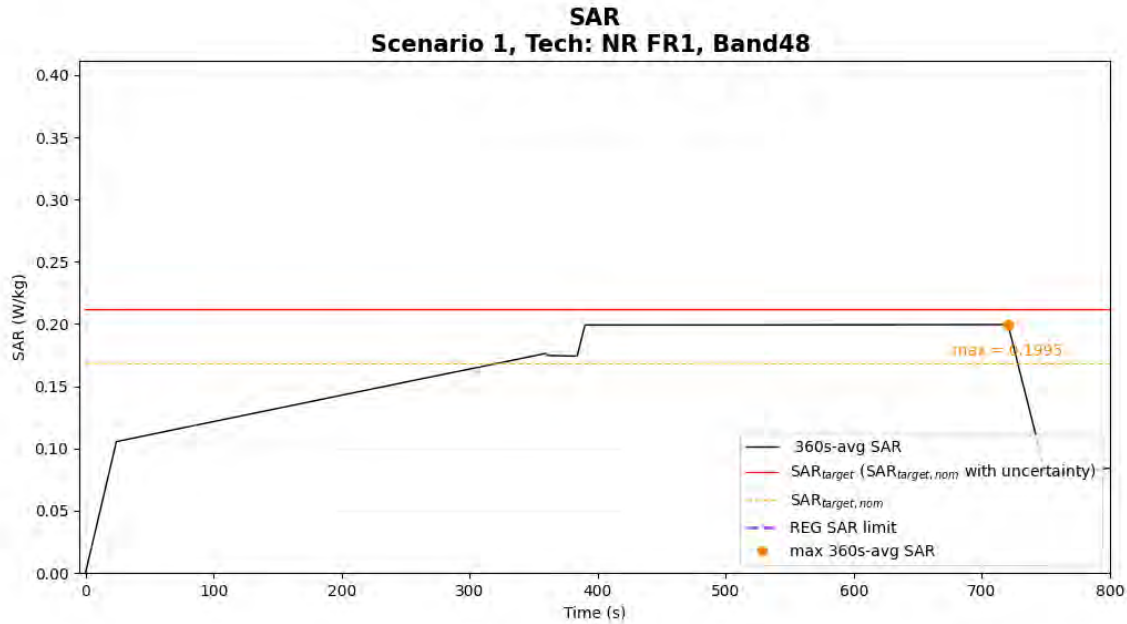


Figure 5-8 Time-averaged SAR for case 5 (sub6 NR n48)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.1995 W/kg
Validation result: pass	

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● Case 10 in Table 5-4

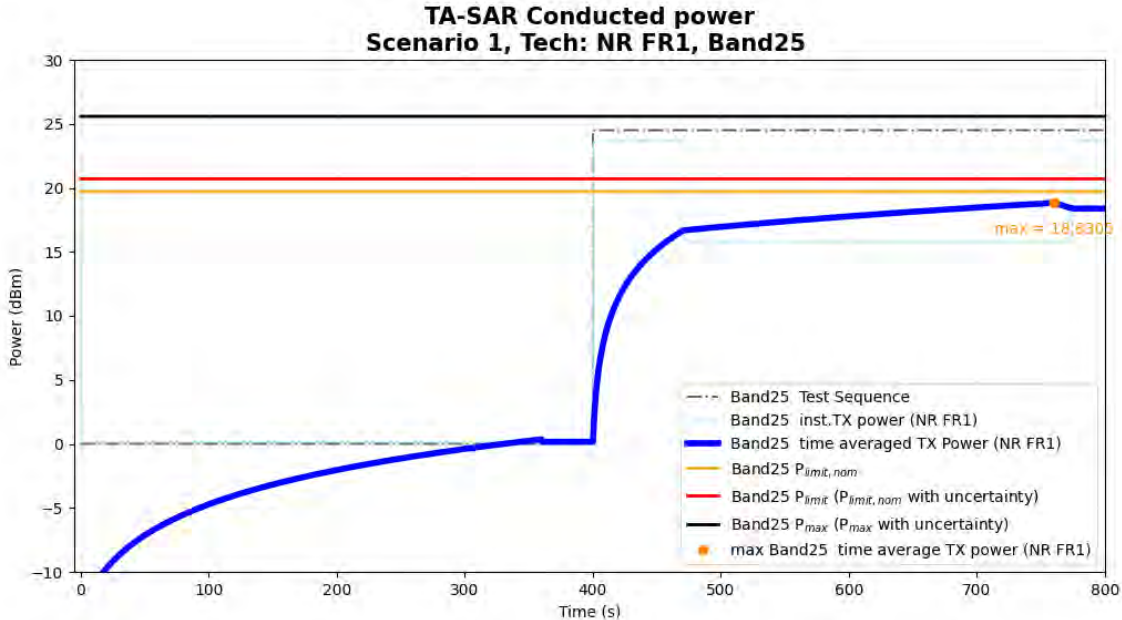


Figure 5-9 Time-averaged conducted TX power over time for case 10 (sub6 NR n25)

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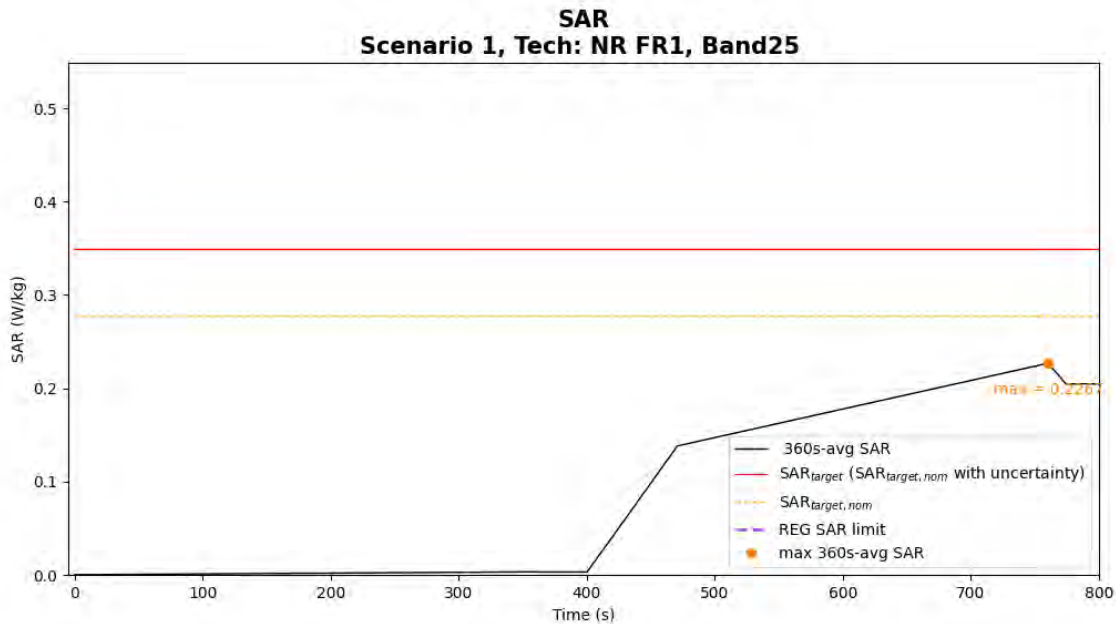


Figure 5-10 Time-averaged SAR for case 10 (sub6 NR n25)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.2267 W/kg
Validation result: pass	

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● Case 11 in Table 5-4

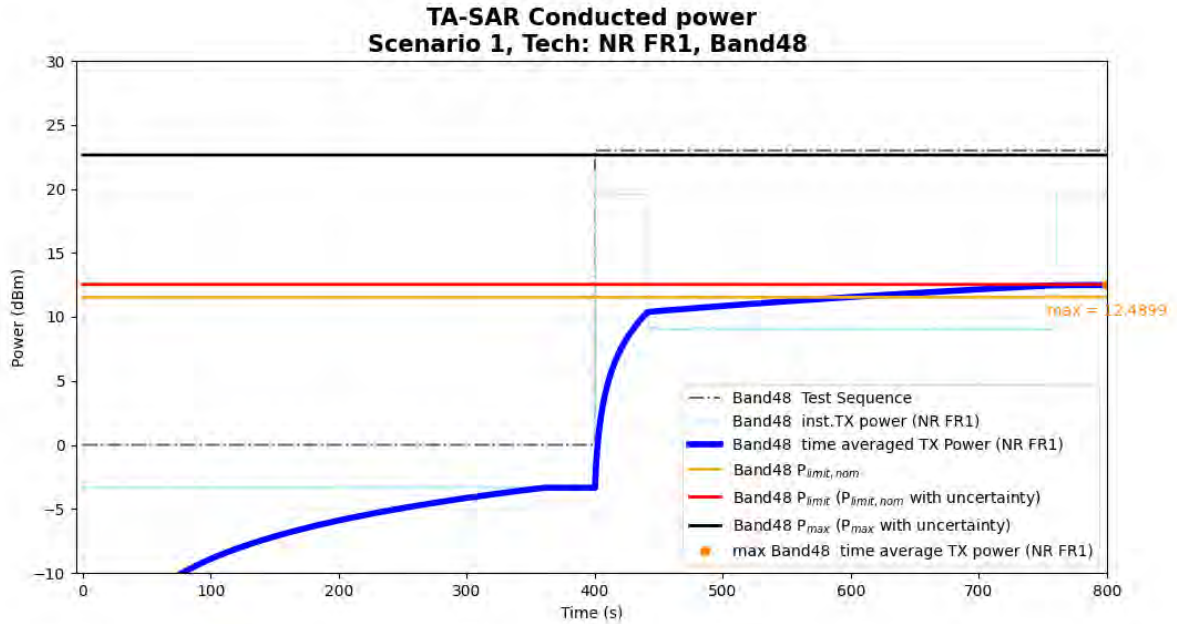


Figure 5-11 Time-averaged conducted TX power over time for case 11 (sub6 NR n48)

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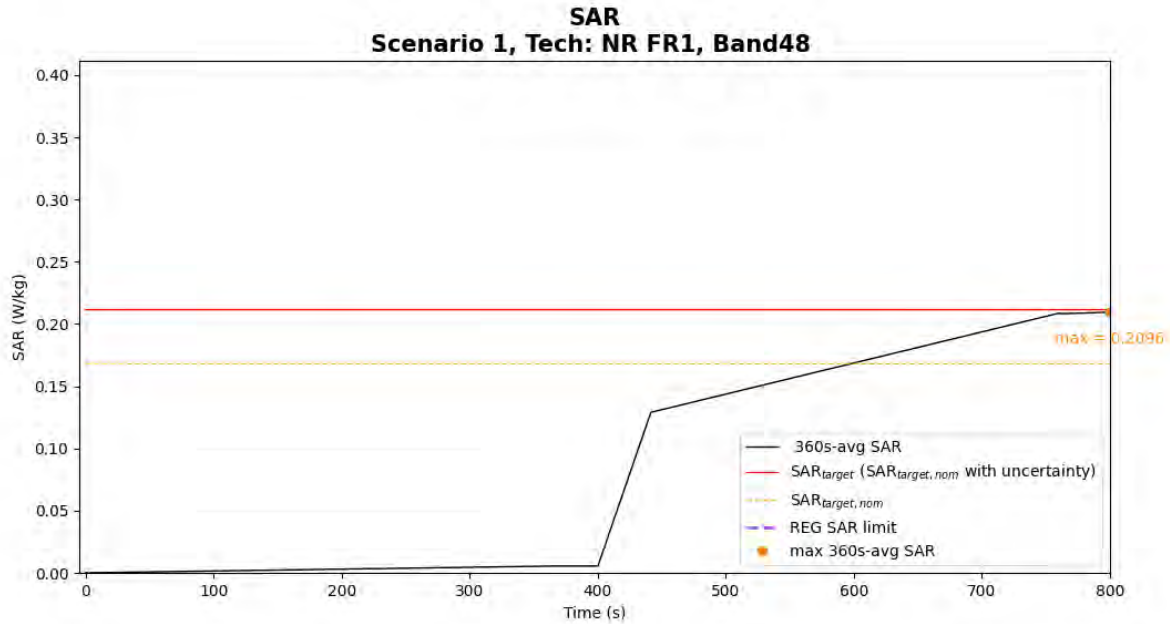


Figure 5-12 Time-averaged SAR for case 11 (sub6 NR n48)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.2096 W/kg
Validation result: pass	

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● Case 16 in Table 5-4

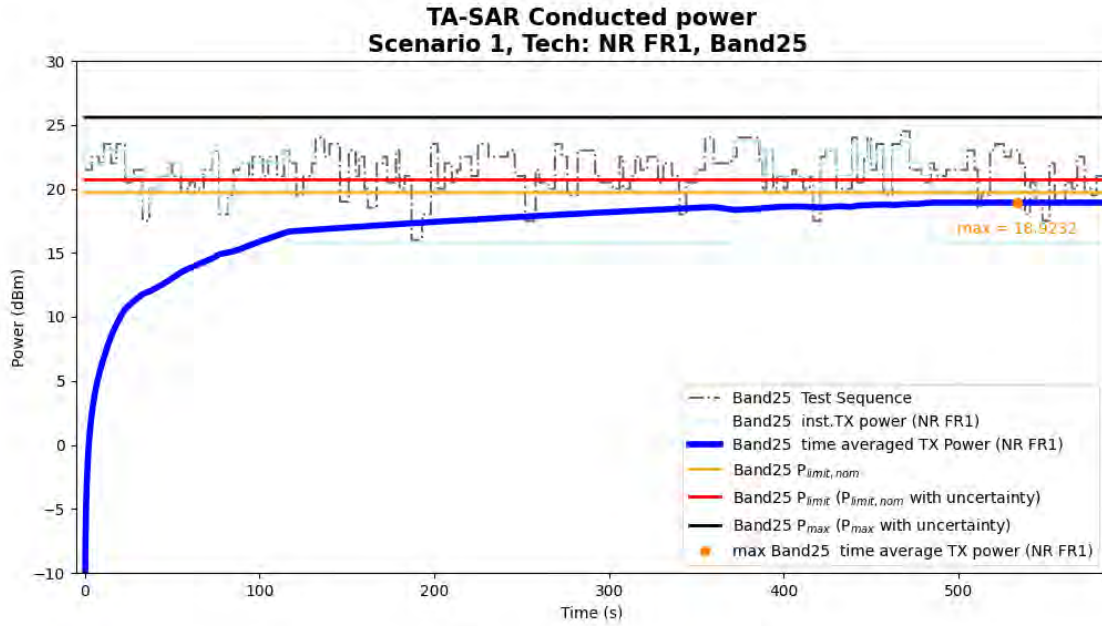


Figure 5-13 Time-averaged conducted TX power over time for case 16 (sub6 NR n25)

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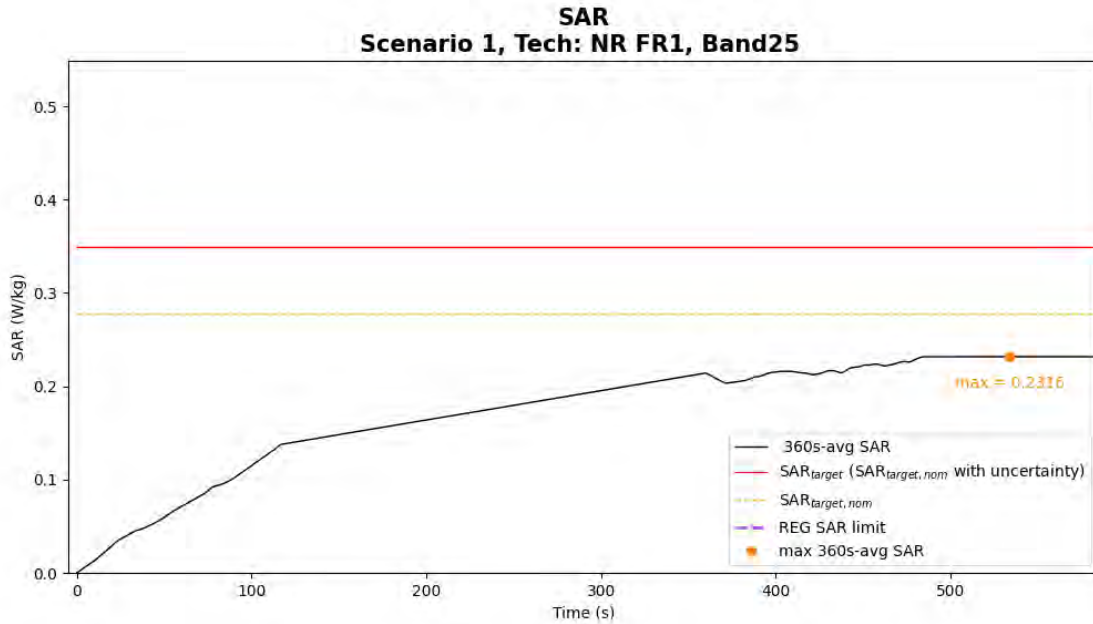


Figure 5-14 Time-averaged SAR for case 16 (sub6 NR n25)

ISED 1gSAR limit	1.6 W/kg
SAR _{target} (SAR _{target,nom} with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.2316 W/kg
Validation result: pass	

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● Case 17 in Table 5-4

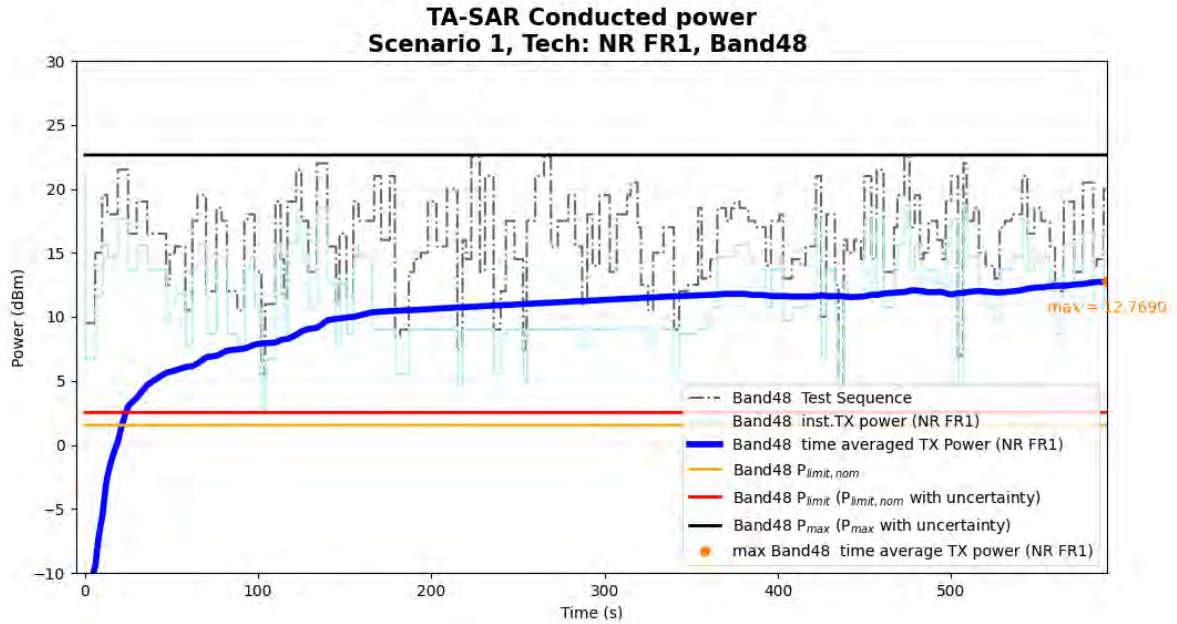


Figure 5-15 Time-averaged conducted TX power over time for case 17 (sub6 NR n48)

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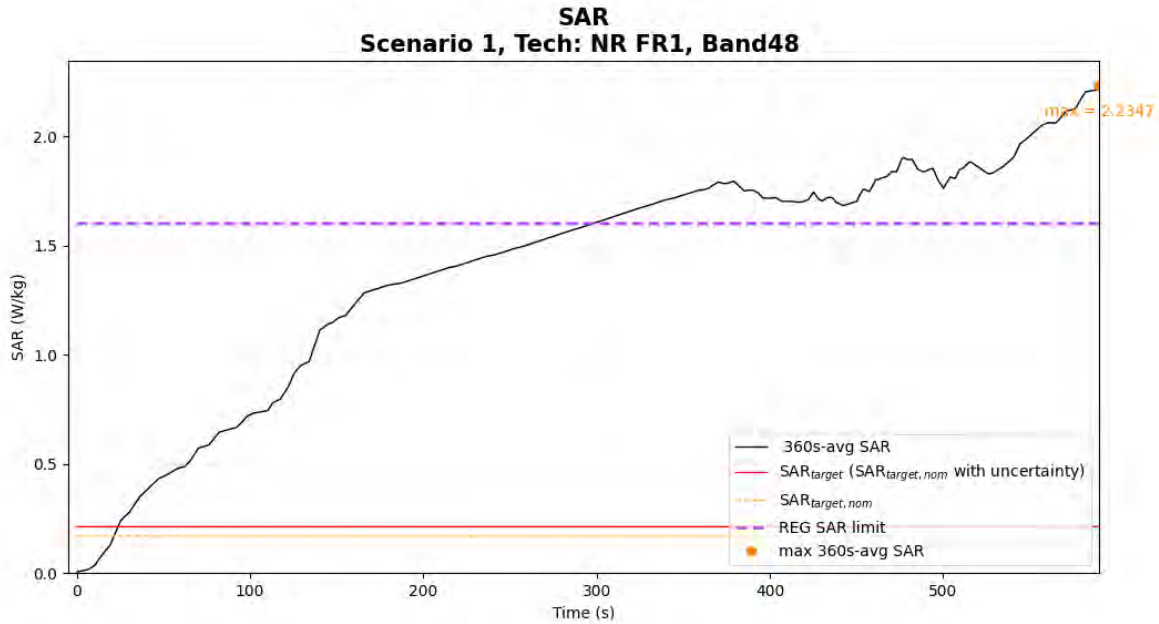


Figure 5-16 Time-averaged SAR for case 17 (sub6 NR n48)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	2.2347 W/kg
Validation result: pass	

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5.2.2 Measurement results for LTE

The corresponding detailed test procedure is described in section 4.2.2. All items in the below figures are illustrated as frame-averaged level.

According to the illustrations of each case, maximum time-averaged conducted TX power value $\leq P_{limit}$, showing that calculated time-averaged conducted TX power does not exceed P_{limit} at all times. Furthermore, maximum time-averaged SAR value $\leq SAR_{target}$, proving that the calculated time-averaged SAR does not exceed SAR_{target} at all times. In conclusion, all test cases of the scenario meet ISED requirement.

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● Case 1 in Table 5-4

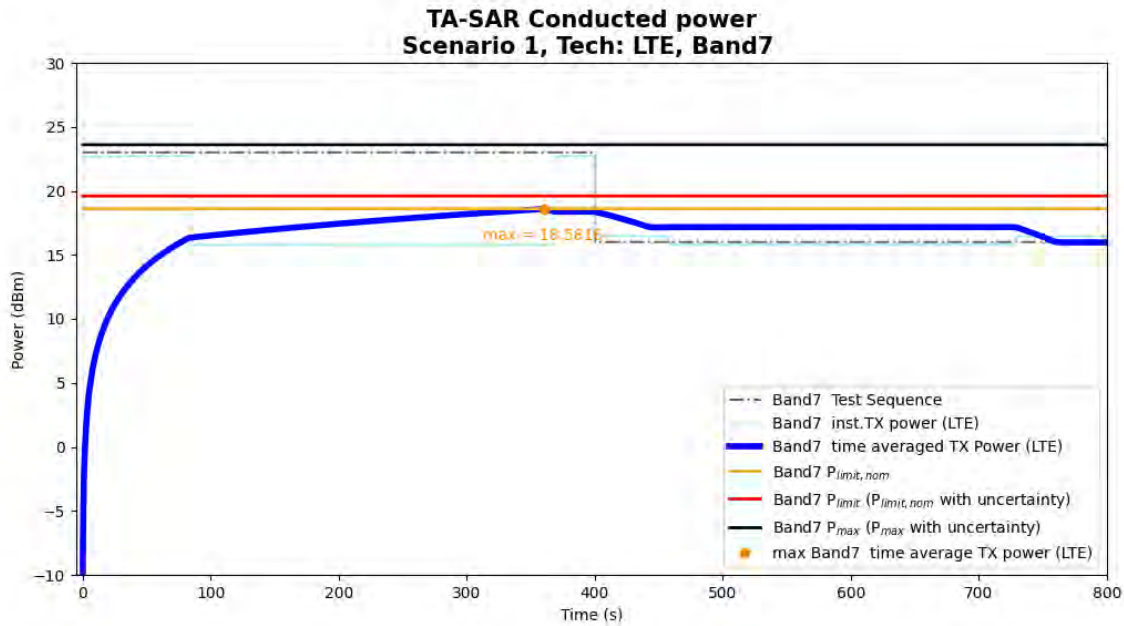


Figure 5-17 Time-averaged conducted TX power over time for case1 (LTE B7)

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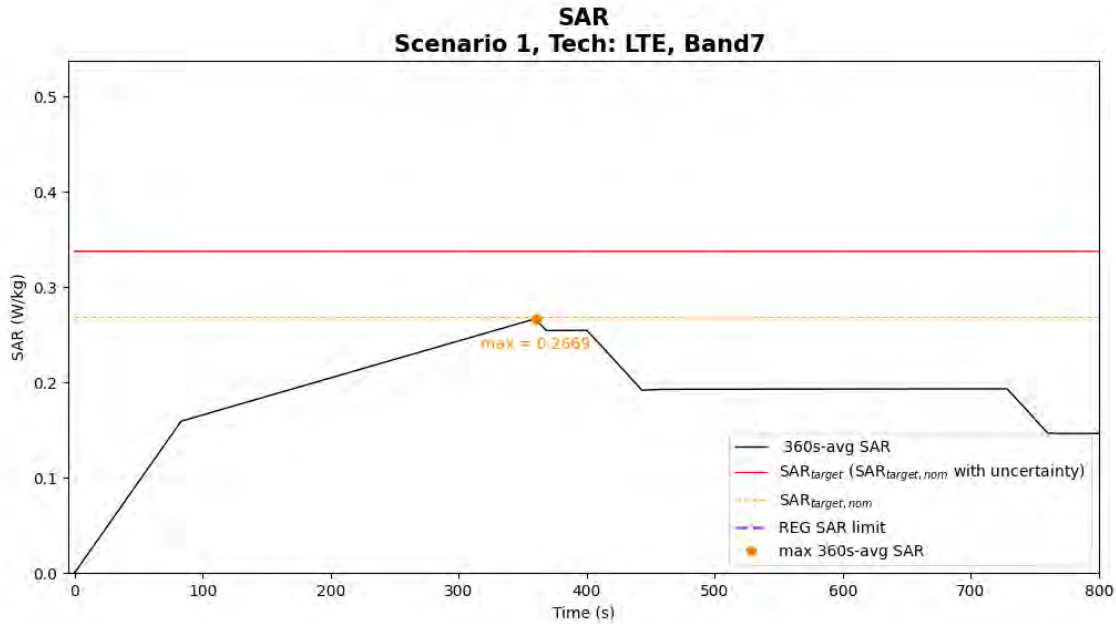


Figure 5-18 Time-averaged SAR for case1 (LTE B7)

ISED 1gSAR limit	1.6 W/kg
SAR _{target} (SAR _{target,nom} with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.2669 W/kg
Validation result: pass	

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● Case 3 in Table 5-4

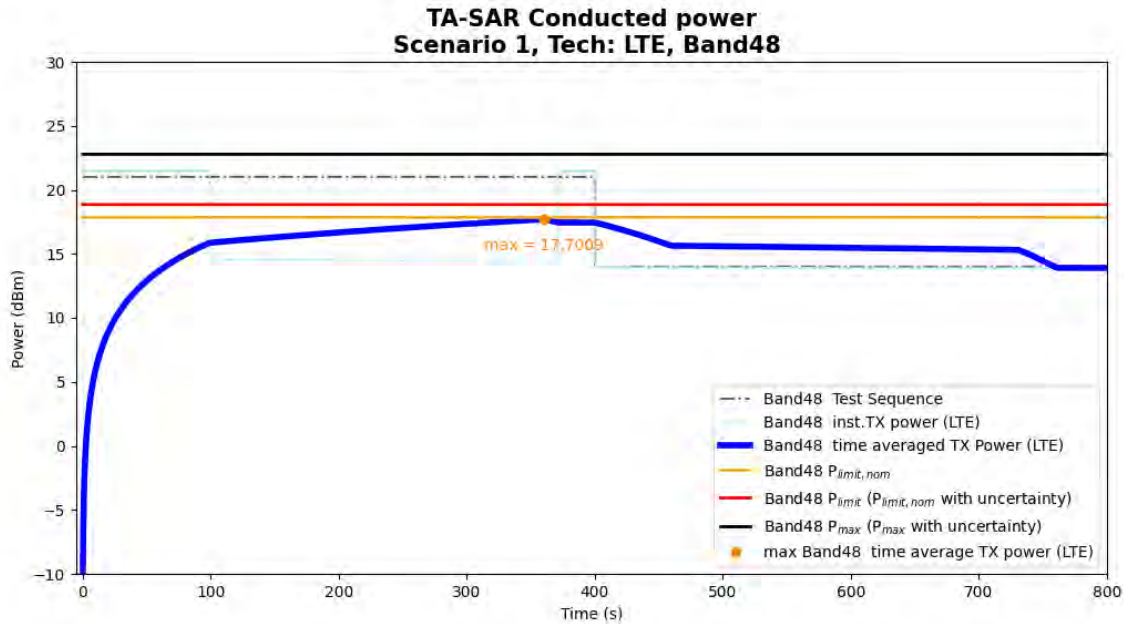


Figure 5-19 Time-averaged conducted TX power over time for case 3 (LTE B48)

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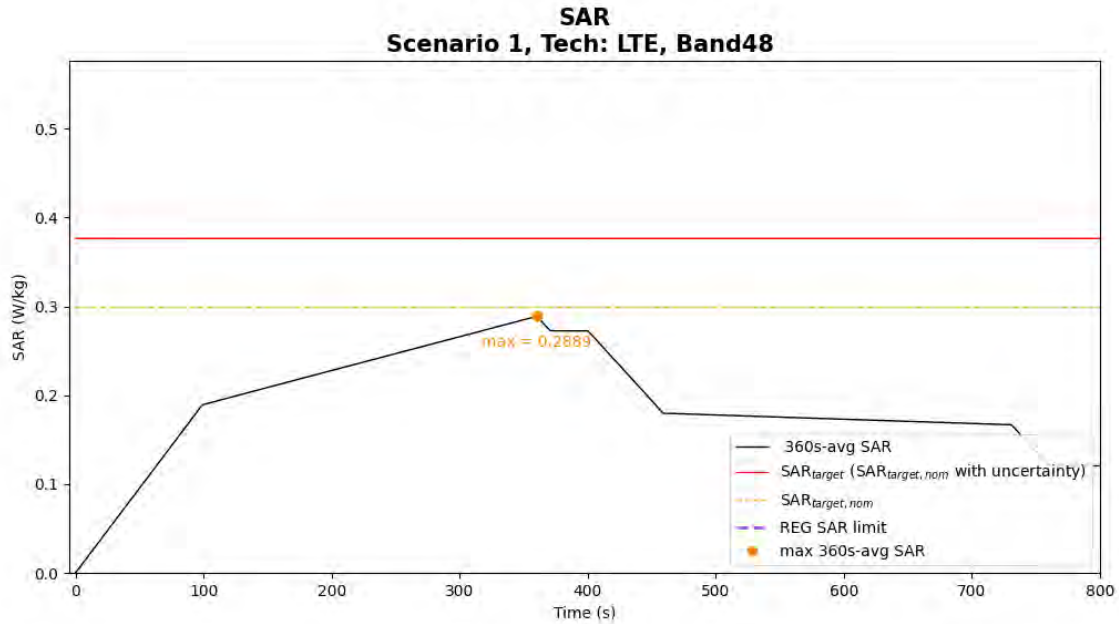


Figure 5-20 Time-averaged SAR for case 3 (LTE B48)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.2889 W/kg
Validation result: pass	

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● Case 7 in Table 5-4

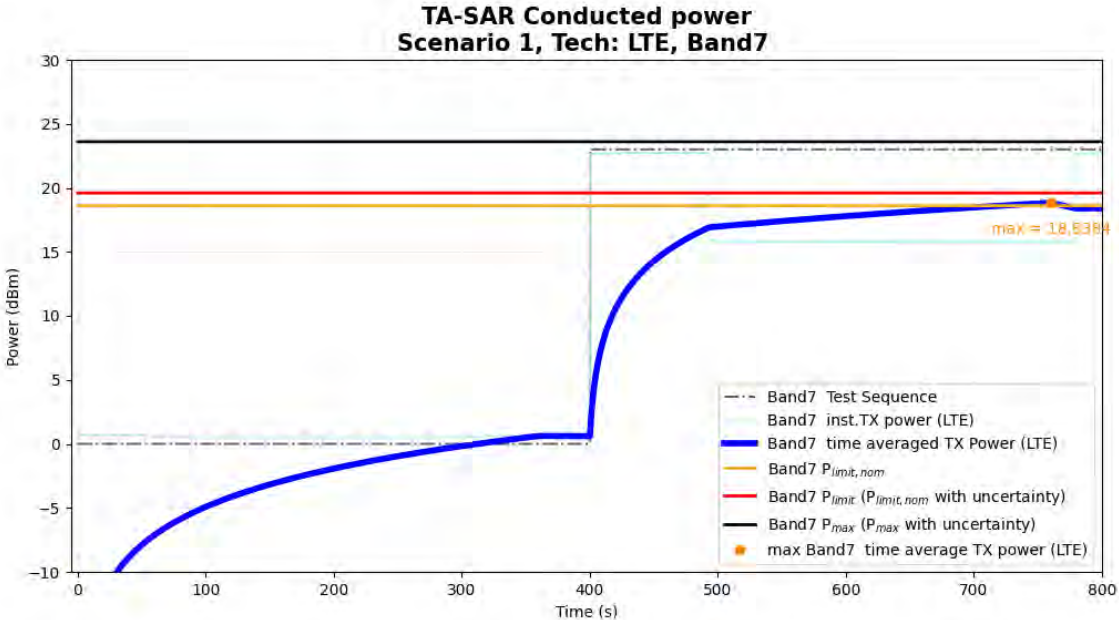


Figure 5-21 Time-averaged conducted TX power over time for case 7 (LTE B7)

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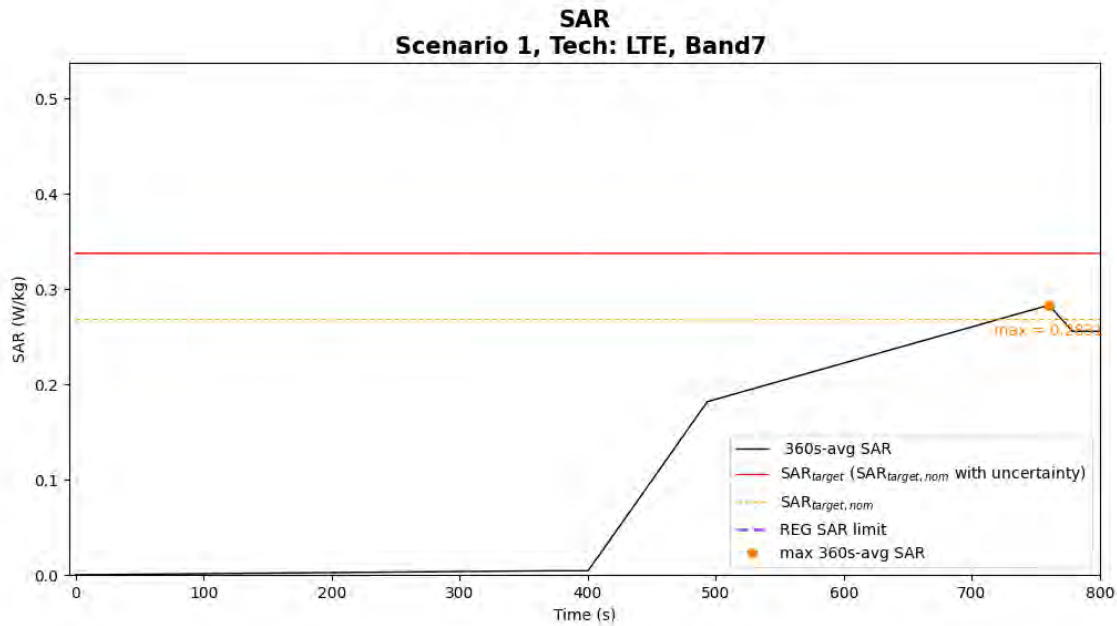


Figure 5-22 Time-averaged SAR for case 7 (LTE B7)

ISED 1gSAR limit	1.6 W/kg
SAR _{target} (SAR _{target,nom} with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.2831 W/kg
Validation result: pass	

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● Case 9 in Table 5-4

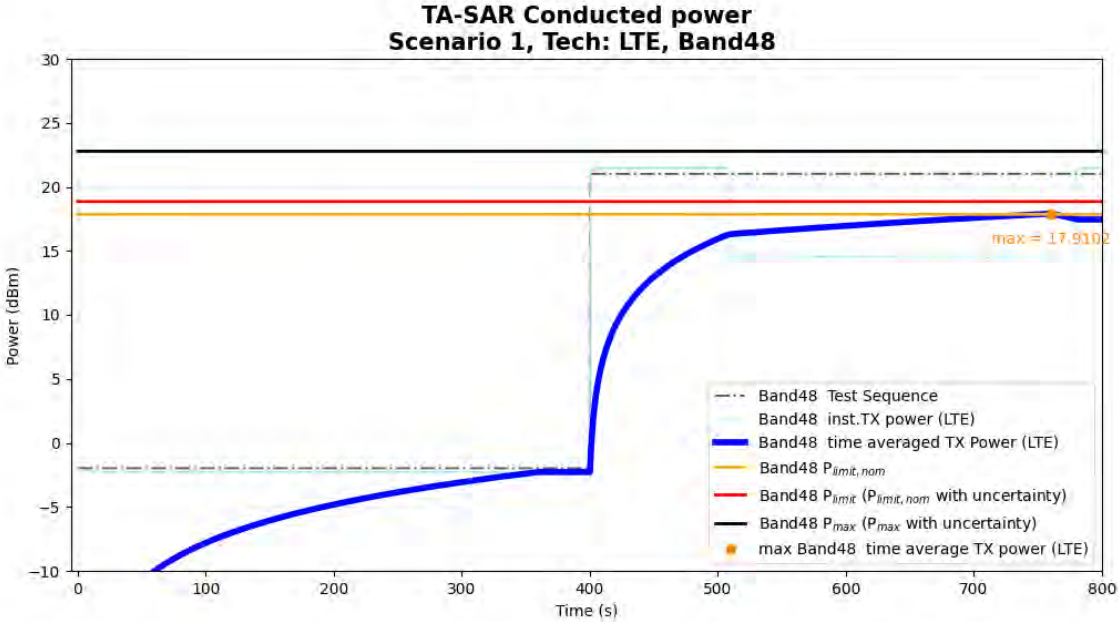


Figure 5-23 Time-averaged conducted TX power over time for case 9 (LTE B48)

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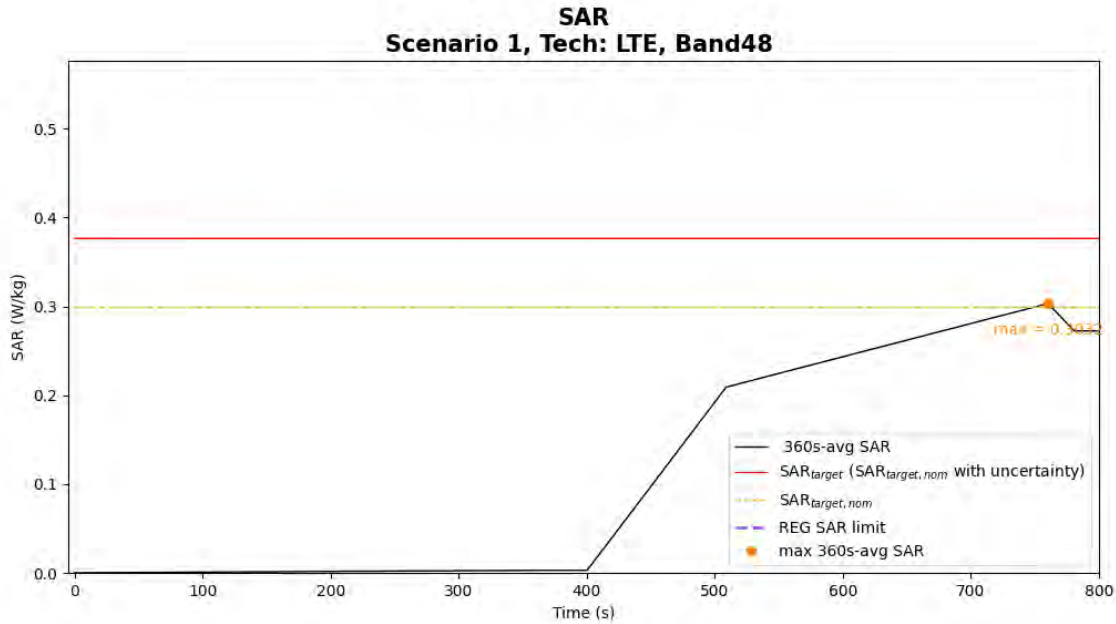


Figure 5-24 Time-averaged SAR for case 9 (LTE B48)

ISED 1gSAR limit	1.6 W/kg
SAR _{target} (SAR _{target,nom} with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.3031 W/kg
Validation result: pass	

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● Case 13 in Table 5-4

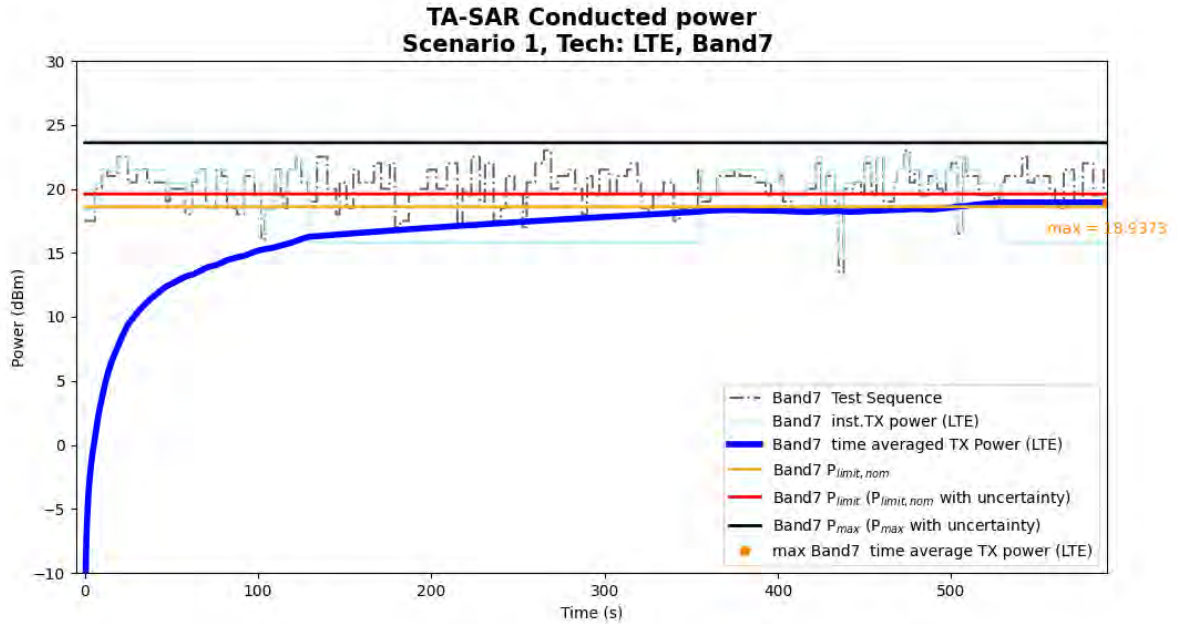


Figure 5-25 Time-averaged conducted TX power over time for case 13 (LTE B7)

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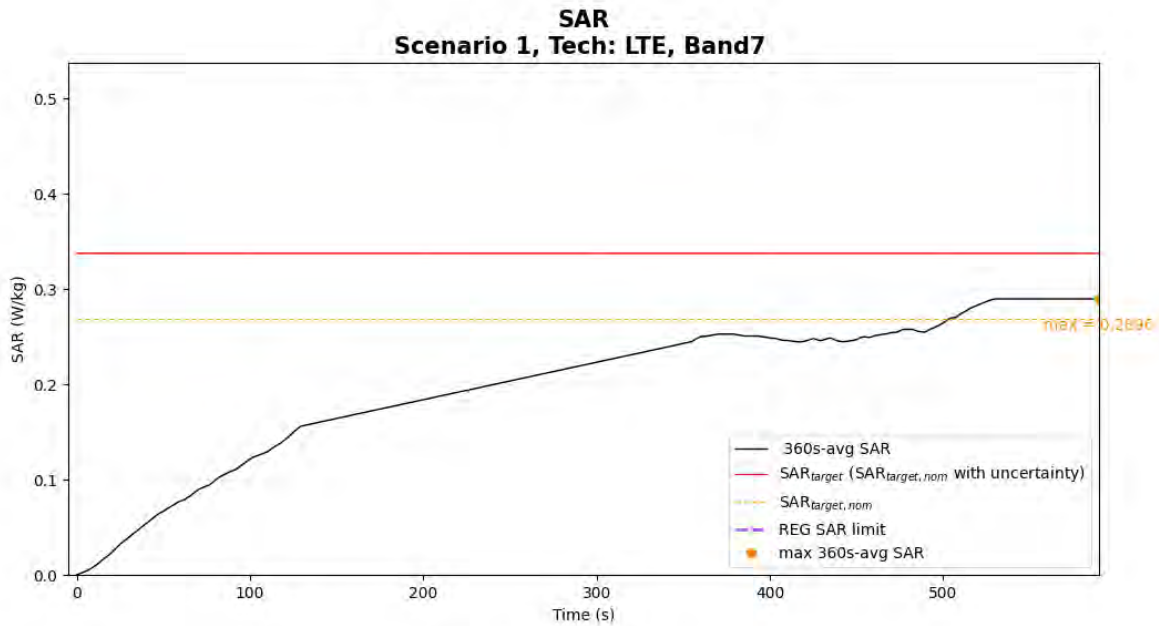


Figure 5-26 Time-averaged SAR for case 13 (LTE B7)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.2896 W/kg
Validation result: pass	

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● Case 15 in Table 5-4

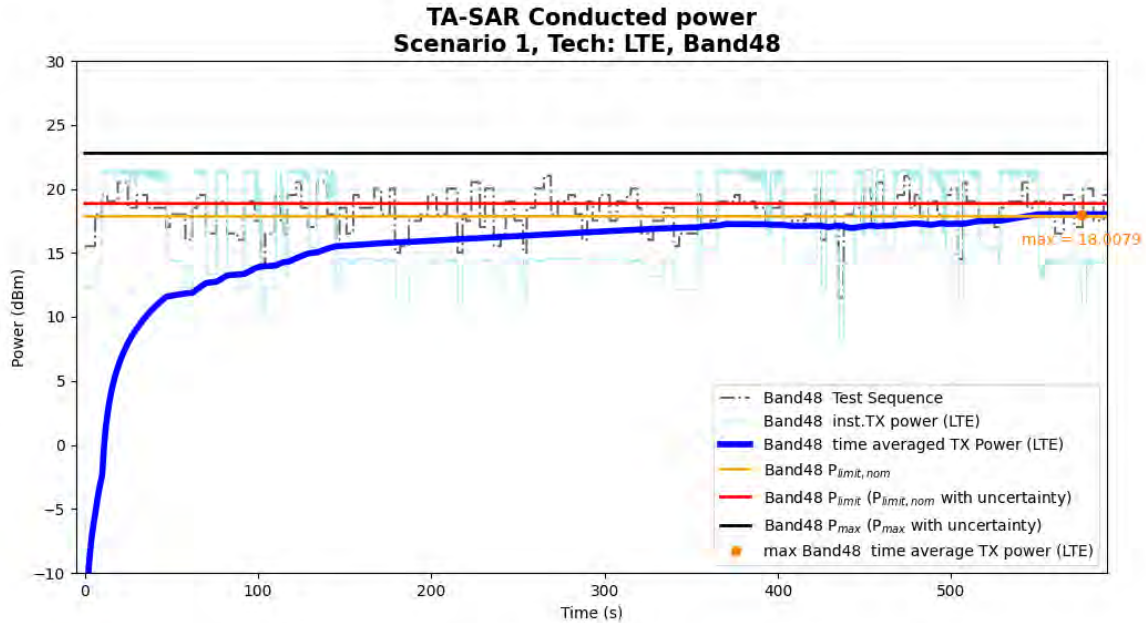


Figure 5-27 Time-averaged conducted TX power over time for case 15 (LTE B48)

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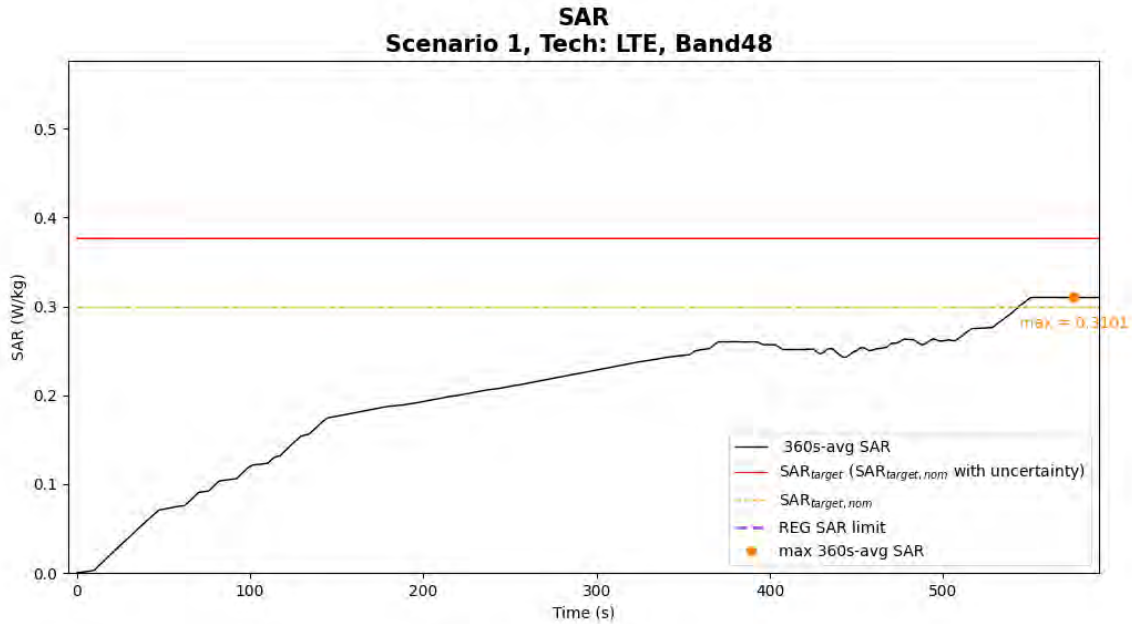


Figure 5-28 Time-averaged SAR for case 15 (LTE B48)

ISED 1gSAR limit	1.6 W/kg
SAR _{target} (SAR _{target,nom} with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.3101 W/kg
Validation result: pass	

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5.2.3 Measurement results for WCDMA

The corresponding detailed test procedure is described in section 4.2.2. All items in the below figures are illustrated as frame-averaged level.

According to the illustrations of each case, maximum time-averaged conducted TX power value $\leq P_{limit}$, showing that calculated time-averaged conducted TX power does not exceed P_{limit} at all times. Furthermore, maximum time-averaged SAR value $\leq SAR_{target}$, proving that the calculated time-averaged SAR does not exceed SAR_{target} at all times. In conclusion, all test cases of the scenario meet ISED requirement.

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● Case 0 in Table 5-4

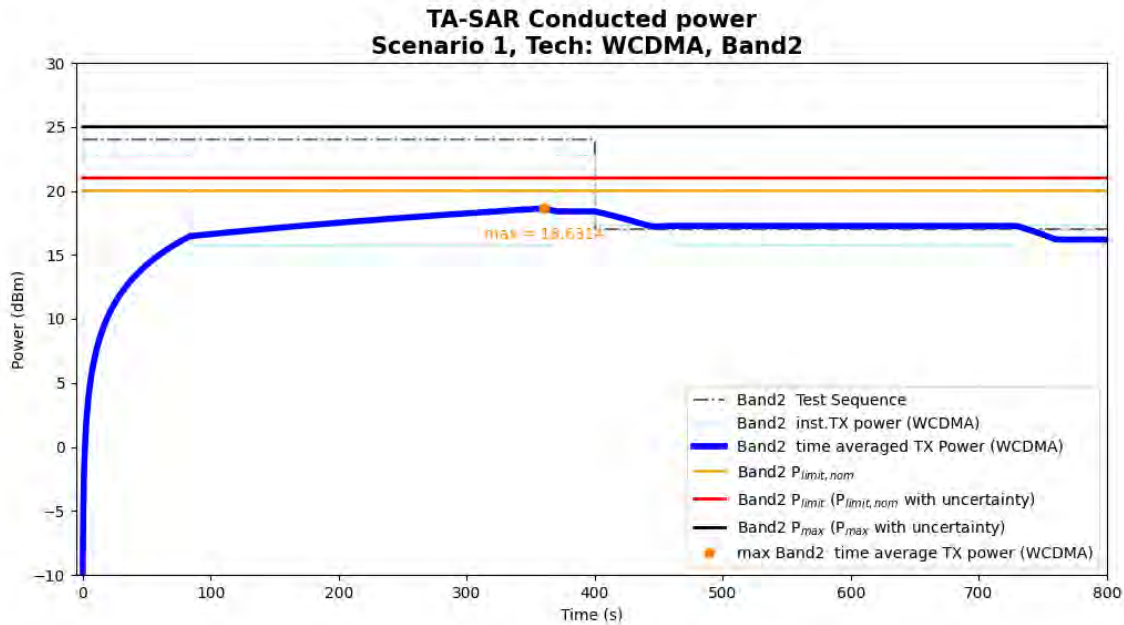


Figure 5-29 Time-averaged conducted TX power over time for case 0 (WCDMA B2)

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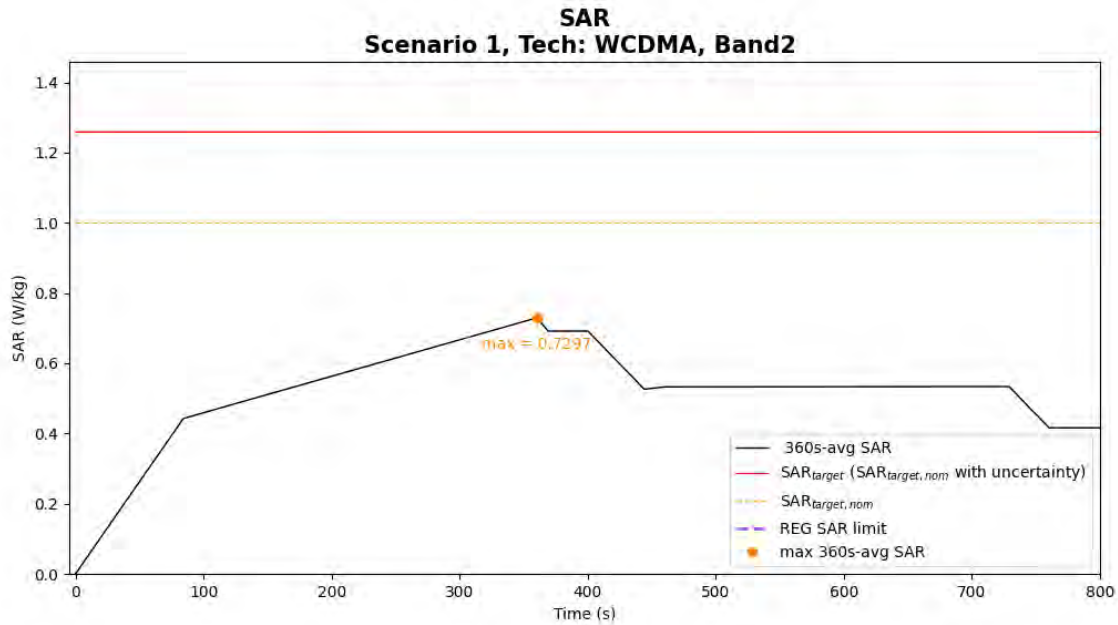


Figure 5-30 Time-averaged SAR for case 0 (WCDMA B2)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.7297 W/kg
Validation result: pass	

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● Case 6 in Table 5-4

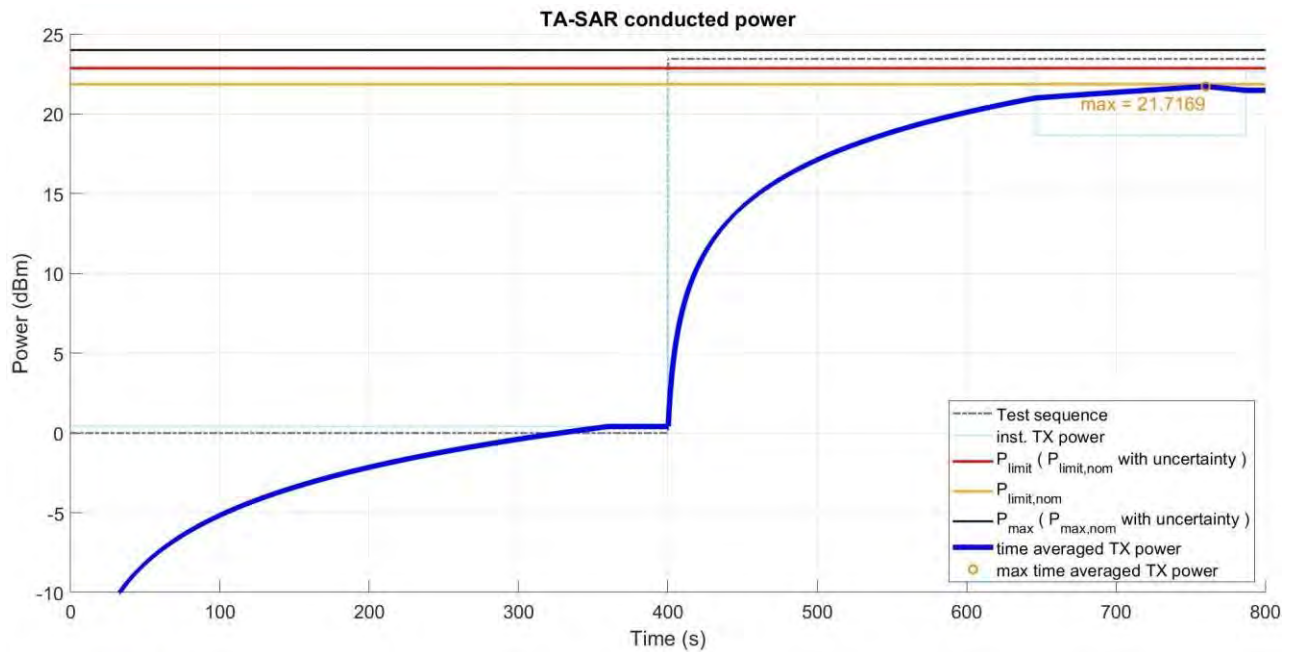
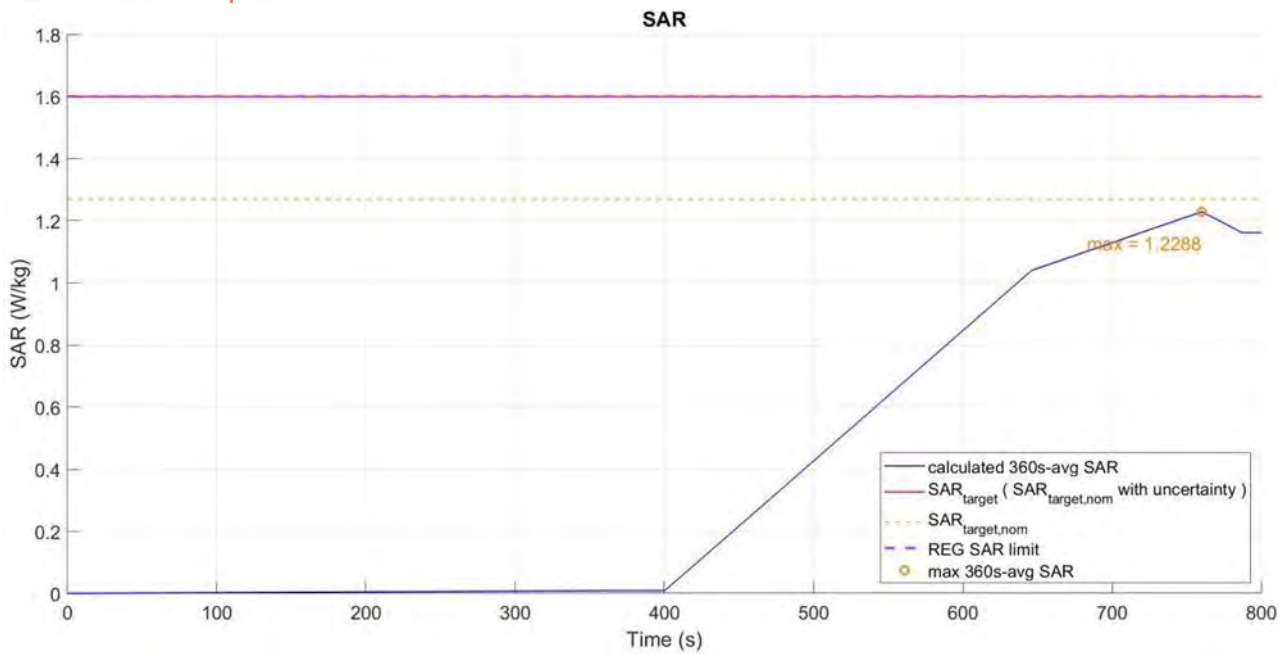


Figure 5-31 Time-averaged conducted TX power over time for case 6 (WCDMA B2)

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Figure 5-32 Time-averaged SAR for case 6 (WCDMA B2)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	1.2288 W/kg
Validation result: pass	

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● Case 12 in Table 5-4

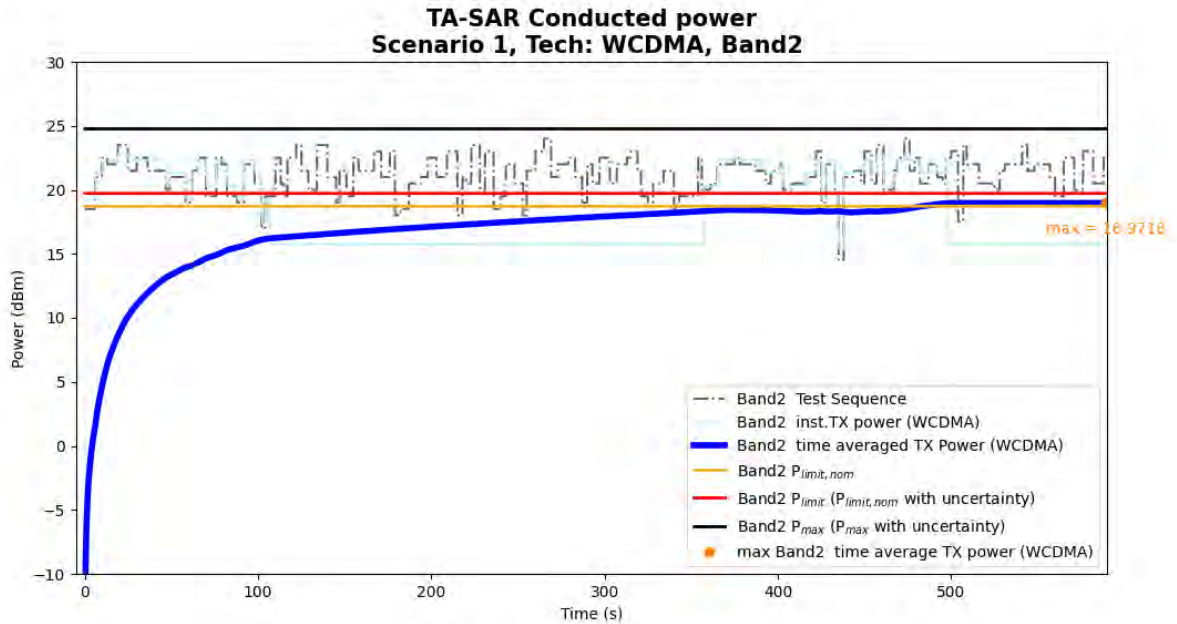


Figure 5-33 Time-averaged conducted TX power over time for case 12 (WCDMA B2)

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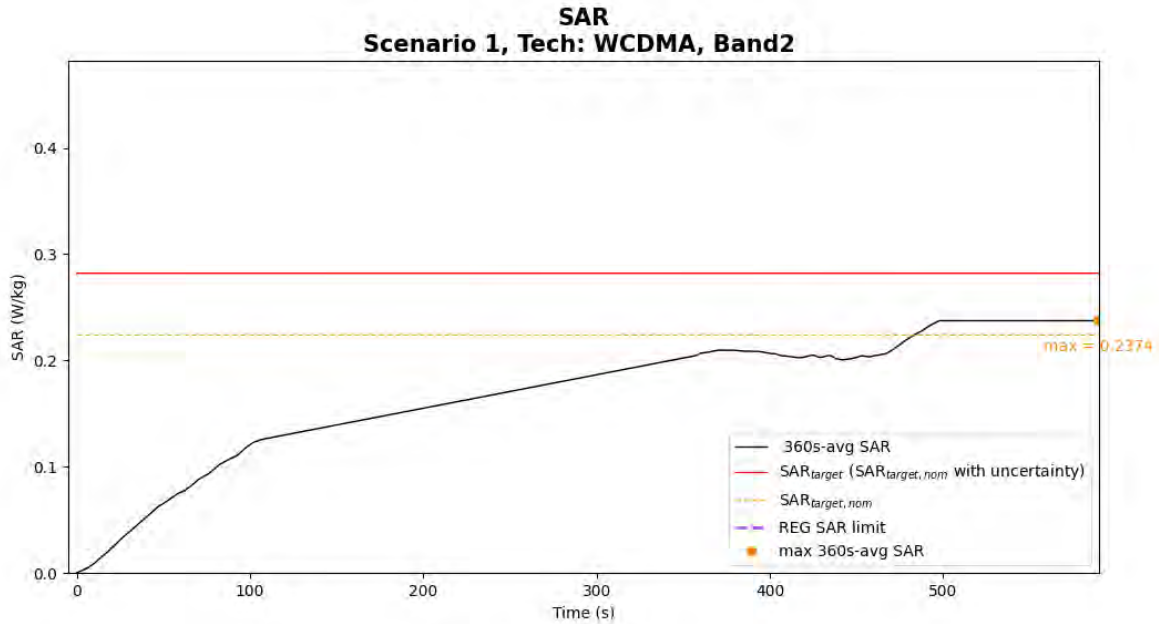


Figure 5-34 Time-averaged SAR for case 12 (WCDMA B2)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.2374 W/kg
Validation result: pass	

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5.3 Conducted Power Measurement Results for Scenario 3: Change in Operating State via Conducted Power Measurements

In this scenario, the test sequence 0 (i.e., maximum TX power is requested by a call box for each RAT) is used, and operating state (ECI) change at the EUT side is manually configured at a specific time instance. The test case covers ECI change scenario between two ECIs. The test case for this scenario is relegated in Table 5-6, and the test procedure follows section 4.4.2. The measurement setup is shown in Figure 5-2. 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 guarantee the time- averaged SAR is always below the ISED requirement. The following details will demonstrate how Mediatek's TA-SAR algorithm behaves.

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

Test case	RAT	Test band	Test seq.	ECI	$P_{max,nom}$ (dBm)	$P_{limit,nom}$ (dBm)	$P_{LowThresh}$ (dBm)	$P_{UE_backoff}$ (dBm)	$P_{UE_max_cust}$ (dBm)	Pass or Fail SAR limit
18	FR1	n48	0	2	23.00	17.00	16.50	14.00	23.00	Pass
				1		13.00	12.50	10.00	23.00	

Note: All power items in above table are frame-averaged level

The corresponding detailed test procedure is described in section 4.4.2. All items in the below figures are illustrated as frame-averaged level.

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For the two figures of each test case, the first figure demonstrates ($P_{limit,nom}$, P_{limit} , and P_{max} are defined in section 2.1):

- Test sequence: requested power (test sequence for each case is defined in Table 5-6)
- inst. TX power: measured instantaneous conducted TX power
- time averaged TX power: calculated time-averaged conducted TX power over time
- $P_{limit,nom}$ and P_{limit} : Power limit in dBm ($P_{limit} = P_{limit,nom} + 1dB \text{ uncertainty}$)
- P_{max} : Capable maximum TX power in dBm ($P_{max} = P_{max,nom} + 1dB \text{ uncertainty}$)
- max time averaged TX power: maximum time-averaged conducted TX power value

The second figure demonstrates ($SAR_{target,nom}$ and SAR_{target} are defined in section 2.1):

- norm. 360s-avg SAR: normalized time-averaged 1gSAR or 10gSAR over time
 Converted from calculated time-averaged conducted TX power following section 4.4.2
- total norm. 360s-avg SAR: normalized total time-averaged 1gSAR or 10gSAR over time
- norm. $SAR_{target,nom}$ and norm. SAR_{target} : normalized $SAR_{target,nom}$ and SAR_{target}
 - $SAR_{target} = SAR_{target,nom} \times 10^{1dB \text{ uncertainty}/10}$
- norm. REG SAR limit: normalized ISED limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)
 - Larger than or equal to normalized SAR_{target}
- max 360s-avg SAR: maximum normalized time-averaged 1gSAR or 10gSAR value All items in the second figure are normalized with SAR_{target} .

During the test period, there is an ECI change event configured at the time instant 1260 seconds. It is observed in the figure that the normalized total time-averaged SAR during the transition of the change is maintained below normalized SAR_{target} .

According to the illustrations, maximum time-averaged conducted TX power value $\leq P_{limit}$ before the time instant 1260 seconds and after the time instant 1620 seconds. As for the transitional period of the ECI change (from 1260s to 1620s), time-averaged conducted TX power is mixed with the TX power of two operating states, therefore, cannot be compared directly with P_{limit} of the changed operating state (ECI 2). However, the scenario can be validated by converting calculated time-averaged conducted TX power to normalized time-averaged SAR for obtaining proper benchmark. Figure 5-14 shows that maximum normalized time-averaged SAR value \leq normalized SAR_{target} , proving that the normalized time-averaged SAR does not exceed normalized SAR_{target} at all times (including 1260s to

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1620s). In conclusion, the test case of the scenario meets ISED requirement.

- Case 18 in Table 5-6: ECI change happens at the time instant 1260 seconds.

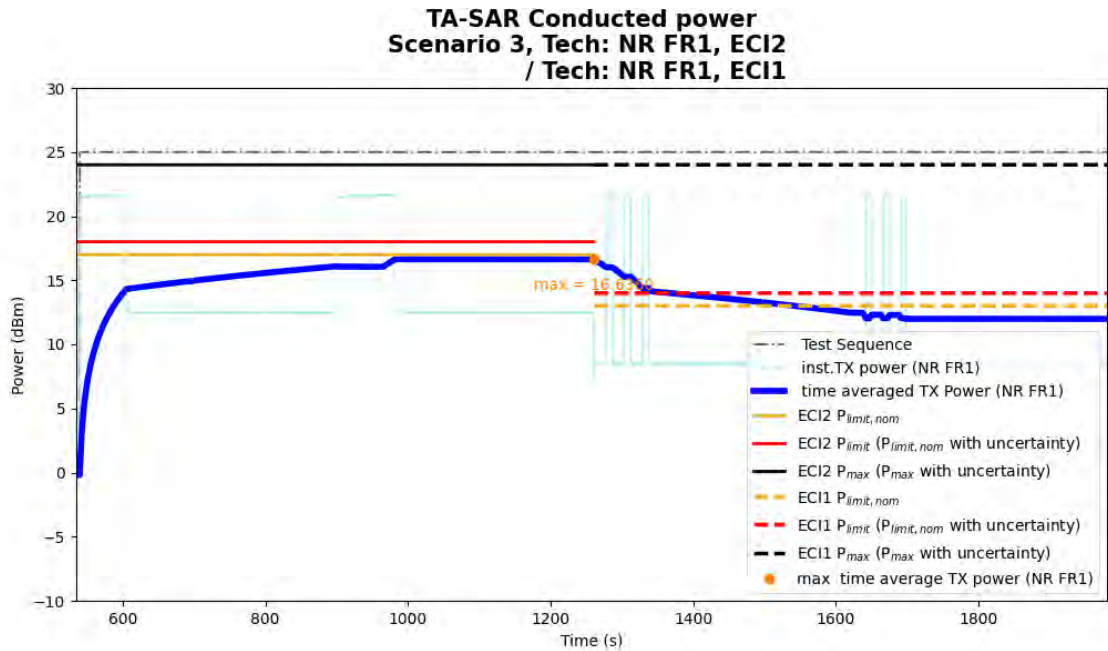


Figure 5-43 Time-averaged conducted TX power over time for case 18 (sub6 NR n48)

NOTE: The instantaneous TX power is transformed to SAR according to the equation in section 4.4.2 to check compliance. As shown in the below figure, the time-averaged SAR still passes ISED regulation during the transitional period of the ECI change (from 1260s to 1620s).

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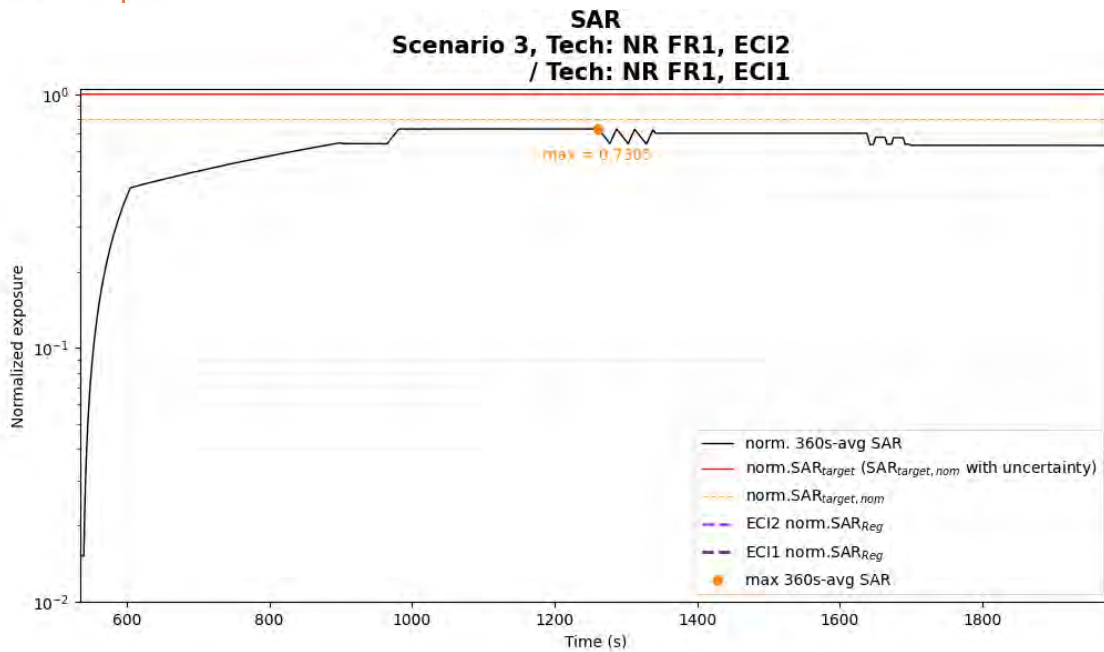


Figure 5-44 Normalized time-averaged SAR for case 18 (sub6 NR n48)

Normalized ISED limit of total RF exposure (normalized with SAR_{target})	1.0
Normalized SAR_{target} (normalized with SAR_{target})	1.0
Max total normalized time-averaged RF exposure	0.7305
Validation result: pass	

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5.4 Conducted Power Measurement Results for Scenario 4: Frequency Band Hand-Off or Redirect via Conducted Power Measurements

In this scenario, the test sequence 0 (i.e., maximum TX power is requested by a call box for each band) is used, and band handover is manually configured at a specific time instant. The test case for this scenario is relegated in Table 5-7, and the test procedure follows section 4.5.2. The measurement setup is shown in Figure 5-3. 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 guarantee the time- averaged SAR is always below the ISED requirement. The following details will demonstrate how Mediatek’s TA-SAR algorithm behaves.

Table 5-7 TA-SAR parameters setting for scenario 4

Test case	RAT	Test band	Testseq.	ECI	$P_{max,nom}$ (dBm)	$P_{limit,nom}$ (dBm)	$P_{LowThresh}$ (dBm)	$P_{UE_backoff}$ (dBm)	$P_{UE_max_cust}$ (dBm)	Pass or Fail SAR limit
19	LTE	B26	0	2	24.50	23.50	23.00	20.50	24.50	Pass
		B25	0	2	24.50	19.50	19.00	16.50	24.50	
20	LTE	B12	0	2	24.50	26.30	25.80	23.30	24.50	Pass
		B25	0	2	24.50	19.50	19.00	16.50	24.50	

Note: All power items in above table are frame-averaged level

The corresponding detailed test procedure is described in 4.5.2. All items in the below figures are illustrated as frame-averaged level.

For the two figures of each test case, the first figure demonstrates ($P_{limit,nom}$, P_{limit} , and P_{max}

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are defined in section 2.1):

- Test sequence: requested power (test sequence is defined in Table 5-7)
- inst. TX power: measured instantaneous conducted TX power
- time averaged TX power: calculated time-averaged conducted TX power over time
- $P_{limit,nom}$ and P_{limit} : Power limit in dBm ($P_{limit} = P_{limit,nom} + 1dB\ uncertainty$)
- P_{max} : Capable maximum TX power in dBm ($P_{max} = P_{max,nom} + 1dB\ uncertainty$)
- max time averaged TX power: maximum time-averaged conducted TX power value

The second figure demonstrates ($SAR_{target,nom}$ and SAR_{target} are defined in section 2.1):

- norm. 360s-avg SAR: normalized time-averaged 1gSAR or 10gSAR over time
 - Converted from calculated time-averaged conducted TX power following section 4.5.2
- total norm. 360s-avg SAR: normalized total time-averaged 1gSAR or 10gSAR over time
- norm. $SAR_{target,nom}$ and norm. SAR_{target} : normalized $SAR_{target,nom}$ and SAR_{target}
 - $SAR_{target} = SAR_{target,nom} \times 10^{1dB\ uncertainty/10}$
- norm. REG SAR limit: normalized ISED limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)
 - Larger than or equal to normalized SAR_{target}
- max 360s-avg SAR: maximum normalized time-averaged 1gSAR or 10gSAR

value All items in the second figure are normalized with SAR_{target} .

During the test period, the handover is configured at the time instant 1260 seconds. It is observed in the figure that the normalized total time-averaged SAR during the transition of the change is maintained below normalized SAR_{target} .

According to the illustrations, all bands meet maximum time-averaged conducted TX power value $\leq P_{limit}$, showing that calculated time-averaged conducted TX power of each band does not exceed its corresponding P_{limit} at all times. Furthermore, maximum normalized time-averaged SAR value \leq normalized SAR_{target} , proving that the normalized total time-averaged SAR does not exceed normalized SAR_{target} at all times. In conclusion, the test case of the scenario meets ISED requirement.

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- Case 19 in Table 5-7: band handover happens at the time instant 1260 seconds.

TA-SAR Conducted power
Scenario 4, Tech: LTE, Band26
/ Tech: LTE, Band25

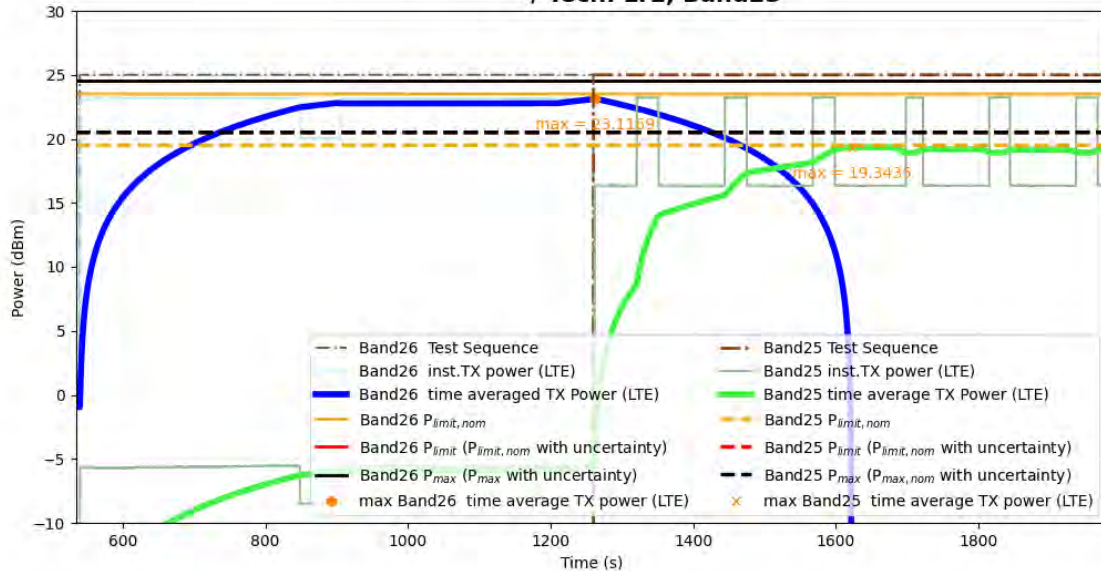


Figure 5-47 Time-averaged conducted TX power over time for case 19 (LTE B26, LTE B25, ECI=2)

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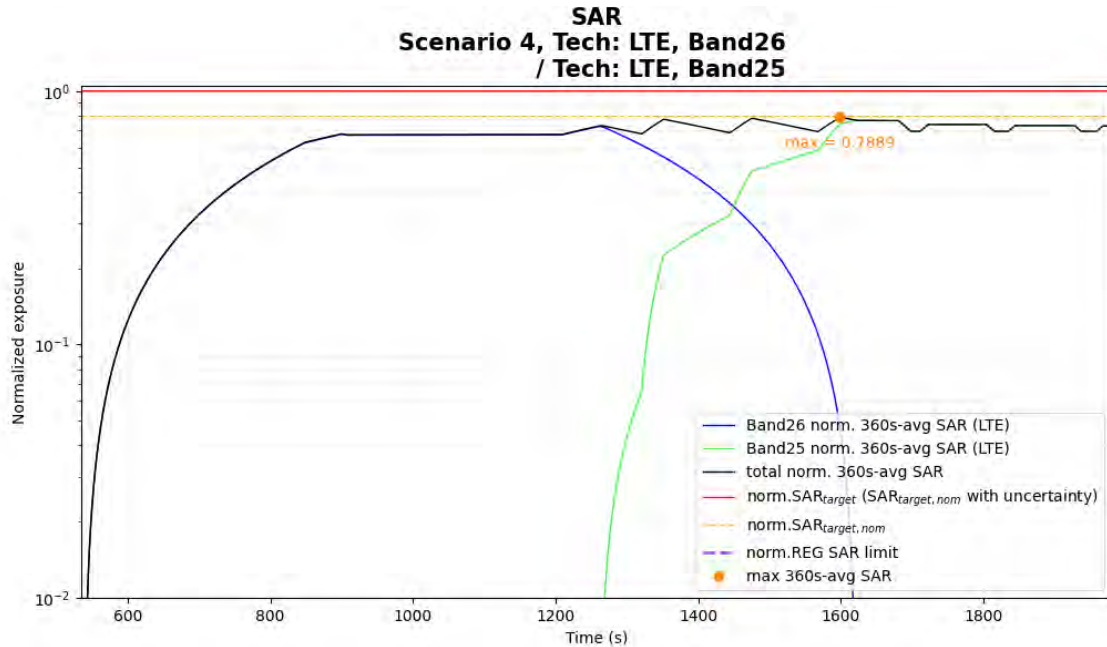


Figure 5-48 Normalized time-averaged SAR for case 19 (LTE B26, LTE B25, ECI=2)

Normalized ISED limit of total RF exposure (normalized with SAR_{target})	1.0
Normalized SAR_{target} (normalized with SAR_{target})	1.0
Max total normalized time-averaged RF exposure	0.7889
Validation result: pass	

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- Case 20 in Table 5-7: band handover happens at the time instant 1260 seconds.

TA-SAR Conducted power
Scenario 4, Tech: LTE, Band12
/ Tech: LTE, Band25

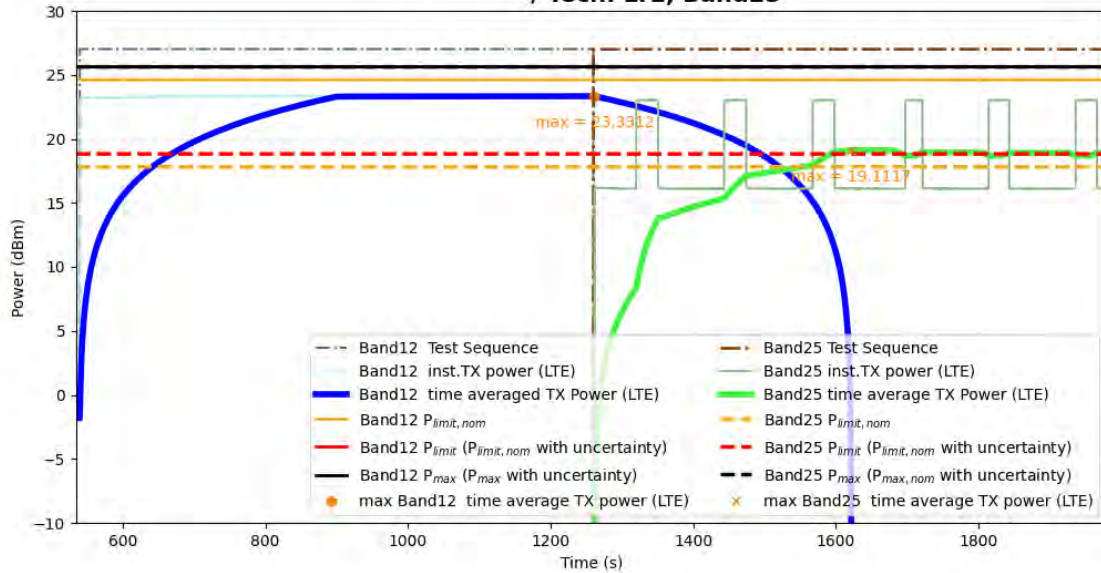


Figure 5-49 Time-averaged conducted TX power over time for case 20 (LTE B12, LTE B25, ECI=2)

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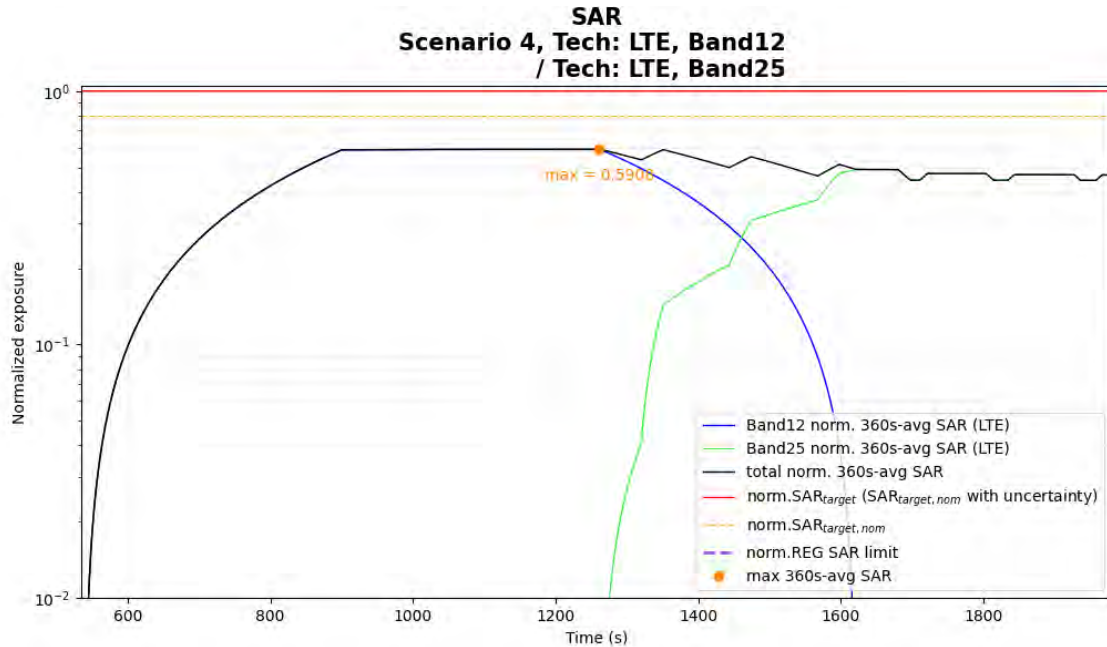


Figure 5-50 Normalized time-averaged SAR for case 20 (LTE B12, LTE B25, ECI=2)

Normalized ISED limit of total RF exposure (normalized with SAR _{target})	1.0
Normalized SAR _{target} (normalized with SAR _{target})	1.0
Max total normalized time-averaged RF exposure	0.5908
Validation result: pass	

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5.5 Conducted Power Measurement Results for Scenario 5.1: Technology Hand-Off or Redirect via Conducted Power Measurements

In this scenario, the test sequence 0 (i.e., maximum TX power is requested by a call box for each RAT) is used, and RAT handover is manually configured at a specific time instance. The test case for this scenario is relegated in Table 5-8, and the test procedure follows section 4.6.2. The measurement setup is shown in Figure 5-4. 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 guarantee the time- averaged SAR is always below the ISED requirement. The following details will demonstrate how Mediatek’s TA-SAR algorithm behaves.

Table 5-8 TA-SAR parameters setting for scenario 5.1

Test case	RAT	Test band	Test seq.	ECI	$P_{max,nom}$ (dBm)	$P_{limit,nom}$ (dBm)	$P_{LowThresh}$ (dBm)	$P_{UE_backoff}$ (dBm)	$P_{UE_max_cust}$ (dBm)	Pass or Fail SAR limit
21	LTE	B26	0	2	24.50	23.50	23.00	20.50	24.50	Pass
	FR1	B25	0	2	24.50	19.50	19.00	16.50	24.50	

NOTE: All power items in above table are frame-averaged level

The corresponding detailed test procedure is described in section 4.6.2. All items in the below figures are illustrated as frame-averaged level.

For the two figures of this test case, the first figure demonstrates ($P_{limit,nom}$, P_{limit} , and P_{max} are defined in section 2.1):

- Test sequence: requested power (test sequence for each case is defined in Table 5-8)
- inst. TX power: measured instantaneous conducted TX power
- time averaged TX power: calculated time-averaged conducted TX power over time
- $P_{limit,nom}$ and P_{limit} : Power limit in dBm ($P_{limit} = P_{limit,nom} + 1dB\ uncertainty$)
- P_{max} : Capable maximum TX power in dBm ($P_{max} = P_{max,nom} + 1dB\ uncertainty$)

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- max time averaged TX power: maximum time-averaged conducted TX power value

The second figure demonstrates ($SAR_{target,nom}$ and SAR_{target} are defined in section 2.1):

- norm. 360s-avg SAR: normalized time-averaged 1gSAR or 10gSAR over time
 - Converted from calculated time-averaged conducted TX power following section 4.6.2
- total norm. 360s-avg SAR: normalized total time-averaged 1gSAR or 10gSAR over time
- norm. $SAR_{target,nom}$ and norm. SAR_{target} : normalized $SAR_{target,nom}$ and SAR_{target}
 - $SAR_{target} = SAR_{target,nom} \times 10^{1dB\ uncertainty/10}$
- norm. REG SAR limit: normalized ISED limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)
 - Larger than or equal to normalized SAR_{target}
- max 360s-avg SAR: maximum normalized time-averaged 1gSAR or 10gSAR

value All items in the second figure are normalized with SAR_{target} .

The handover is configured at the time instant 1260 seconds. It is observed in the figure that the normalized total time-averaged SAR during the transition of the change is maintained below normalized SAR_{target} .

According to the illustrations, all bands meet maximum time-averaged conducted TX power value $\leq P_{limit}$, showing that calculated time-averaged conducted TX power of each band does not exceed its corresponding P_{limit} at all times. Furthermore, maximum normalized time-averaged SAR value \leq normalized SAR_{target} , proving that the normalized total time-averaged SAR does not exceed normalized SAR_{target} at all times. In conclusion, the test case of the scenario meets ISED requirement.

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•Case 21 in Table 5-8: RAT/band handover happens at the time instant 1260 seconds.

TA-SAR Conducted power
Scenario 5, Tech: LTE, Band26
/ Tech: NR FR1, Band25

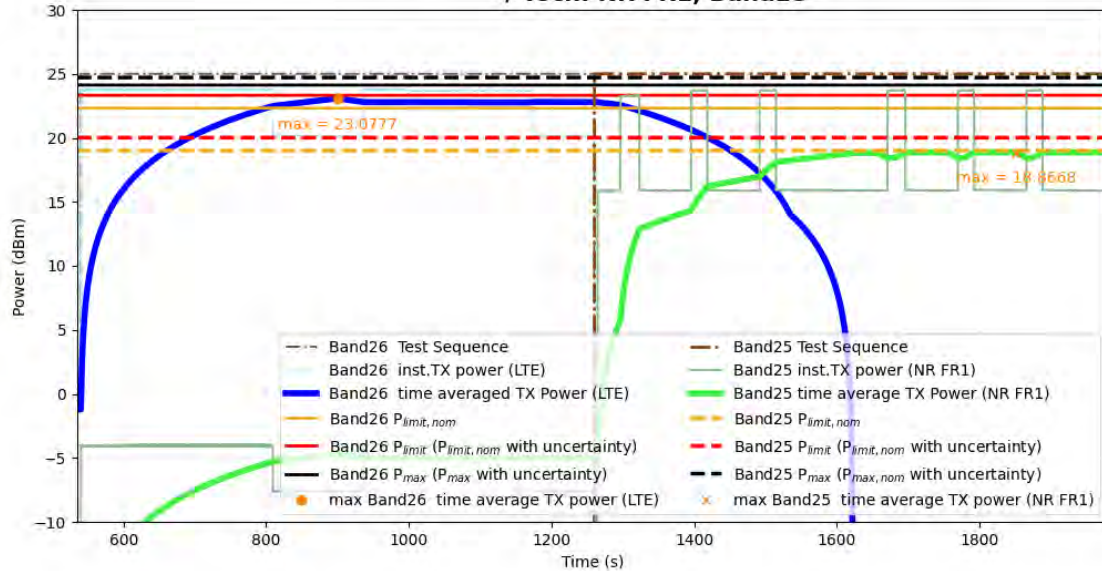


Figure 5-51 Time-averaged conducted TX power over time for case 21 (LTE B26, sub6 NR B25)

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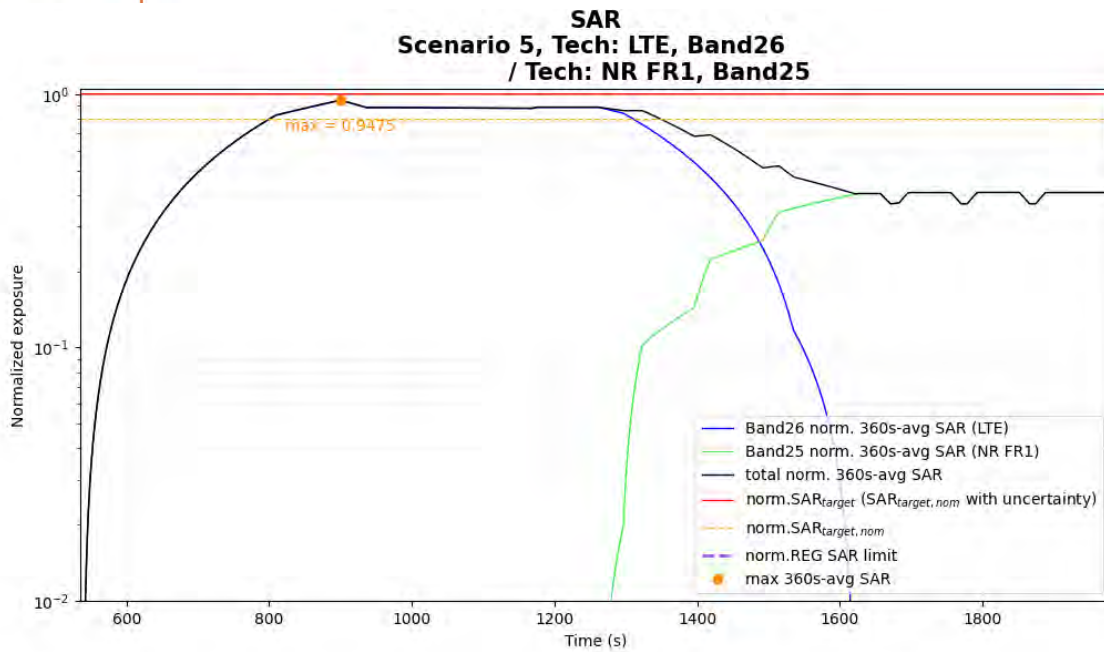


Figure 5-52 Normalized time-averaged SAR for case 21 (LTE B26, sub6 NR B25)

Normalized ISED limit of total RF exposure (normalized with SAR_{target})	1.0
Normalized SAR_{target} (normalized with SAR_{target})	1.0
Max total normalized time-averaged RF exposure	0.9575
Validation result: pass	

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5.6 Conducted Power Measurement Results for Scenario 5.2: SAR Exposure Switch via Conducted Power Measurements (ENDC)

In this scenario, the test 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 ISED limit when the two radios change TX power dynamically. The experiment parameters are summarized in Table 5-9, and the test procedure follows section 4.7.2. The measurement setup is shown in Figure 5-4.

Table 5-9 TA-SAR parameters setting for scenario 5.2

Test case	RAT	Test band	Test seq.	ECI	$P_{max,nom}$ (dBm)	$P_{limit,nom}$ (dBm)	$P_{LowThresh}$ (dBm)	$P_{UE_backoff}$ (dBm)	$P_{UE_max_cust}$ (dBm)	Pass or Fail SAR limit
22	LTE	B30	0	2	23.00	19.00	18.50	16.00	23.00	Pass
	NR	B66	0	2	24.00	20.00	19.50	17.00	24.00	

NOTE: All power items in above table are frame-averaged level

During the test period,

- Time = 540s~1260s: NR FR1 predominant scenario.
- Time = 1260s~1980s: LTE + NR FR1 scenario.
- Time = 1980s~2700s: LTE predominant scenario.

All items in the below figures are illustrated as frame-averaged level.

For the two figures of this test case, the first figure demonstrates ($P_{limit,nom}$, P_{limit} , and P_{max} are defined in section 2.1):

- Test sequence: requested power (test sequence for each case is defined in Table 5-9)
- inst. TX power: measured instantaneous conducted TX power

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- time averaged TX power: calculated time-averaged conducted TX power over time
- $P_{limit,nom}$ and P_{limit} : Power limit in dBm ($P_{limit} = P_{limit,nom} + 1dB \text{ uncertainty}$)
- P_{max} : Capable maximum TX power in dBm ($P_{max} = P_{max,nom} + 1dB \text{ uncertainty}$)
- max time averaged TX power: maximum time-averaged conducted TX power value
- total norm. 360s-avg SAR: normalized total time-averaged 1gSAR or 10gSAR over time

The second figure demonstrates ($SAR_{target,nom}$ and SAR_{target} are defined in section 2.1):

- norm. 360s-avg SAR: normalized time-averaged 1gSAR or 10gSAR over time
 - Converted from calculated time-averaged conducted TX power following section 4.7.2
 - norm. $SAR_{target,nom}$ and norm. SAR_{target} : normalized $SAR_{target,nom}$ and SAR_{target}
 - $SAR_{target} = SAR_{target,nom} \times 10^{1dB \text{ uncertainty}/10}$
 - norm. REG SAR limit: normalized ISED limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)
 - Larger than or equal to normalized SAR_{target}
 - max 360s-avg SAR: maximum normalized time-averaged 1gSAR or 10gSAR value
- All items in the second figure are normalized with SAR_{target} .

During the test period, the switches are configured at the time instants 1260 seconds and 1980 seconds. It is observed in the figure that the normalized total time-averaged SAR during the transition of the change is maintained below normalized SAR_{target} .

According to the illustrations, all bands meet maximum time-averaged conducted TX power value $\leq P_{limit}$, showing that calculated time-averaged conducted TX power of each band does not exceed its corresponding P_{limit} at all times. Furthermore, maximum normalized time-averaged SAR value \leq normalized SAR_{target} , proving that the normalized total time-averaged SAR does not exceed normalized SAR_{target} at all times. In conclusion, the test case of the scenario meets ISED requirement.

-

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•Case 22 in Table 5-9:

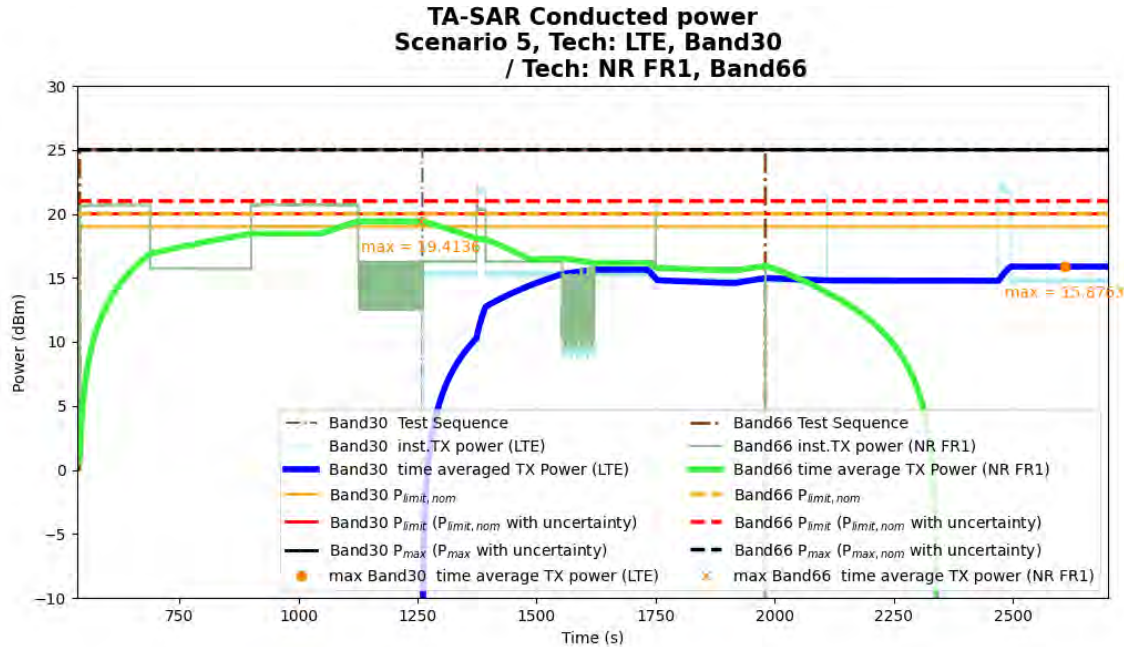


Figure 5-53 Time-averaged conducted TX power over time for case 22 (LTE B30, sub6 NR B66)

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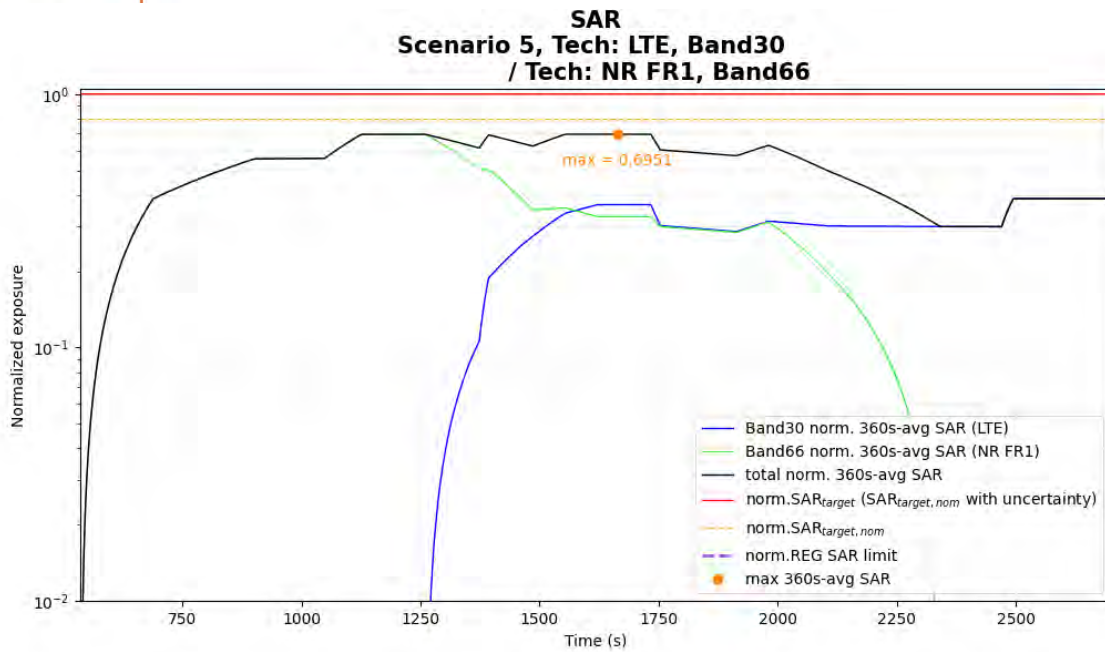


Figure 5-54 Normalized time-averaged SAR for case 22 (LTE B30, sub6 NR B66)

Normalized ISED limit of total RF exposure (normalized with SAR_{target})	1.0
Normalized SAR_{target} (normalized with SAR_{target})	1.0
Max total normalized time-averaged RF exposure	0.6951
Validation result: pass	

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5.7 Conducted Power Measurement Results for Scenario 6: Switching between TDD and FDD Configurations via Conducted Power Measurement

In this scenario, the test sequence 0 (i.e., maximum TX power is requested by a call box for each RAT) is used, and band handover between TDD and FDD is manually configured at a specific time instant. The test case for this scenario is relegated in Table 5-11, and the test procedure follows section 4.8.2. The measurement setup is shown in Figure 5-3. 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 guarantee the time-averaged SAR is always below the ISED requirement. The following details will demonstrate how Mediatek's TA-SAR algorithm behaves.

Table 5-11 TA-SAR parameters setting for scenario 6

Test case	RAT	Test band	Test seq.	ECI	$P_{max,nom}$ (dBm)	$P_{limit,nom}$ (dBm)	$P_{LowThresh}$ (dBm)	$P_{UE_backoff}$ (dBm)	$P_{UE_max_cust}$ (dBm)	Pass or Fail SAR limit
23	FR1	B48	0	2	23.00	17.00	16.50	14.00	23.00	Pass
	FR1	B25	0	2	24.50	19.50	19.00	16.50	24.50	

NOTE: All power items in above table are frame-averaged level

The corresponding detailed test procedure is described in section 4.8.2. All items in the below figures are illustrated as frame-averaged level.

For the two figures of this test case, the first figure demonstrates ($P_{limit,nom}$, P_{limit} , and P_{max} are defined in section 2.1):

- Test sequence: requested power (test sequence for each case is defined in Table 5-11)
- inst. TX power: measured instantaneous conducted TX power
- time averaged TX power: calculated time-averaged conducted TX power over time
- $P_{limit,nom}$ and P_{limit} : Power limit in dBm ($P_{limit} = P_{limit,nom} + 1dB \text{ uncertainty}$)

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- P_{max} : Capable maximum TX power in dBm ($P_{max} = P_{max,nom} + 1dB \text{ uncertainty}$)
- max time averaged TX power: maximum time-averaged conducted TX power value

The second figure demonstrates ($SAR_{target,nom}$ and SAR_{target} are defined in section 2.1):

- norm. 360s-avg SAR: normalized time-averaged 1gSAR or 10gSAR over time
 - Converted from calculated time-averaged conducted TX power following section 4.8.2
 - total norm. 360s-avg SAR: normalized total time-averaged 1gSAR or 10gSAR over time
 - norm. $SAR_{target,nom}$ and norm. SAR_{target} : normalized $SAR_{target,nom}$ and SAR_{target}
 - $SAR_{target} = SAR_{target,nom} \times 10^{1dB \text{ uncertainty}/10}$
 - norm. REG SAR limit: normalized ISED limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)
 - Larger than or equal to normalized SAR_{target}
 - max 360s-avg SAR: maximum normalized time-averaged 1gSAR or 10gSAR value
- All items in the second figure are normalized with SAR_{target} .

The handover is configured at the time instant 1260 seconds. It is observed in the figure that the normalized total time-averaged SAR during the transition of the change is maintained below normalized SAR_{target} .

According to the illustrations, all bands meet maximum time-averaged conducted TX power value \leq

P_{limit} , showing that calculated time-averaged conducted TX power of each band does not exceed its corresponding P_{limit} at all times. Furthermore, maximum normalized time-averaged SAR value \leq normalized SAR_{target} , proving that the normalized total time-averaged SAR does not exceed normalized SAR_{target} at all times. In conclusion, the test case of the scenario meets ISED requirement.

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•Case 23 in Table 5-11: TDD/FDD band switching happens at the time instant 1260 seconds.

TA-SAR Conducted power
Scenario 6, Tech: NR FR1, Band48
/ Tech: NR FR1, Band25

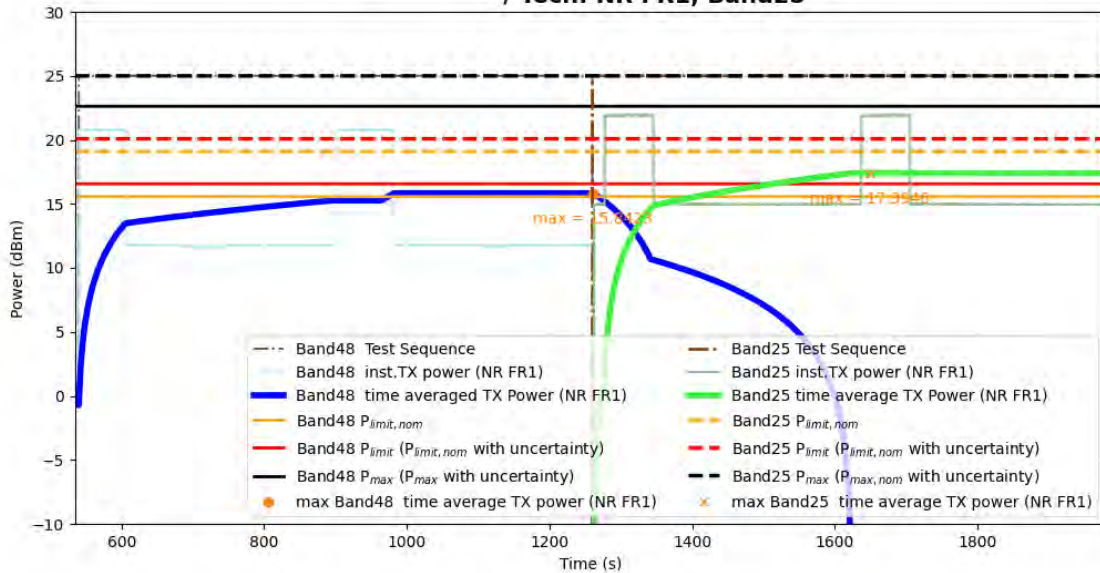


Figure 5-57 Time-averaged conducted TX power over time for case 23 (sub6 NR B48 and B25)

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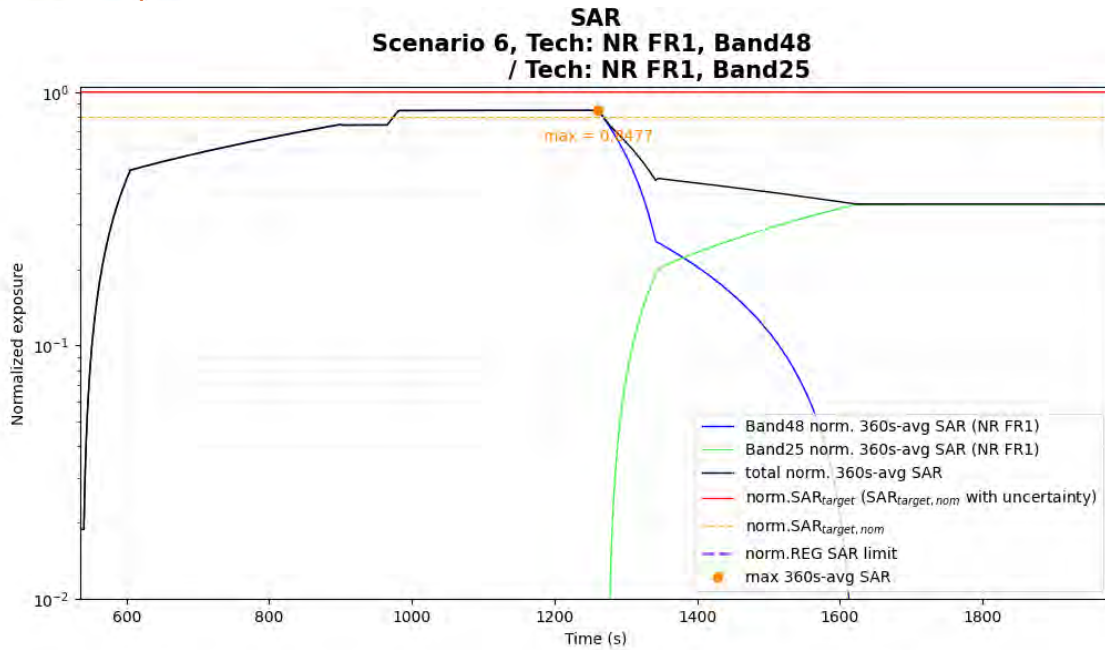


Figure 5-58 Normalized time-averaged SAR for case 23 (sub6 NR B48 and B25)

Normalized ISED limit of total RF exposure (normalized with SAR_{target})	1.0
Normalized SAR_{target} (normalized with SAR_{target})	1.0
Max total normalized time-averaged RF exposure	0.8477
Validation result: pass	

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5.8 Conducted Power Measurement Results for Scenario 8: Dropped Connection via Conducted Power Measurements

In this scenario, the test sequence 0 (i.e., maximum TX power is requested by a call box for each RAT) is used, and the connection 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 5-13, and the test procedure follows section 4.10.2. The measurement setup is shown in Figure 5-2. 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 guarantee the time-averaged SAR is always below the ISED requirement. The following details will demonstrate how Mediatek's TA-SAR algorithm behaves.

Table 5-13 TA-SAR parameters setting for scenario 8

Test case	RAT	Test band	Test seq.	ECI	$P_{max,nom}$ (dBm)	$P_{limit,nom}$ (dBm)	$P_{LowThresh}$ (dBm)	$P_{UE_backoff}$ (dBm)	$P_{UE_max_cust}$ (dBm)	Pass or Fail SAR limit
24	FR1	B25	0	2	24.50	19.50	19.00	16.50	24.50	Pass

NOTE: All power items in above table are frame-averaged level

The corresponding detailed test procedure is described in 4.10.2. All items in the below figures are illustrated as frame-averaged level.

For the figures set of this case, the first figure demonstrates ($P_{limit,nom}$, P_{limit} , and P_{max} are defined in section 2.1):

- Test sequence: requested power (test sequence for each case is defined in Table 5-13)
- inst. TX power: measured instantaneous conducted TX power
- time averaged TX power: calculated time-averaged conducted TX power over time
- $P_{limit,nom}$, P_{limit} : Power limit in dBm ($P_{limit} = P_{limit,nom} + 1dB \text{ uncertainty}$)
- P_{max} : Capable maximum TX power in dBm ($P_{max} = P_{max,nom} + 1dB \text{ uncertainty}$)
- max time averaged TX power: maximum time-averaged conducted TX power value

The second figure demonstrates ($SAR_{target,nom}$ and SAR_{target} are defined in section 2.1):

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- calculated 360s-avg SAR: calculated time-averaged 1gSAR or 10gSAR over time
 - Converted from calculated time-averaged conducted TX power following section 4.10.2
- $SAR_{target,nom}$ and SAR_{target} : $SAR_{target} = SAR_{target,nom} \times 10^{1dB\ uncertainty/10}$
- REG SAR limit: ISED limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)
 - Larger than or equal to SAR_{target}
- max 360s-avg SAR: maximum time-averaged 1gSAR or 10gSAR value

During the test period, there is a connection drop event configured at the time instant 1260 seconds. It is observed in the figure that the time-averaged SAR during and after the transition of the change is maintained below normalized SAR_{target} , demonstrating that TA-SAR algorithm has taken connection drop into consideration.

According to the illustrations, maximum time-averaged conducted TX power value $\leq P_{limit}$, showing that calculated time-averaged conducted TX power does not exceed P_{limit} at all times. Furthermore, maximum time-averaged SAR value $\leq SAR_{target}$, proving that the calculated time-averaged SAR does not exceed SAR_{target} at all times. In conclusion, the test case of the scenario meets ISED requirement.

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- Case 24 in Table 5-13: connection drop happens at the time instant 1260 seconds.

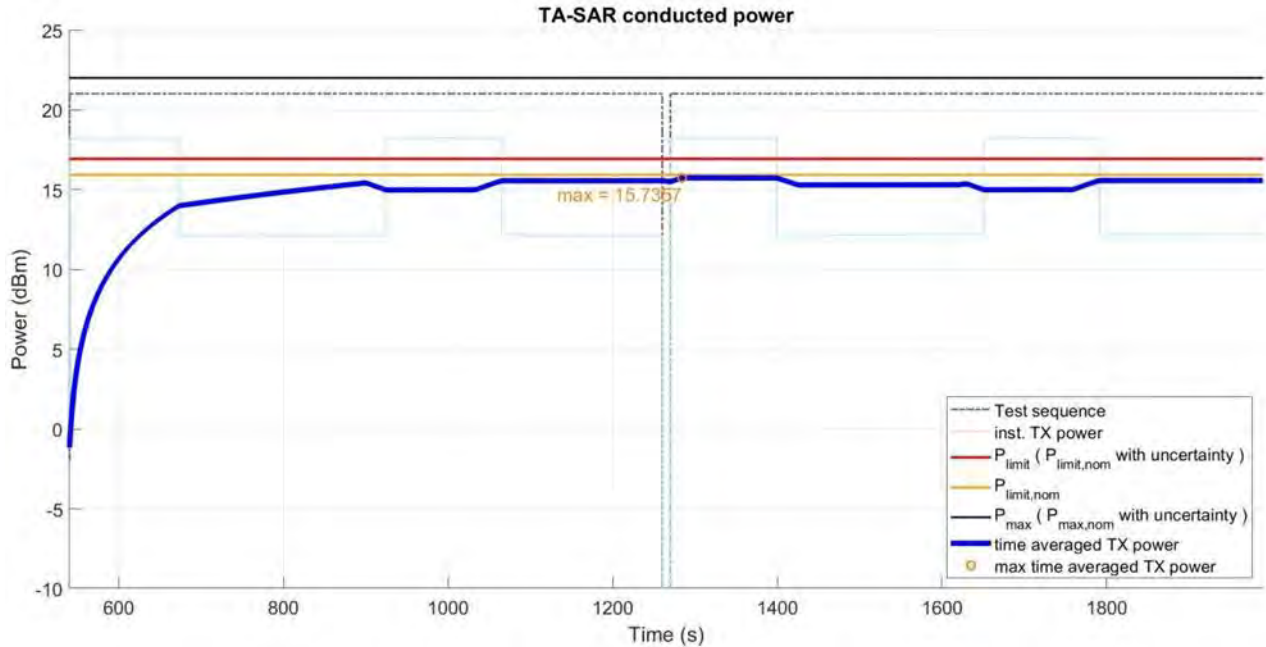


Figure 5-67 Time-averaged conducted TX power over time for case 24 (sub6 NR B25)

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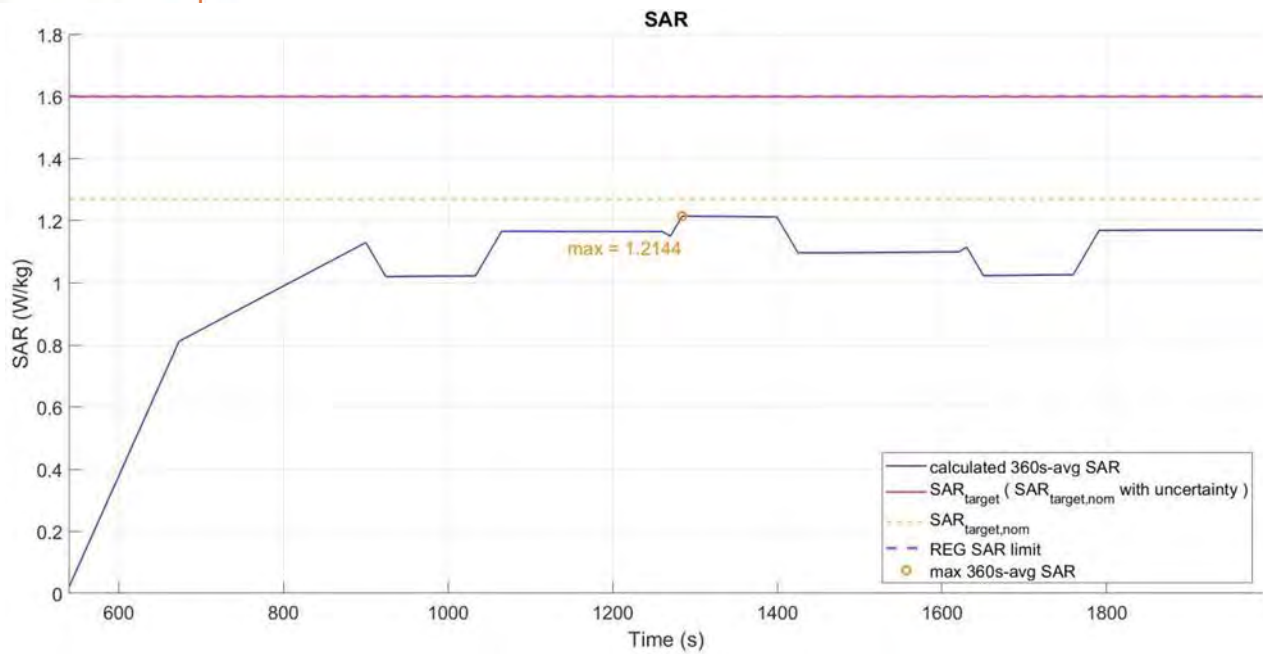


Figure 5-68 Normalized time-averaged SAR for case case 24 (sub6 NR B25)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	1.2144 W/kg
Validation result: pass	

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6 TA-SAR Validation via Single Point SAR Measurements

6.1 Measurement Setup

The measurement setup is similar to normal fixed power single point SAR measurement. The difference in single point 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 a 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 6-1.

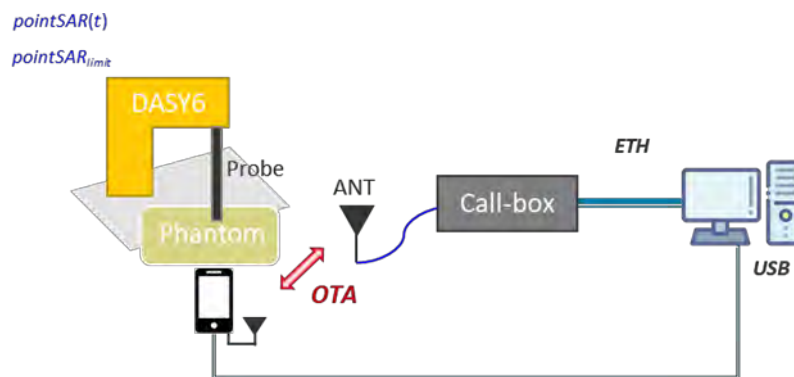


Figure 6-1 TA-SAR wireless test environment

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6.2 Single Point SAR Measurement Results for Scenario 1: Change in Requested Power

Table 6-1 summarizes the single point SAR (near-field SAR) test configuration for each antenna. The test case #nfsar stands for near-filed SAR and its configuration is different from those in conducted power measurement cases.

Table 6-1 SAR Test configurations of radio technologies for each antenna

Test Case	Test Scenario	Test band	Test Sequence	BW (MHz)	Modulation	duty cycle	RB size	RB offset	Test Position	Gap (mm)	ANT	ANT Index	ANT data (TX/RX)	ECI	DL Channel	UL Freq (MHz)	DL Channel	DL Freq (MHz)	Part 1 SAR@P1dB (W/kg)	SAR eq.	Min. P _{limit, nom}	Max. P _{max, nom}	P _{limit, nom}	P _{max, nom}	min power duration	duration 1	drop call	duration 2	duration 3
0		WCDMA Band II	1	N/A	BMC	100.00%	N/A	N/A	Bottom Edge	50	BM20	1	0/0	2	9400	1880	9800	1960	0.224	1.6	18.72	23.75	20.00	24.00	0	400		400	
1		LTE Band 7	1	20	QPSK	100.00%	50	0	Back Side	50	BM20	1	0/0	2	20850	1820	2850	2820	0.268	1.6	18.6	22.6	19.00	23.00	0	400		400	
2		LTE Band 13	1	10	QPSK	100.00%	1	49	Back Side	50	AM14	0	0/0	2	23330	782	5230	751	0.203	1.6	21.04	23.95	20.50	23.50	0	400		400	
3		LTE Band 48	1	20	QPSK	61.30%	1	0	Right Cheek	0	FB30	5	0/1	1	55773	3603.3	55773	3603.3	0.299	1.6	17.85	21.78	17.01	21.01	0	400		400	
4		FR1 n25	1	40	QPSK(DFT-s-OFDM)	100.00%	108	54	Back Side	50	BM20	1	0/0	2	376500	1882.5	392500	1962.5	0.277	1.6	19.7	24.58	19.50	24.50	0	400		400	
5		FR1 n48	1	40	QPSK(DFT-s-OFDM)	100.00%	1	1	Right Cheek	0	FB30	5	0/1	1	641666	3624.99	641666	3624.99	0.188	1.6	11.53	21.64	13.00	23.00	0	400		400	
6		WCDMA Band II	2	N/A	BMC	100.00%	N/A	N/A	Bottom Edge	50	BM20	1	0/0	2	9400	1880	9800	1960	0.224	1.6	18.72	23.75	20.00	24.00	0	400		400	
7		LTE Band 7	2	20	QPSK	100.00%	50	0	Back Side	50	BM20	1	0/0	2	20850	1820	2850	2820	0.268	1.6	18.6	22.6	19.00	23.00	0	400		400	
8	1. Changes in requested power (continuous + near field)	LTE Band 13	1	10	QPSK	100.00%	1	49	Back Side	50	AM14	0	0/0	2	23330	782	5230	751	0.203	1.6	21.04	23.95	20.50	23.50	0	400		400	
9		LTE Band 48	2	20	QPSK	61.30%	1	0	Right Cheek	0	FB30	5	0/1	1	55773	3603.3	55773	3603.3	0.299	1.6	17.85	21.78	17.01	21.01	0	400		400	
10		FR1 n25	2	40	QPSK(DFT-s-OFDM)	100.00%	108	54	Back Side	50	BM20	1	0/0	2	376500	1882.5	392500	1962.5	0.277	1.6	19.7	24.58	19.50	24.50	0	400		400	
11		FR1 n48	2	40	QPSK(DFT-s-OFDM)	100.00%	1	1	Right Cheek	0	FB30	5	0/1	1	641666	3624.99	641666	3624.99	0.188	1.6	11.53	21.64	13.00	23.00	0	400		400	
12		WCDMA Band II	3(4)	N/A	BMC	100.00%	N/A	N/A	Bottom Edge	50	BM20	1	0/0	2	9400	1880	9800	1960	0.224	1.6	18.72	23.75	20.00	24.00	0	400		400	
13		LTE Band 7	3(4)	20	QPSK	100.00%	50	0	Back Side	50	BM20	1	0/0	2	20850	1820	2850	2820	0.268	1.6	18.6	22.6	19.00	23.00	0	400		400	
14		LTE Band 13	1	10	QPSK	100.00%	1	49	Back Side	50	AM14	0	0/0	2	23330	782	5230	751	0.203	1.6	21.04	23.95	20.50	23.50	0	400		400	
15		LTE Band 48	3(4)	20	QPSK	61.30%	1	0	Right Cheek	0	FB30	5	0/1	1	55773	3603.3	55773	3603.3	0.299	1.6	17.85	21.78	17.01	21.01	0	400		400	
16		FR1 n25	3(4)	40	QPSK(DFT-s-OFDM)	100.00%	108	54	Back Side	50	BM20	1	0/0	2	376500	1882.5	392500	1962.5	0.277	1.6	19.7	24.58	19.50	24.50	0	400		400	
17		FR1 n48	3(4)	40	QPSK(DFT-s-OFDM)	100.00%	1	1	Right Cheek	0	FB30	5	0/1	1	641666	3624.99	641666	3624.99	0.188	1.6	11.53	21.64	13.00	23.00	0	400		400	
18	3. Change in operating state	FR1 n48	0	40	QPSK(DFT-s-OFDM)	100.00%	1	1	N/A	50	FB30	5	0/1	2	641666	3624.99	641666	3624.99	0.188	1.6	11.56	21.62	13.00	23.00	540	720		720	
19		FR1 n25	0	15	QPSK	100.00%	1	74	N/A	50	AM14	0	0/0	2	28855	831.5	2475	876.5	0.168	1.6	21.69	23.20	23.50	24.50	540	720		720	
20	4. Frequency band hand-off or redirect	LTE Band 25	0	20	QPSK	100.00%	1	0	N/A	50	BM20	1	0/0	2	28855	1882.5	8365	1962.5	0.201	1.6	17.82	21.80	19.50	24.50	540	720		720	
21		LTE Band 12	0	10	QPSK	100.00%	1	45	N/A	50	AM14	0	0/0	2	28855	707.5	5895	1927.5	0.188	1.6	24.62	24.62	26.50	24.50	540	720		720	
22	5. Technology hand-off (S.1 handover)	LTE Band 26	0	15	QPSK	100.00%	1	74	N/A	50	AM14	0	0/0	2	28855	831.5	2475	876.5	0.168	1.6	22.32	23.10	23.50	24.50	540	720		720	
23	5. Technology hand-off (S.2 handover)	FR1 n25	0	40	QPSK(DFT-s-OFDM)	100.00%	108	54	N/A	50	BM20	1	0/0	2	376500	1882.5	392500	1962.5	0.277	1.6	19.01	23.71	19.50	24.50	540	720		720	720
24	5. Technology hand-off (S.2 handover)	FR1 n48	0	10	QPSK	100.00%	1	0	N/A	50	BM20	1	0/0	2	27710	1310	8820	2355	0.081	1.6	17.88	19.20	18.50	18.50	540	720		720	720
25	6. Switching between TDD and FDD configurations	FR1 n48	0	40	QPSK(DFT-s-OFDM)	100.00%	1	1	N/A	50	FB30	5	0/1	2	641666	3624.99	641666	3624.99	0.188	1.6	11.56	21.62	13.00	23.00	540	720		720	
26		FR1 n25	0	40	QPSK(DFT-s-OFDM)	100.00%	108	54	N/A	50	BM20	1	0/0	2	376500	1882.5	392500	1962.5	0.277	1.6	19.08	23.99	19.50	24.50	540	720		720	
27	8. Dropped connection	FR1 n25	0	40	QPSK(DFT-s-OFDM)	100.00%	108	54	N/A	50	BM20	1	0/0	2	376500	1882.5	392500	1962.5	0.277	1.6	18.71	24.6	19.50	24.50	540	720	10	720	

NOTE:

* $P_{limit, nom}$, $P_{max, nom}$ are frame-averaged power values in dBm, which take TX duty cycle into account for TDD bands with TX duty cycle less than or equal to 100%.

All of the test cases for this scenario are relegated in Table 6-2, and the test procedure follows section 4.11.2. All of the measurements are conducted 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 guarantee the time-averaged SAR is always below the ISED requirement for all test cases. The following details will demonstrate case-by-case to show how Mediatek's TA-SAR algorithm behaves for each RAT.

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Table 6-2 Operating parameters for different TA-SAR parameters setting

Test case	RAT	Testband	Test seq.	ECI	$P_{max,nom}$ (dBm)	$P_{limit,nom}$ (dBm)	$P_{LowThresh}$ (dBm)	$P_{UE_backoff}$ (dBm)	$P_{UE_max_cust}$ (dBm)	Pass or Fail SAR limit
0	WCDMA	Band 2	1	2	24.00	20.00	19.50	17.00	24.00	Pass
1	LTE	Band 7	1	2	23.00	19.00	18.50	16.00	23.00	Pass
2	LTE	Band 13	1	2	23.50	20.50	20.00	17.50	23.50	Pass
3	LTE	Band 48	1	1	21.01	17.01	16.51	14.01	21.01	Pass
4	FR1	n25	1	2	24.50	19.50	19.00	16.50	24.50	Pass
5	FR1	n48	1	1	23.00	13.00	12.50	10.00	23.00	Pass
6	WCDMA	Band 2	2	2	24.00	20.00	19.50	17.00	24.00	Pass
7	LTE	Band 7	2	2	23.00	19.00	18.50	16.00	23.00	Pass
8	LTE	Band 13	1	2	24.50	28.10	27.60	25.10	24.50	Pass
9	LTE	Band 48	2	1	23.50	20.50	20.00	17.50	23.50	Pass
10	FR1	n25	2	2	24.50	19.50	19.00	16.50	24.50	Pass
11	FR1	n48	2	1	23.00	13.00	12.50	10.00	23.00	Pass
12	WCDMA	Band 2	3(4)	2	24.00	20.00	19.50	17.00	24.00	Pass
13	LTE	Band 7	3(4)	2	23.00	19.00	18.50	16.00	23.00	Pass
14	LTE	Band 13	1	2	23.50	20.50	20.00	17.50	23.50	Pass
15	LTE	Band 48	3(4)	1	21.01	17.01	16.51	14.01	21.01	Pass
16	FR1	n25	3(4)	2	24.50	19.50	19.00	16.50	24.50	Pass
17	FR1	n48	3(4)	1	23.00	13.00	12.50	10.00	23.00	Pass

Note: All power items in above table are frame-averaged level

For the figure of each case, all items in the figures are illustrated as frame-averaged level, and the figure demonstrates ($SAR_{target,nom}$ and SAR_{target} are defined in section 2.1):

- calculated 360s-avg SAR: calculated time-averaged 1gSAR or 10gSAR over time
- $SAR_{target,nom}$ and SAR_{target} : $SAR_{target} = SAR_{target,nom} \times 10^{1dB\ uncertainty/10}$
- REG SAR limit: ISED limit of 1.6 W/kg (1gSAR) or 4.0 W/kg (10gSAR)
 - Larger than or equal to SAR_{target}

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- max 360s-avg SAR: maximum time-averaged 1gSAR or 10gSAR value
- measured inst. SAR: measured instantaneous single point SAR

According to the illustrations, maximum time-averaged SAR value $\leq SAR_{target}$, proving that the calculated time-averaged SAR does not exceed SAR_{target} at all times. In conclusion, all test cases of the scenario meet ISED requirement, and scenario 1 in section 5.2 is further validated through SAR measurement.

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6.2.1 SAR Measurement results for NR

•Case 4 in table 6-2

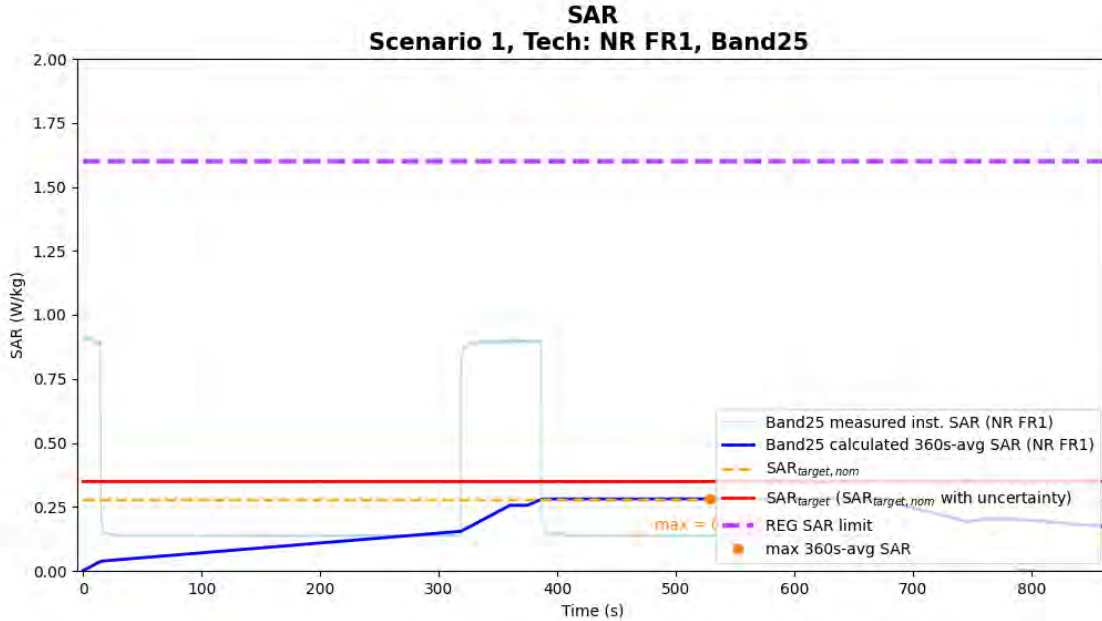


Figure 6-3 Time-averaged SAR over time for case 4 (sub6 NR 25)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.2809 W/kg
Validation result: pass	

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•Case 5 in table 6-2

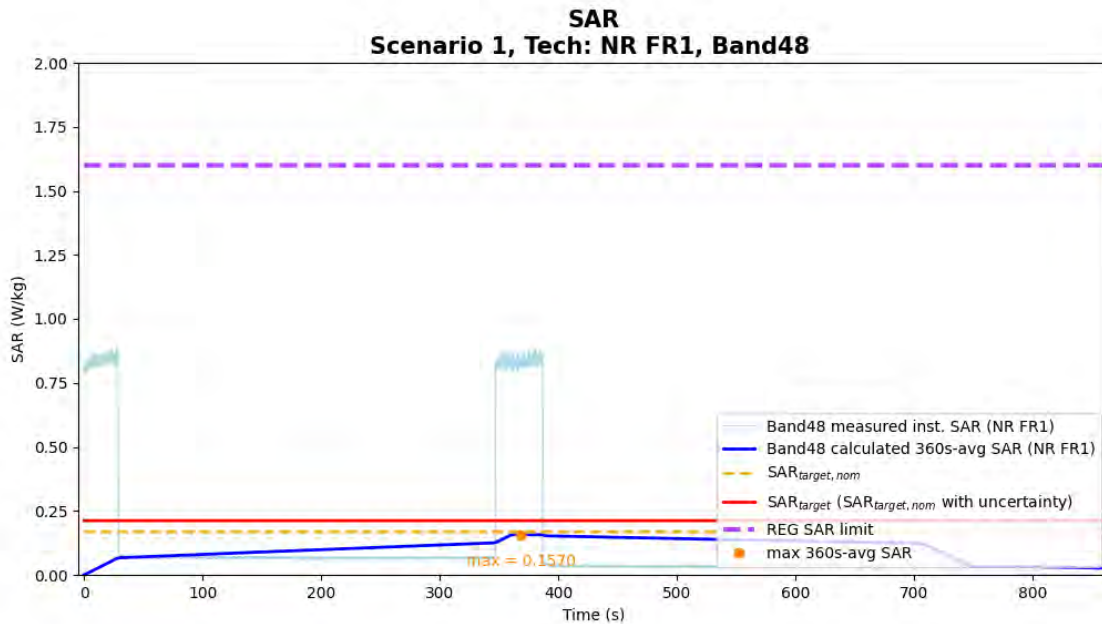


Figure 6-4 Time-averaged SAR over time for case 5 (sub6 NR n48)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.1570 W/kg
Validation result: pass	

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•Case 10 in table 6-2

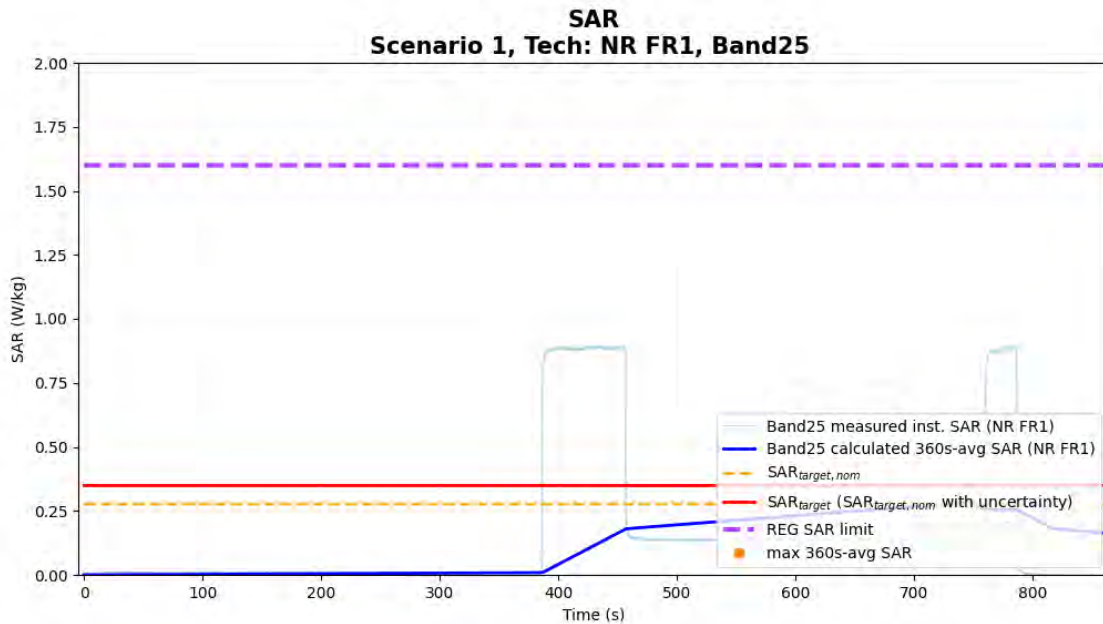


Figure 6-5 Time-averaged SAR over time for case 10 (sub6 NR n25)

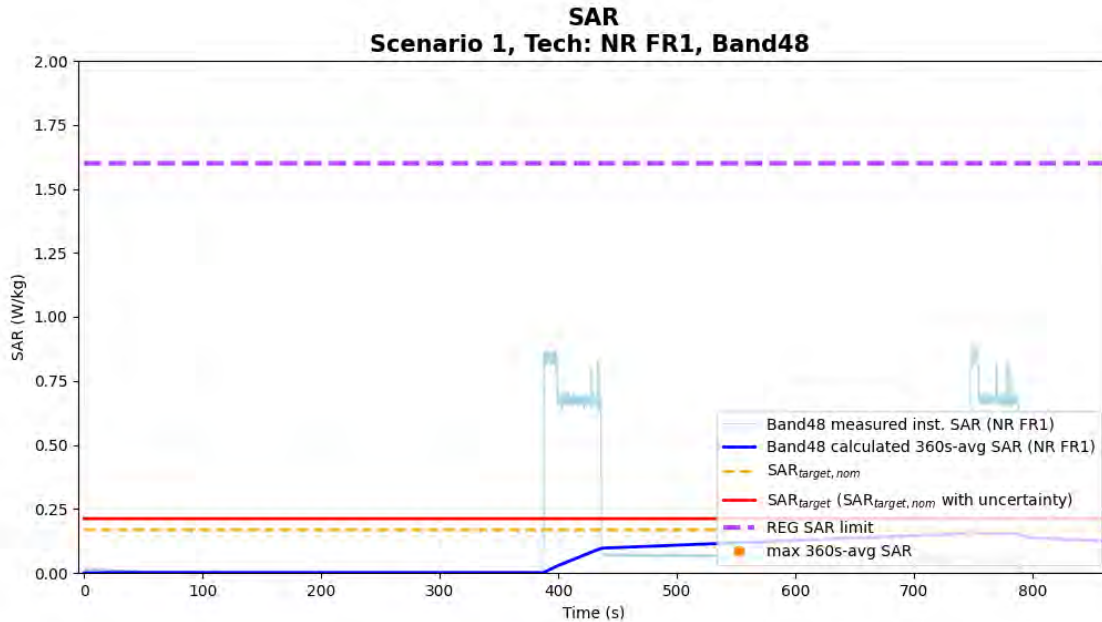
ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.2831 W/kg
Validation result: pass	

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•Case 11 in table 6-2


Figure 6-6 Time-averaged SAR over time for case 11 (sub6 NR n48)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.1547 W/kg
Validation result: pass	

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•Case 16 in table 6-2

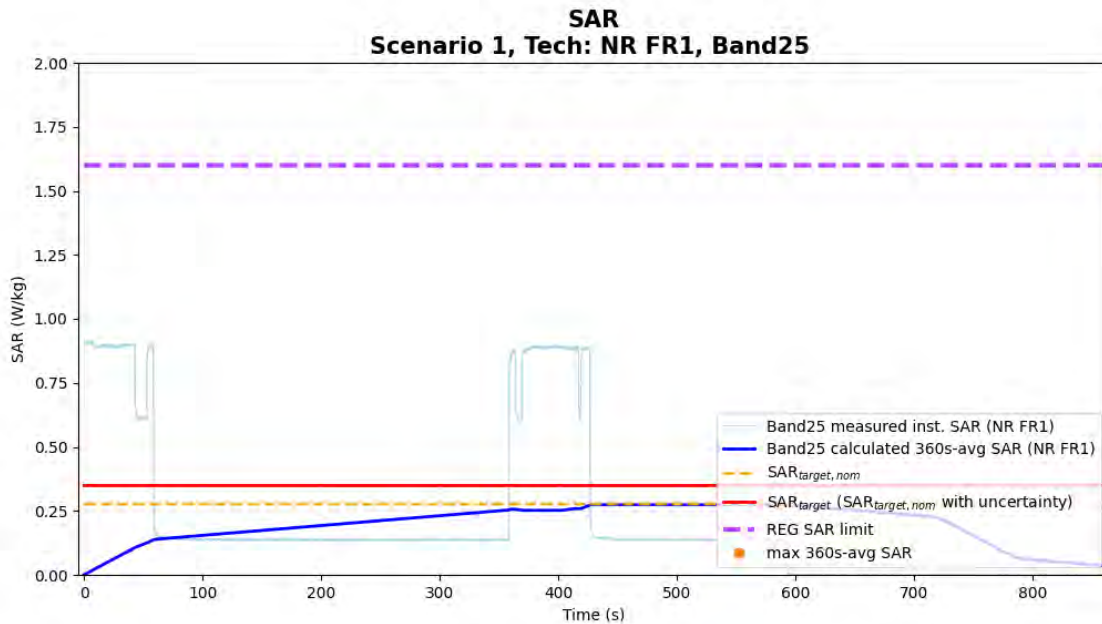


Figure 6-7 Time-averaged SAR over time for case 16 (sub6 NR n25)

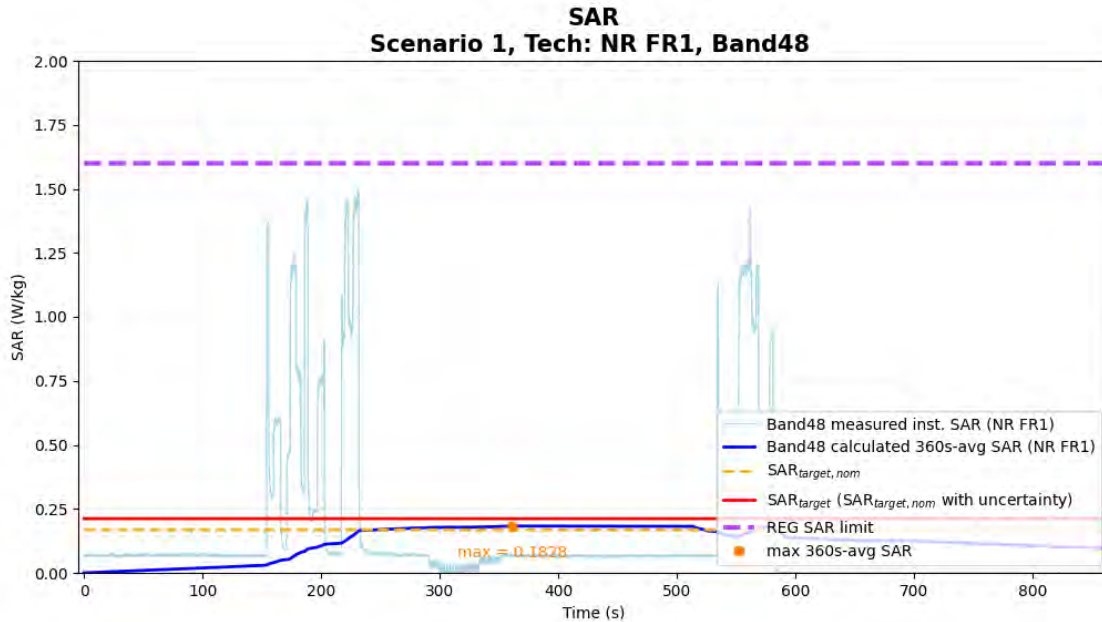
ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.2742 W/kg
Validation result: pass	

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•Case 17 in table 6-2


Figure 6-8 Time-averaged SAR over time for case 17 (sub6 NR n48)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.1828 W/kg
Validation result: pass	

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6.2.2 SAR Measurement results for LTE

•Case 1 in table 6-2

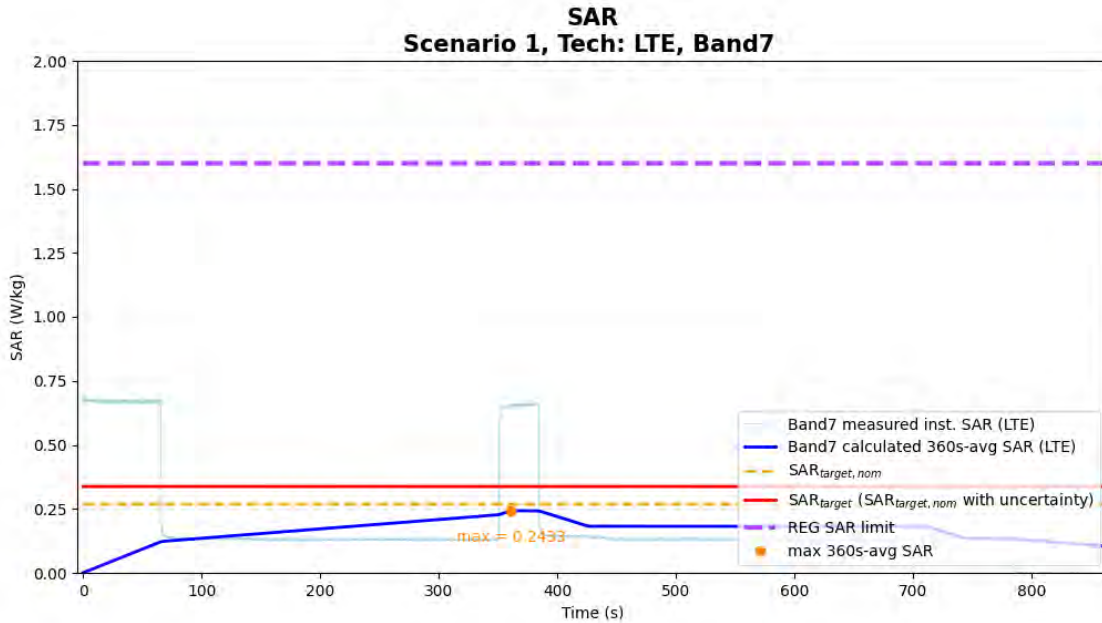


Figure 6-9 Time-averaged SAR over time for case 1 (LTE B7)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.2433 W/kg
Validation result: pass	

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•Case 2 in table 6-2

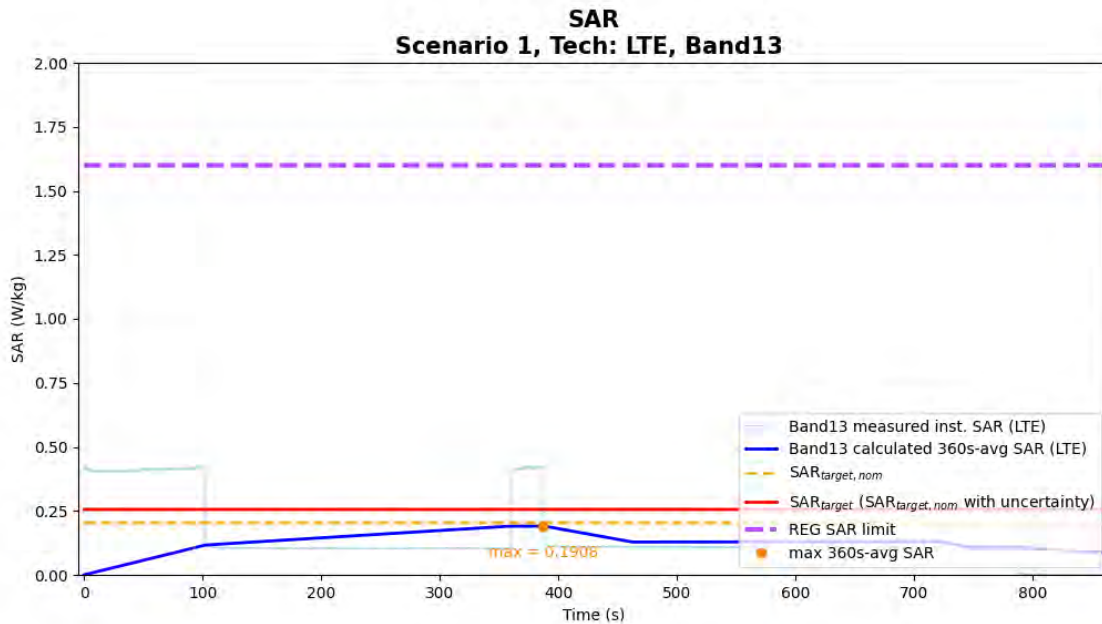


Figure 6-10 Time-averaged SAR over time for case 2 (LTE B13)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.1908 W/kg
Validation result: pass	

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•Case 3 in table 6-2

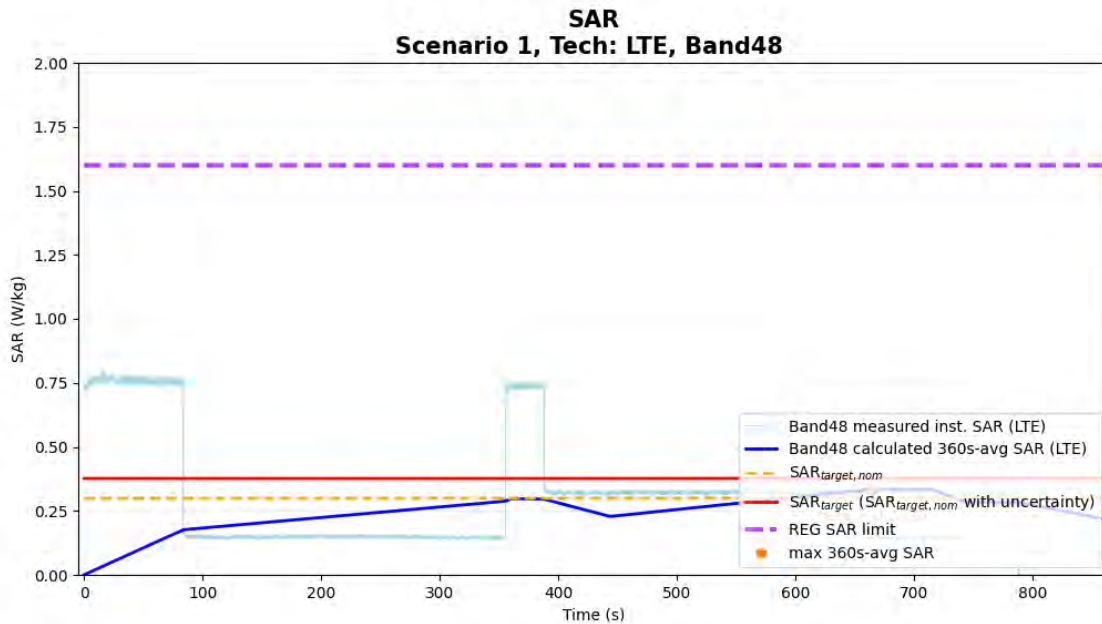


Figure 6-10 Time-averaged SAR over time for case 3 (LTE B48)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.3326 W/kg
Validation result: pass	

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- Case 7 in table 6-2

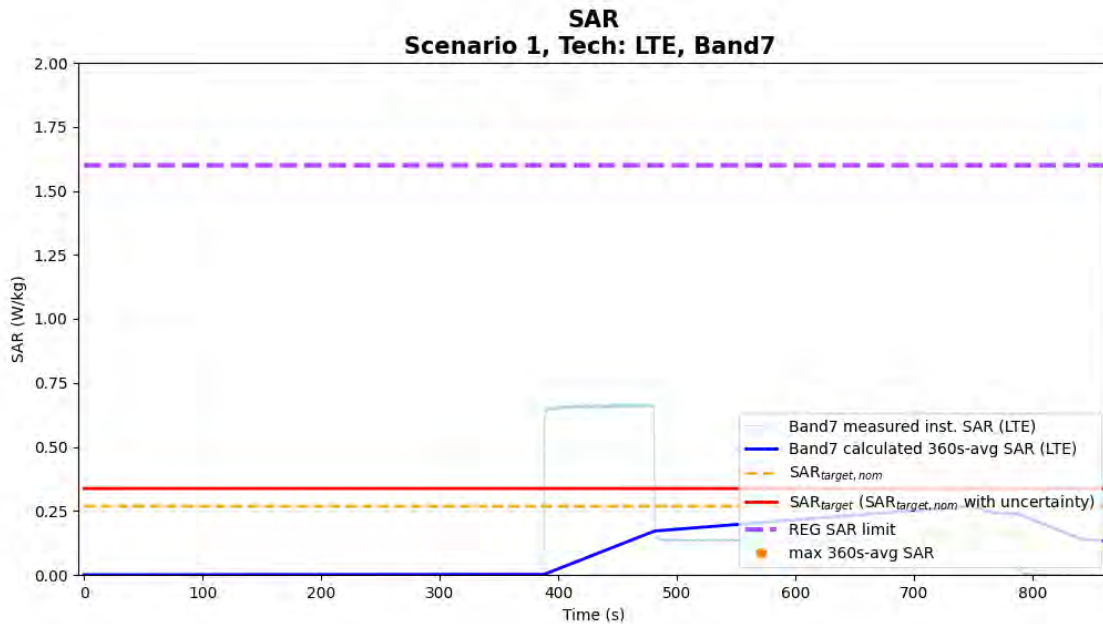


Figure 6-11 Time-averaged SAR over time for case 7 (LTE B7)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.2691 W/kg
Validation result: pass	

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•Case 8 in table 6-2

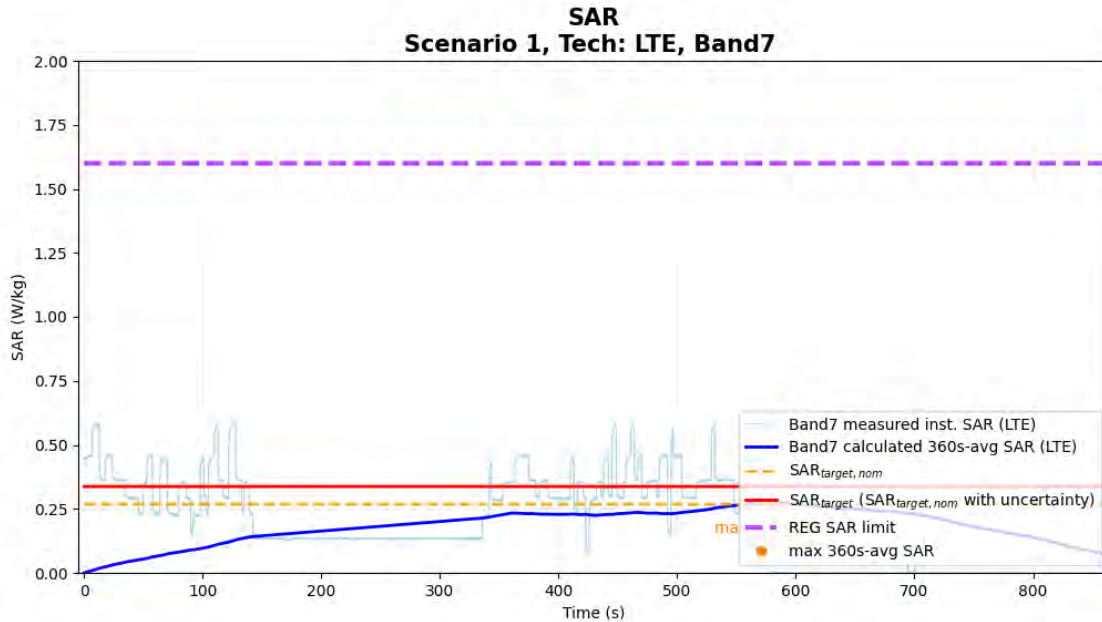


Figure 6-12 Time-averaged SAR over time for case 8 (LTE B13)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.2768 W/kg
Validation result: pass	

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•Case 9 in table 6-2

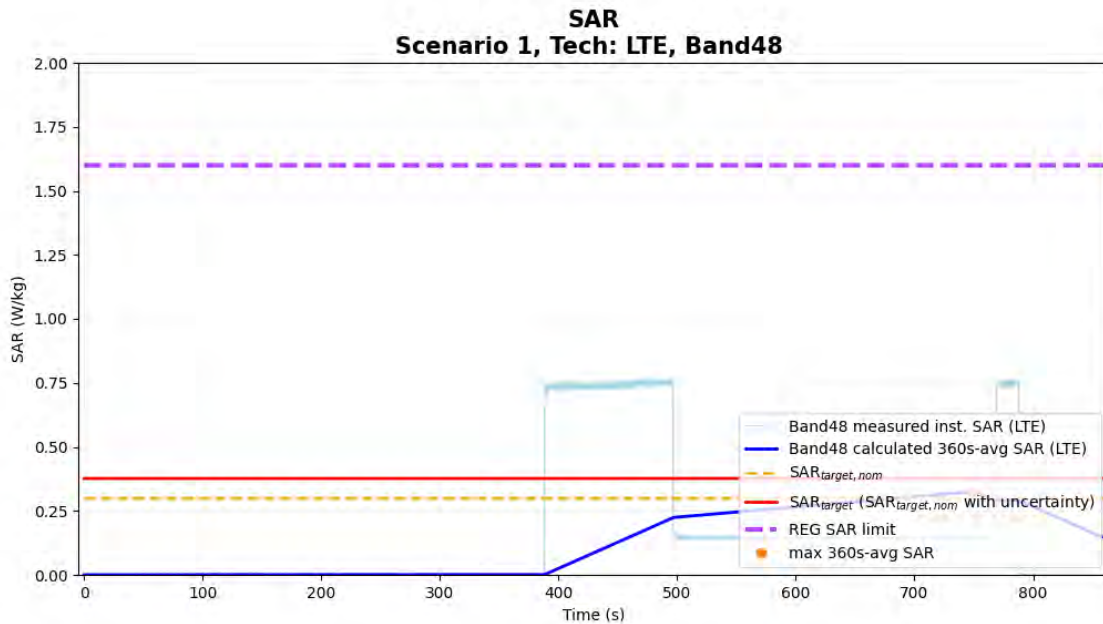


Figure 6-12 Time-averaged SAR over time for case 9 (LTE B48)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.3244 W/kg
Validation result: pass	

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Case 13 in table 6-2

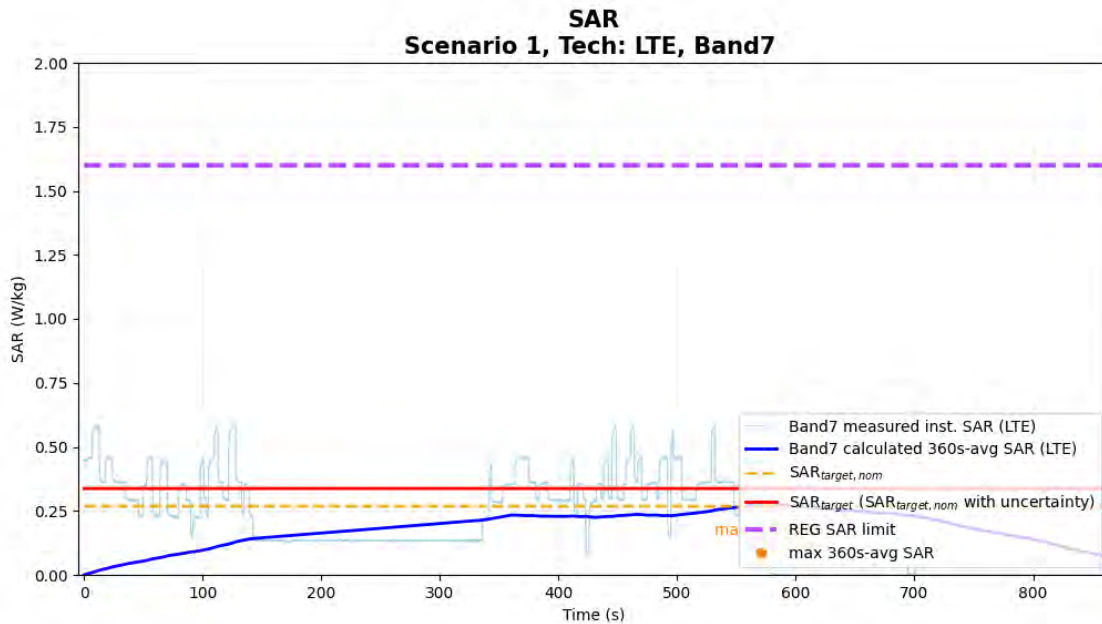


Figure 6-13 Time-averaged SAR over time for case 13 (LTE B7)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.2768 W/kg
Validation result: pass	

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•Case 14 in table 6-2

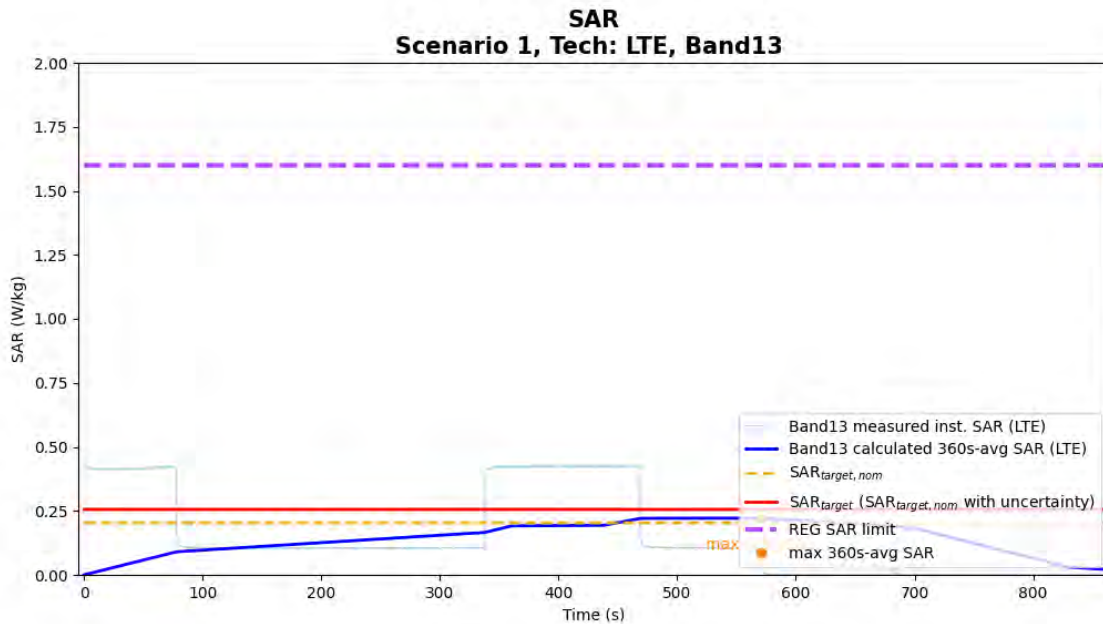


Figure 6-14 Time-averaged SAR over time for case 14 (LTE B13)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.2212 W/kg
Validation result: pass	

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•Case 15 in table 6-2

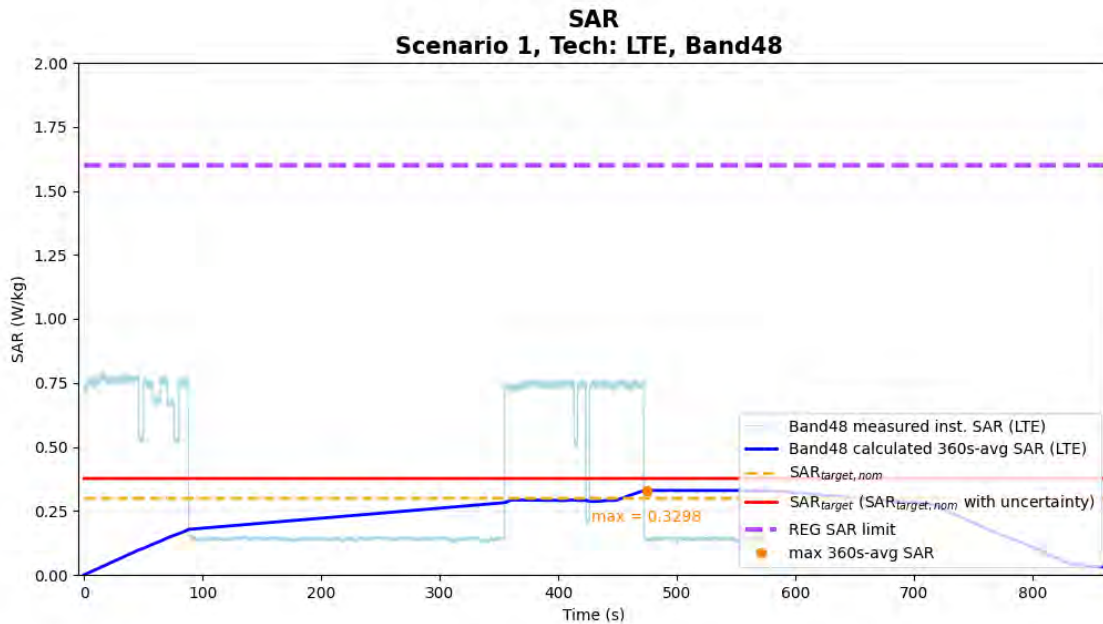


Figure 6-14 Time-averaged SAR over time for case 15 (LTE B48)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.3298 W/kg
Validation result: pass	

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6.2.3 SAR Measurement results for WCDMA

•Case 0 in table 6-2

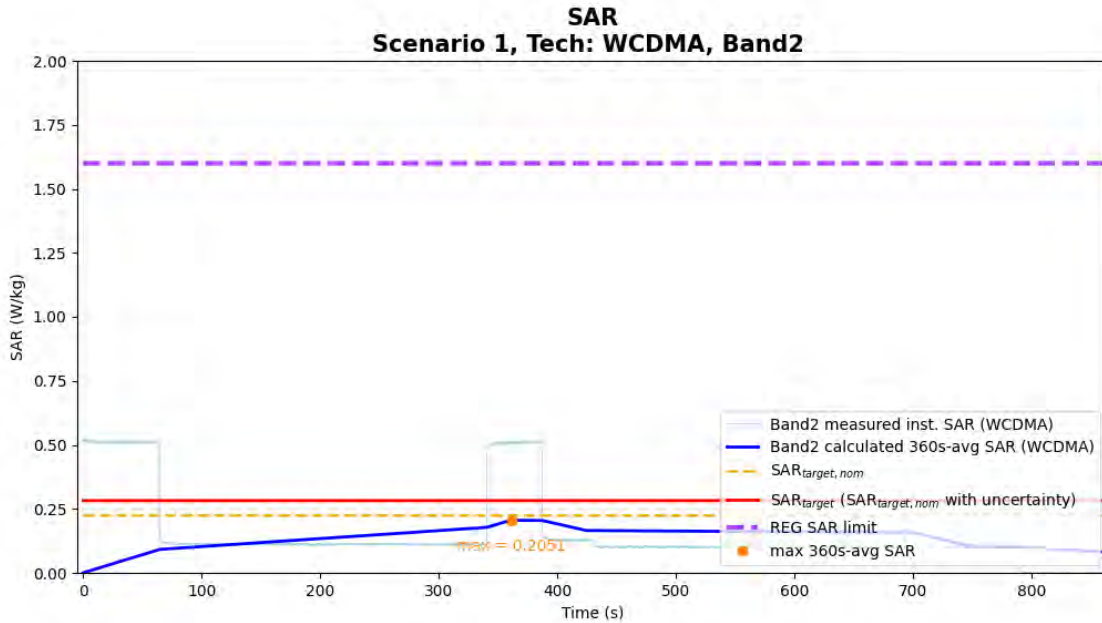


Figure 6-15 Time-averaged SAR over time for case 0 (WCDMA B2)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.2051 W/kg
Validation result: pass	

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•Case 6 in table 6-2

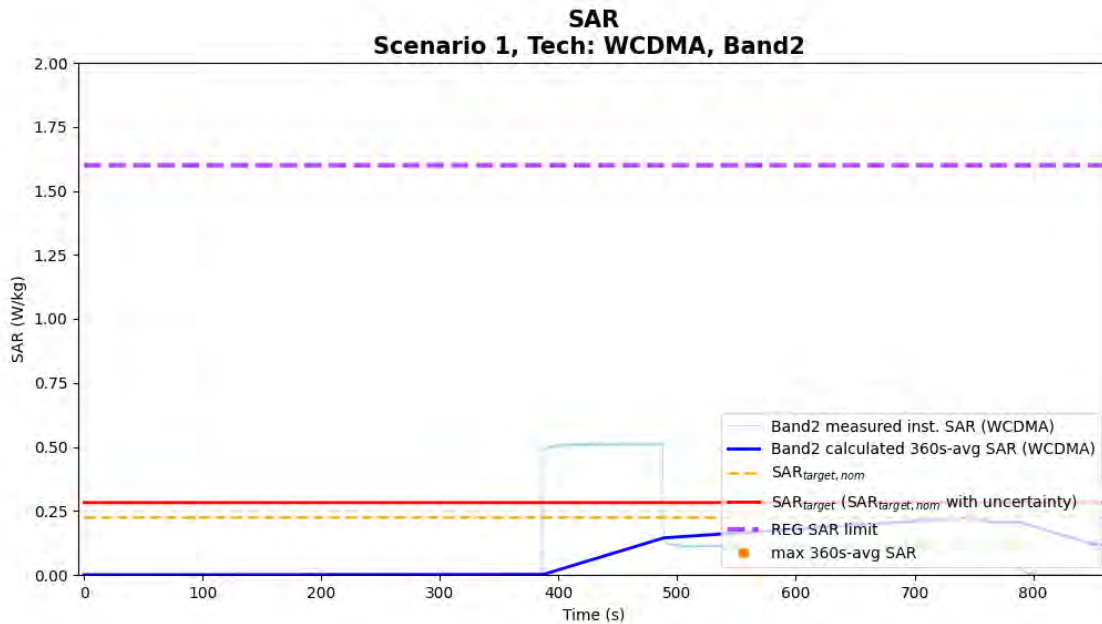


Figure 6-16 Time-averaged SAR over time for case 6 (WCDMA B2)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.2241 W/kg
Validation result: pass	

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- Case12 in table 6-2

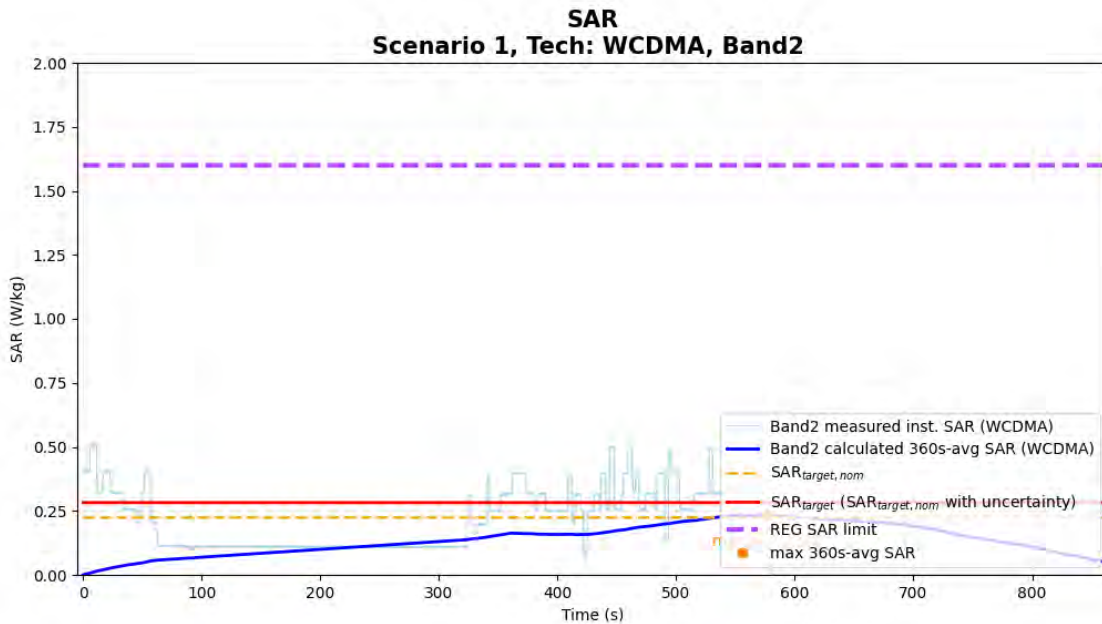


Figure 6-17 Time-averaged SAR over time for case 12 (WCDMA B2)

ISED 1gSAR limit	1.6 W/kg
SAR_{target} ($SAR_{target,nom}$ with 1-dB uncertainty)	1.6 W/kg
Max 360s-time averaged 1gSAR	0.2322 W/kg
Validation result: pass	

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7. Conclusions

This document proposes the TA-SAR test procedures for the test scenarios of SPR-004, and further proves Mediatek's TA-SAR algorithm can meet the ISED SAR regulations. As shown in Chapters 5, Mediatek's TA-SAR algorithm is able to maintain SAR over time below the ISED regulatory limits (based on the TX-power-to-SAR translation). Furthermore, the near-field measurements are also done in a certified lab to further validate the proposed test methodologies, and the results shown in Chapters 6 demonstrate that Mediatek's TA-SAR algorithm indeed can maintain SAR over time below the ISED regulatory limits.

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Appendix A: TAS Validation Checklist

Table A1: TAS validation checklist

TAS algorithm validation test	Test result (pass, fail, n/a)	Justification for omission of test
Changes in requested power	Pass	
Antenna switching	n/a	The test case covered by test case #19
Change in operating state	Pass	
Frequency band hand-off or redirect	Pass	
Technology hand-off	Pass	
SAR Exposure Switch via Conducted Power Measurements.	Pass	
Switching between time division duplexing (TDD) and frequency division duplexing (FDD) configurations	Pass	
Change in modulation scheme	n/a	same Plimit value is applied for all modulation schemes
Dropped connection	Pass	

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Appendix B: TAS Validation Checklist

Uncertainty components associated with the conducted power: +/- 1dB

Test Case#12								
Time(s)	T _{rq} (S)	P _{req} (dBm)	Time(s)	T _{rq} (S)	P _{req} (dBm)	Time(s)	T _{rq} (S)	P _{req} (dBm)
6	6	18.5	209	3	21	413	5	20.5
10	4	21	215	6	23	416	3	20.5
13	3	22.5	218	3	18	422	6	21
19	6	22	220	2	21	425	3	23
25	6	23.5	223	3	20.5	428	3	19
30	5	21.5	228	5	23.5	433	5	22
36	6	22.5	231	3	20	435	2	20
41	5	21.5	236	5	23	438	3	14.5
47	6	21.5	240	4	18.5	440	2	21
49	2	20	243	3	19.5	444	4	21
52	3	21	248	5	22	448	4	21.5
58	6	21	253	5	20.5	450	2	20.5
62	4	19	255	2	18	454	4	23
65	3	21.5	260	5	21.5	457	3	20.5
70	5	22.5	265	5	23	461	4	23.5
76	6	19.5	269	4	24	467	6	20
79	3	22.5	273	4	21	469	2	21.5
82	3	22	279	6	22	473	4	22.5
88	6	19.5	283	4	22.5	476	3	24
92	4	19	287	4	21	479	3	21.5
94	2	22	290	3	19	482	3	22.5
98	4	22	293	3	22	484	2	20.5
102	4	20.5	297	4	20.5	487	3	20.5
104	2	17	303	6	22.5	492	5	22
110	6	19.5	307	4	20.5	495	3	21
113	3	22.5	313	6	22	497	2	20.5
115	2	20.5	315	2	22.5	500	3	22.5
117	2	19.5	319	4	23	504	4	23
122	5	22.5	321	2	21.5	507	3	17.5
125	3	23.5	325	4	19.5	509	2	23.5
129	4	21.5	328	3	19	513	4	22
134	5	20	334	6	20.5	516	3	22
140	6	23.5	340	6	21.5	520	4	20.5
145	5	21	343	3	18.5	525	5	20.5
147	2	19	348	5	19.5	528	3	20
151	4	21.5	354	6	19.5	531	3	21.5
155	4	19.5	356	2	22.5	535	4	22
158	3	22.5	361	5	20	541	6	22
163	5	21.5	365	4	20.5	544	3	23.5
167	4	21.5	370	5	22	548	4	21.5
171	4	23	373	3	22	552	4	22
176	5	21	375	2	22	557	5	22
179	3	23	378	3	22.5	560	3	21
182	3	18	383	5	22	565	5	19.5
187	5	18.5	387	4	22	571	6	22.5
190	3	20.5	393	6	21.5	576	5	20
194	4	20.5	396	3	20.5	582	6	23
198	4	21	401	5	21.5	584	2	20.5
203	5	22.5	403	2	22	588	4	20.5
206	3	21	408	5	20	590	2	22.5

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Test Case#13								
Time(s)	T _{req} (S)	P _{req} (dBm)	Time(s)	T _{req} (S)	P _{req} (dBm)	Time(s)	T _{req} (S)	P _{req} (dBm)
6	6	17.5	209	3	20	413	5	19.5
10	4	20	215	6	22	416	3	19.5
13	3	21.5	218	3	17	422	6	20
19	6	21	220	2	20	425	3	22
25	6	22.5	223	3	19.5	428	3	18
30	5	20.5	228	5	22.5	433	5	21
36	6	21.5	231	3	19	435	2	19
41	5	20.5	236	5	22	438	3	13.5
47	6	20.5	240	4	17.5	440	2	20
49	2	19	243	3	18.5	444	4	20
52	3	20	248	5	21	448	4	20.5
58	6	20	253	5	19.5	450	2	19.5
62	4	18	255	2	17	454	4	22
65	3	20.5	260	5	20.5	457	3	19.5
70	5	21.5	265	5	22	461	4	22.5
76	6	18.5	269	4	23	467	6	19
79	3	21.5	273	4	20	469	2	20.5
82	3	21	279	6	21	473	4	21.5
88	6	18.5	283	4	21.5	476	3	23
92	4	18	287	4	20	479	3	20.5
94	2	21	290	3	18	482	3	21.5
98	4	21	293	3	21	484	2	19.5
102	4	19.5	297	4	19.5	487	3	19.5
104	2	16	303	6	21.5	492	5	21
110	6	18.5	307	4	19.5	495	3	20
113	3	21.5	313	6	21	497	2	19.5
115	2	19.5	315	2	21.5	500	3	21.5
117	2	18.5	319	4	22	504	4	22
122	5	21.5	321	2	20.5	507	3	16.5
125	3	22.5	325	4	18.5	509	2	22.5
129	4	20.5	328	3	18	513	4	21
134	5	19	334	6	19.5	516	3	21
140	6	22.5	340	6	20.5	520	4	19.5
145	5	20	343	3	17.5	525	5	19.5
147	2	18	348	5	18.5	528	3	19
151	4	20.5	354	6	18.5	531	3	20.5
155	4	18.5	356	2	21.5	535	4	21
158	3	21.5	361	5	19	541	6	21
163	5	20.5	365	4	19.5	544	3	22.5
167	4	20.5	370	5	21	548	4	20.5
171	4	22	373	3	21	552	4	21
176	5	20	375	2	21	557	5	21
179	3	22	378	3	21.5	560	3	20
182	3	17	383	5	21	565	5	18.5
187	5	17.5	387	4	21	571	6	21.5
190	3	19.5	393	6	20.5	576	5	19
194	4	19.5	396	3	19.5	582	6	22
198	4	20	401	5	20.5	584	2	19.5
203	5	21.5	403	2	21	588	4	19.5
206	3	20	408	5	19	590	2	21.5

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Test Case#15								
Time(s)	T _{req} (S)	P _{req} (dBm)	Time(s)	T _{req} (S)	P _{req} (dBm)	Time(s)	T _{req} (S)	P _{req} (dBm)
6	6	17.5	209	3	20	413	5	19.5
10	4	20	215	6	22	416	3	19.5
13	3	21.5	218	3	17	422	6	20
19	6	21	220	2	20	425	3	22
25	6	22.5	223	3	19.5	428	3	18
30	5	20.5	228	5	22.5	433	5	21
36	6	21.5	231	3	19	435	2	19
41	5	20.5	236	5	22	438	3	13.5
47	6	20.5	240	4	17.5	440	2	20
49	2	19	243	3	18.5	444	4	20
52	3	20	248	5	21	448	4	20.5
58	6	20	253	5	19.5	450	2	19.5
62	4	18	255	2	17	454	4	22
65	3	20.5	260	5	20.5	457	3	19.5
70	5	21.5	265	5	22	461	4	22.5
76	6	18.5	269	4	23	467	6	19
79	3	21	273	4	20	469	2	20.5
82	3	21	279	6	21	473	4	21.5
88	6	18.5	283	4	21.5	476	3	23
92	4	18	287	4	20	479	3	20.5
94	2	21	290	3	18	482	3	21.5
98	4	21	293	3	21	484	2	19.5
102	4	19.5	297	4	19.5	487	3	19.5
104	2	16	303	6	21.5	492	5	21
110	6	18.5	307	4	19.5	495	3	20
113	3	21.5	313	6	21	497	2	19.5
115	2	19.5	315	2	21.5	500	3	21.5
117	2	18.5	319	4	22	504	4	22
122	5	21.5	321	2	20.5	507	3	16.5
125	3	22.5	325	4	18.5	509	2	22.5
129	4	20.5	328	3	18	513	4	21
134	5	19	334	6	19.5	516	3	21
140	6	22.5	340	6	20.5	520	4	19.5
145	5	20	343	3	17.5	525	5	19.5
147	2	18	348	5	18.5	528	3	19
151	4	20.5	354	6	18.5	531	3	20.5
155	4	18.5	356	2	21.5	535	4	21
158	3	21.5	361	5	19	541	6	21
163	5	20.5	365	4	19.5	544	3	22.5
167	4	20.5	370	5	21	548	4	20.5
171	4	22	373	3	21	552	4	21
176	5	20	375	2	21	557	5	21
179	3	22	378	3	21.5	560	3	20
182	3	17	383	5	21	565	5	18.5
187	5	17.5	387	4	21	571	6	21.5
190	3	19.5	393	6	20.5	576	5	19
194	4	19.5	396	3	19.5	582	6	22
198	4	20	401	5	20.5	584	2	19.5
203	5	21.5	403	2	21	588	4	19.5
206	3	20	408	5	19	590	2	21.5

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Test Case#16								
Time(s)	T _{rq} (S)	P _{req} (dBm)	Time(s)	T _{rq} (S)	P _{req} (dBm)	Time(s)	T _{rq} (S)	P _{req} (dBm)
4	4	21.5	202	4	23.5	400	4	21
8	4	22.5	206	4	20	402	2	20
11	3	22	210	4	22	405	3	21
15	4	23.5	213	3	20.5	407	2	21.5
18	3	22	215	2	21.5	411	4	21
23	5	23.5	218	3	22.5	415	4	20
28	5	20.5	221	3	22.5	417	2	21
33	5	21.5	225	4	21	421	4	17.5
37	4	17.5	231	6	23.5	424	3	22.5
43	6	20	234	3	22.5	430	6	23
48	5	21	236	2	22.5	436	6	20
50	2	22	242	6	22.5	439	3	20
55	5	21	246	4	23	442	3	24
60	5	20	252	6	21	446	4	20.5
63	3	20.5	258	6	17.5	448	2	22.5
65	2	20	260	2	21.5	450	2	24
68	3	20	265	5	20.5	453	3	21.5
73	5	21.5	269	4	20	457	4	23.5
77	4	23	273	4	23.5	462	5	19.5
82	5	18	276	3	22.5	467	5	23.5
85	3	19.5	282	6	19.5	472	5	24.5
89	4	21.5	286	4	23	477	5	21.5
94	5	22	292	6	23	479	2	21.5
96	2	21	295	3	21	484	5	20.5
102	6	22.5	298	3	20.5	486	2	22
105	3	21	302	4	20.5	488	2	21.5
110	5	22.5	306	4	20	493	5	21
114	4	21	308	2	22.5	499	6	21.5
117	3	23	312	4	20	505	6	21.5
121	4	22	315	3	21	509	4	23
125	4	19.5	318	3	22.5	511	2	21.5
130	5	21	322	4	21.5	513	2	18.5
132	2	22	328	6	22.5	518	5	19.5
137	5	24	331	3	20.5	521	3	23
140	3	22.5	336	5	22	526	5	23.5
146	6	23.5	340	4	21	530	4	22.5
151	5	19	344	4	18	535	5	23
155	4	23	350	6	20.5	538	3	22
157	2	21	355	5	21.5	541	3	18
160	3	22.5	360	5	24	544	3	20.5
162	2	20	366	6	22	548	4	19
167	5	18.5	370	4	22	552	4	17.5
171	4	22	373	3	22.5	555	3	22
173	2	22.5	378	5	24	561	6	19
178	5	20.5	383	5	24	565	4	20.5
180	2	23	386	3	24	568	3	20
183	3	20	388	2	22	572	4	22.5
187	4	21	390	2	20	576	4	20
193	6	16	394	4	23	579	3	19.5
198	5	18	396	2	20	585	6	21

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Test Case#17								
Time(s)	T _{rq} (S)	P _{req} (dBm)	Time(s)	T _{rq} (S)	P _{req} (dBm)	Time(s)	T _{rq} (S)	P _{req} (dBm)
6	6	9.5	209	3	15.5	413	5	14.5
10	4	15	215	6	20	416	3	14
13	3	19.5	218	3	7.5	422	6	15.5
19	6	18	220	2	16	425	3	21
25	6	21.5	223	3	14.5	428	3	10
30	5	16.5	228	5	22.5	433	5	18
36	6	19	231	3	13.5	435	2	12.5
41	5	16.5	236	5	21	438	3	-1
47	6	16.5	240	4	9	440	2	16
49	2	12.5	243	3	12	444	4	15
52	3	15	248	5	17.5	448	4	16
58	6	15.5	253	5	14.5	450	2	14.5
62	4	10.5	255	2	7.5	454	4	21
65	3	17.5	260	5	17.5	457	3	14.5
70	5	19.5	265	5	21	461	4	21.5
76	6	12	269	4	22.5	467	6	13.5
79	3	18.5	273	4	15.5	469	2	17
82	3	17.5	279	6	17.5	473	4	19.5
88	6	12	283	4	19.5	476	3	22.5
92	4	10.5	287	4	15.5	479	3	17
94	2	17.5	290	3	11	482	3	19.5
98	4	18	293	3	18	484	2	14.5
102	4	13.5	297	4	14	487	3	15
104	2	5.5	303	6	19.5	492	5	17.5
110	6	11	307	4	13.5	495	3	16
113	3	19	313	6	18	497	2	14.5
115	2	14.5	315	2	19.5	500	3	19
117	2	11.5	319	4	20.5	504	4	21
122	5	19	321	2	17	507	3	7
125	3	21.5	325	4	12.5	509	2	22
129	4	17.5	328	3	10.5	513	4	17.5
134	5	13.5	334	6	15	516	3	18.5
140	6	22	340	6	17	520	4	15
145	5	15.5	343	3	9	525	5	14
147	2	11	348	5	12	528	3	13
151	4	16.5	354	6	12.5	531	3	17
155	4	11.5	356	2	18.5	535	4	17.5
158	3	19	361	5	13	541	6	18
163	5	17.5	365	4	14.5	544	3	21
167	4	17.5	370	5	18.5	548	4	16.5
171	4	21	373	3	17.5	552	4	18.5
176	5	16	375	2	18.5	557	5	17.5
179	3	21	378	3	19	560	3	15.5
182	3	8.5	383	5	18.5	565	5	12
187	5	9	387	4	17.5	571	6	19
190	3	13.5	393	6	17	576	5	13.5
194	4	14.5	396	3	14	582	6	20.5
198	4	15	401	5	17.5	584	2	14
203	5	19	403	2	18	588	4	14.5
206	3	15.5	408	5	13	590	2	20


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Appendix C. cDASY6 System Verification

EX3DV4 E-Field Probe


Construction	Symmetrical design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)	
Calibration	Basic Broad Band Calibration in air Conversion Factors (CF) for HSL 1900/2450/2600/3700 MHz Additional CF for other liquids and frequencies upon request	
Frequency	10 MHz to > 6 GHz	
Directivity	± 0.3 dB in HSL (rotation around probe axis) ± 0.5 dB in tissue material (rotation normal to probe axis)	
Dynamic Range	10 µW/g to > 100 mW/g Linearity: ± 0.2 dB (noise: typically < 1 µW/g)	
Dimensions	Tip diameter: 2.5 mm	
Application	High precision dosimetric measurements in any exposure scenario (e.g., very strong gradient fields). Only probe which enables compliance testing for frequencies up to 6 GHz with precision of better 30%.	

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Phantom

Model	Twin SAM	
Construction	<p>The shell corresponds to the specifications of the Specific Anthropomorphic Mannequin (SAM) phantom defined in IEEE 1528 and IEC 62209.</p> <p>It enables the dosimetric evaluation of left and right hand phone usage as well as body mounted usage at the flat phantom region. A cover prevents evaporation of the liquid. Reference markings on the phantom allow the complete setup of all predefined phantom positions and measurement grids by manually teaching three points with the robot.</p>	
Shell Thickness	2 ± 0.2 mm	
Filling Volume	Approx. 25 liters	
Dimensions	Height: 850 mm; Length: 1000 mm; Width: 500 mm	

DEVICE HOLDER

Construction	<p>In combination with the Twin SAM Phantom V4.0/V4.0C or Twin SAM, the Mounting Device (made from POM) enables the rotation of the mounted transmitter in spherical coordinates, whereby the rotation point is the ear opening. The devices can be easily and accurately positioned according to IEC, IEEE, CENELEC, FCC or other specifications. The device holder can be locked at different phantom locations (left head, right head, flat phantom).</p>	 <p style="text-align: center;">Device Holder</p>
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Appendix D. Instruments List

Equipment List					
Manufacturer	Device	Type	Serial number	Date of last calibration	Date of next calibration
SPEAG	Data acquisition Electronics	DAE4	856	Apr/26/2023	Apr/25/2024
SPEAG	Dosimetric E-Field Probe	EX3DV4	7712	Apr/14/2023	Apr/13/2024
SPEAG	System Validation Dipole	D1900V2	5d173	Apr/26/2023	Apr/25/2024
SPEAG	System Validation Dipole	D2450V2	727	Apr/25/2023	Apr/24/2024
SPEAG	System Validation Dipole	D2600V2	1005	Jan/11/2023	Jan/10/2024
SPEAG	System Validation Dipole	D3700V2	1057	Nov/22/2022	Nov/21/2023
SPEAG	Dielectric Assessment Kit	DAKS-3.5	1053	Feb/27/2023	Feb/26/2024
R&S	MXG Analog Signal Generator	SMB100A03	182012	May/23/2023	May/22/2024
Agilent	Dual-directional coupler	772D	MY52180142	Oct/23/2023	Oct/22/2024
Agilent	Dual-directional coupler	778D	MY52180302	Oct/23/2023	Oct/22/2024
EMCI	Amplifier	ZHL-42	980189	Calibration not required	Calibration not required
EMCI	Amplifier	ZVE-8G	980190	Calibration not required	Calibration not required
R&S	Power Sensor	NRP18S	109065	Oct/23/2023	Oct/22/2024
R&S	Power Meter	NRX	102034	Jan/11/2023	Jan/10/2024
R&S	Power Sensor	NRP18S	109066	Oct/23/2023	Oct/22/2024
SPEAG	Software	DASY 6 V16.0.2.136	N/A	Calibration not required	Calibration not required
SPEAG	Phantom	SAM	N/A	Calibration not required	Calibration not required
R&S	Radio Communication Test	CMW 500	165070	Oct/21/2023	Oct/20/2024
Keysight	UXM 5G Wireless Test Platform	E7515B	MY60101215	Feb/07/2023	Feb/06/2024
TECPEL	Digital thermometer	DTM-303A	TP130075	Jan/11/2023	Jan/10/2024

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Appendix E Tissue and System Verification

• Tissue Verification

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

The composition of the brain tissue simulating liquid is:

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

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

• Tissue Simulant Fluid for the Frequency Band

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

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

The depth of the tissue simulant in the flat section of the phantom was $\geq 15 \text{ cm} \pm 5 \text{ mm}$ during all tests. (Fig. 2)

Measured Frequency (MHz)	Target Dielectric Constant, ϵ_r	Target Conductivity, σ (S/m)	Measured Dielectric Constant, ϵ_r	Measured Conductivity, σ (S/m)	% dev ϵ_r	% dev σ	Limit	Measurement Date	Liquid Temp. (°C)	Ambient Temp (°C)
1880	40.000	1.400	39.337	1.454	-1.66%	3.86%	$\pm 5\%$	Oct. 26, 2023	21.7	22.1
1882.5	40.000	1.400	39.330	1.458	-1.68%	4.14%	$\pm 5\%$	Oct. 26, 2023	21.7	22.1
1900	40.000	1.400	39.318	1.462	-1.71%	4.43%	$\pm 5\%$	Oct. 26, 2023	21.7	22.1
2510	39.120	1.864	38.537	1.865	-1.49%	0.05%	$\pm 5\%$	Oct. 27, 2023	21.8	22.3
2600	39.000	1.960	38.413	1.932	-1.51%	-1.43%	$\pm 5\%$	Oct. 27, 2023	21.8	22.3
3603.3	37.797	3.017	37.231	2.894	-1.50%	-4.09%	$\pm 5\%$	Oct. 28, 2023	21.9	22.4
3624.99	37.775	3.040	37.212	3.017	-1.49%	-0.76%	$\pm 5\%$	Oct. 28, 2023	21.9	22.4
3700	37.700	3.118	37.120	3.109	-1.54%	-0.29%	$\pm 5\%$	Oct. 28, 2023	21.9	22.4

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• System Verification

The microwave circuit arrangement for system verification is sketched in Fig. b. The daily system accuracy verification occurs within the flat section of the SAM phantom. A SAR measurement was performed to see if the measured SAR was within $\pm 10\%$ from the target SAR values. These tests were done at 1900/2600MHz. The tests were conducted on the same days as the measurement of the DUT. The obtained results from the system accuracy verification are displayed in the table 1 (SAR values are normalized to 1W forward power delivered to the dipole). During the tests, the liquid depth above the ear reference points was above 15 cm in all the cases. It is seen that the system is operating within its specification, as the results are within acceptable tolerance of the reference values.

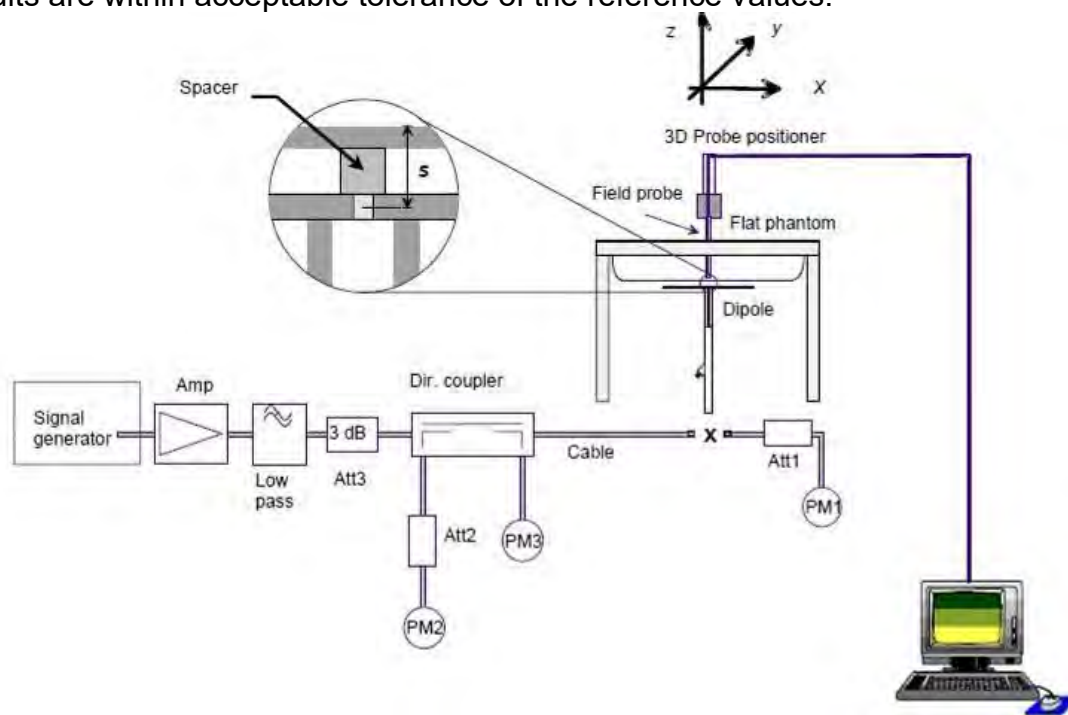


Fig. b The block diagram of system verification

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Validation Kit	S/N	Frequency (MHz)	1W Target 1g-SAR (W/kg)	pin=250mW Measured 1g-SAR (W/kg)	Normalized to 1W 1g-SAR (W/kg)	Deviation (%)	Limit	Measurement Date
D1900V2	5d173	1900	40.3	10.2	40.8	1.24	± 10%	Oct.26,2023
D2600V2	1005	2600	55.4	14.1	56.4	1.81	± 10%	Oct.27,2023

Validation Kit	S/N	Frequency (MHz)	1W Target 1g-SAR (W/kg)	pin=100mW Measured 1g-SAR (W/kg)	Normalized to 1W 1g-SAR (W/kg)	Deviation (%)	Limit	Measurement Date
D3700V2	1057	3700	66.6	6.6	66	-0.90	± 10%	Oct.28,2023

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Appendix F Measurement uncertainty

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

A	c	D	e		f	g	$h=c * f / e$	$i=c * g / e$	k
Source of Uncertainty	Tolerance/ Uncertainty	Probability Distributio	Div	Div Value	ci (1g)	ci (10g)	Standard uncertainty	Standard uncertainty	v_i , or V_{eff}
Measurement system									
Probe calibration	6.55%	N	1	1	1	1	6.55%	6.55%	∞
<i>Isotropy, Axial</i>	3.50%	R	$\sqrt{3}$	1.732	1	1	2.02%	2.02%	∞
<i>Isotropy, Hemispherical</i>	9.60%	R	$\sqrt{3}$	1.732	1	1	5.54%	5.54%	∞
Modulation Response	2.40%	R	$\sqrt{3}$	1.732	1	1	1.40%	1.40%	∞
Boundary Effect	1.00%	R	$\sqrt{3}$	1.732	1	1	0.58%	0.58%	∞
Linearity	4.70%	R	$\sqrt{3}$	1.732	1	1	2.71%	2.71%	∞
Detection Limits	1.00%	R	$\sqrt{3}$	1.732	1	1	0.58%	0.58%	∞
Readout Electronics	0.30%	N	1	1	1	1	0.30%	0.30%	∞
Response time	0.80%	R	$\sqrt{3}$	1.732	1	1	0.46%	0.46%	∞
Integration Time	2.60%	R	$\sqrt{3}$	1.732	1	1	1.50%	1.50%	∞
Measurement drift (class A evaluation)	1.75%	R	$\sqrt{3}$	1.732	1	1	1.01%	1.01%	∞
RF ambient condition - noise	3.00%	R	$\sqrt{3}$	1.732	1	1	1.73%	1.73%	∞
RF ambient conditions - reflections	3.00%	R	$\sqrt{3}$	1.732	1	1	1.73%	1.73%	∞
Probe positioner Mechanical restrictions	0.40%	R	$\sqrt{3}$	1.732	1	1	0.23%	0.23%	∞
Probe Positioning with respect to phantom shell	2.90%	R	$\sqrt{3}$	1.732	1	1	1.67%	1.67%	∞
Post-processing	1.00%	R	$\sqrt{3}$	1.732	1	1	0.58%	0.58%	∞
Max SAR Eval	1.00%	R	$\sqrt{3}$	1.732	1	1	0.58%	0.58%	∞
Test Sample related									
Test sample positioning	2.90%	N	1	1	1	1	2.90%	2.90%	M-1
Device Holder Uncertainty	3.60%	N	1	1	1	1	3.60%	3.60%	M-1
Drift of output power	5.00%	R	$\sqrt{3}$	1.732	1	1	2.89%	2.89%	∞
Phantom and Setup									
Phantom Uncertainty	4.00%	R	$\sqrt{3}$	1.732	1	1	2.31%	2.31%	∞
Liquid permittivity (mea.)	3.27%	N	1	1	0.64	0.43	2.09%	1.41%	M
Liquid Conductivity (mea.)	1.44%	N	1	1	0.6	0.49	0.86%	0.71%	M
Combined standard uncertainty		RSS					11.93%	11.81%	
Expan uncertainty (95% confidence interval), K=2							23.87%	23.62%	

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

A	c	D	e		f	g	h=c * f / e	i=c * g / e	k
Source of Uncertainty	Tolerance/ Uncertainty	Probability Distributio	Div	Div Value	ci (1g)	ci (10g)	Standard uncertainty	Standard uncertainty	vi, or Veff
Measurement system									
Probe calibration	6.00%	N	1	1	1	1	6.00%	6.00%	∞
<i>Isotropy, Axial</i>	3.50%	R	√3	1.732	1	1	2.02%	2.02%	∞
<i>Isotropy, Hemispherical</i>	9.60%	R	√3	1.732	1	1	5.54%	5.54%	∞
Modulation Response	2.40%	R	√3	1.732	1	1	1.40%	1.40%	∞
Boundary Effect	1.00%	R	√3	1.732	1	1	0.58%	0.58%	∞
Linearity	4.70%	R	√3	1.732	1	1	2.71%	2.71%	∞
Detection Limits	1.00%	R	√3	1.732	1	1	0.58%	0.58%	∞
Readout Electronics	0.30%	N	1	1	1	1	0.30%	0.30%	∞
Response time	0.80%	R	√3	1.732	1	1	0.46%	0.46%	∞
Integration Time	2.60%	R	√3	1.732	1	1	1.50%	1.50%	∞
Measurement drift (class A evaluation)									
RF ambient condition - noise	3.00%	R	√3	1.732	1	1	1.73%	1.73%	∞
RF ambient conditions - reflections	3.00%	R	√3	1.732	1	1	1.73%	1.73%	∞
Probe positioner	0.40%	R	√3	1.732	1	1	0.23%	0.23%	∞
Mechanical restrictions									
Probe Positioning with respect to phantom shell	2.90%	R	√3	1.732	1	1	1.67%	1.67%	∞
Post-processing	1.00%	R	√3	1.732	1	1	0.58%	0.58%	∞
Max SAR Eval	1.00%	R	√3	1.732	1	1	0.58%	0.58%	∞
Test Sample related									
Test sample positioning	2.90%	N	1	1	1	1	2.90%	2.90%	M-1
Device Holder Uncertainty	3.60%	N	1	1	1	1	3.60%	3.60%	M-1
Drift of output power	5.00%	R	√3	1.732	1	1	2.89%	2.89%	∞
Phantom and Setup									
Phantom Uncertainty	4.00%	R	√3	1.732	1	1	2.31%	2.31%	∞
Liquid permittivity (mea.)	1.41%	N	1	1	0.64	0.43	0.90%	0.61%	M
Liquid Conductivity (mea.)	2.15%	N	1	1	0.6	0.49	1.29%	1.05%	M
Combined standard uncertainty		RSS					11.53%	11.47%	
Expan uncertainty (95% confidence interval), K=2							23.05%	22.95%	

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8. SAR SYSTEM CHECK RESULTS

Date: 2023/10/26

Report No. : TESA2310000626ES

Dipole 1900 MHz_SN:5d173

Communication System: CW; Frequency: 1900 MHz; Duty cycle= 1:1

Medium parameters used: $f = 1900$ MHz; $\sigma = 1.462$ S/m; $\epsilon_r = 39.318$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Ambient temperature: 22.1°C; Liquid temperature: 21.7°C

DASY5 Configuration:

- Probe: EX3DV4 – SN7712; ConvF(8.47, 8.47, 8.47); Calibrated: 2023/4/14
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn856; Calibrated: 2023/4/26
- Phantom: SAM
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Area Scan (51x61x1): Interpolated grid: dx=15 mm, dy=15 mm

Maximum value of SAR (interpolated) = 15.3 W/kg

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

Reference Value = 105.6 V/m; Power Drift = -0.02 dB

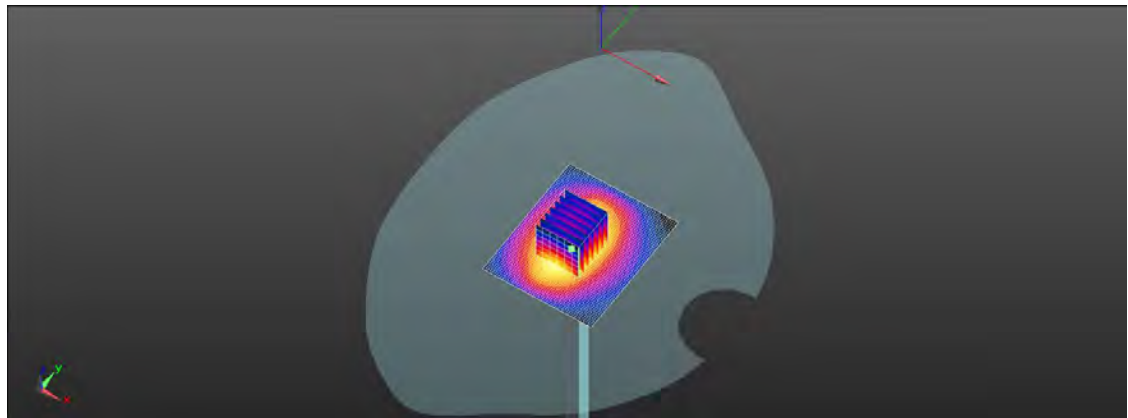
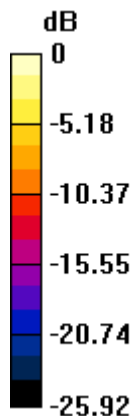
Peak SAR (extrapolated) = 18.6 W/kg

SAR(1 g) = 10.2 W/kg; SAR(10 g) = 5.42 W/kg

Smallest distance from peaks to all points 3 dB below = 10.2 mm

Ratio of SAR at M2 to SAR at M1 = 55.6%

Maximum value of SAR (measured) = 14.5 W/kg



0 dB = 15.3 W/kg = 11.83 dBW/kg

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Date: 2023/10/27

Report No. : TESA2310000626ES
Dipole 2600 MHz_SN:1005

Communication System: CW; Frequency: 2600 MHz; Duty cycle= 1:1

 Medium parameters used: $f = 2600$ MHz; $\sigma = 1.932$ S/m; $\epsilon_r = 38.413$; $\rho = 1000$ kg/m³

Phantom section: Flat Section

Ambient temperature: 22.3°C; Liquid temperature: 21.8°C

DASY5 Configuration:

- Probe: EX3DV4 – SN7712; ConvF(7.66, 7.66, 7.66); Calibrated: 2023/4/14
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn856; Calibrated: 2023/4/26
- Phantom: SAM
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Area Scan (71x111x1): Interpolated grid: dx=12 mm, dy=12 mm

Maximum value of SAR (interpolated) = 22.4 W/kg

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

Reference Value = 105.4 V/m; Power Drift = -0.04 dB

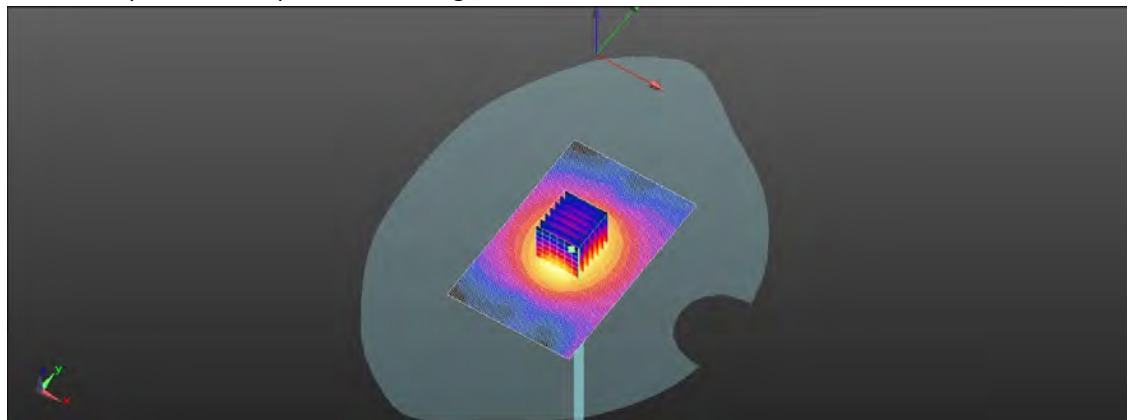
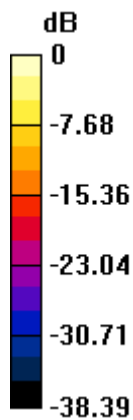
Peak SAR (extrapolated) = 28.1 W/kg

SAR(1 g) = 14.1 W/kg; SAR(10 g) = 6.73 W/kg

Smallest distance from peaks to all points 3 dB below = 9 mm

Ratio of SAR at M2 to SAR at M1 = 51.2%

Maximum value of SAR (measured) = 21.3 W/kg



0 dB = 22.4 W/kg = 13.51 dBW/kg

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Date: 2023/10/28

Report No. : TESA2310000626ES
Dipole 3700 MHz_SN:1057

Communication System: CW; Frequency: 3700 MHz; Duty cycle= 1:1

 Medium parameters used: $f = 3700 \text{ MHz}$; $\sigma = 3.109 \text{ S/m}$; $\epsilon_r = 37.120$; $\rho = 1000 \text{ kg/m}^3$

Phantom section: Flat Section

Ambient temperature: 22.4°C; Liquid temperature: 21.9°C

DASY5 Configuration:

- Probe: EX3DV4 – SN7712; ConvF(7.46, 7.46, 7.46); Calibrated: 2023/4/14
- Sensor-Surface: 2mm (Mechanical Surface Detection)
- Electronics: DAE4 Sn856; Calibrated: 2023/4/26
- Phantom: SAM
- DASY52 52.10.4(1527); SEMCAD X 14.6.14(7483)

Area Scan (81x91x1): Interpolated grid: dx=10 mm, dy=10 mm

Maximum value of SAR (interpolated) = 12.6 W/kg

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

Reference Value = 57.53 V/m; Power Drift = 0.02 dB

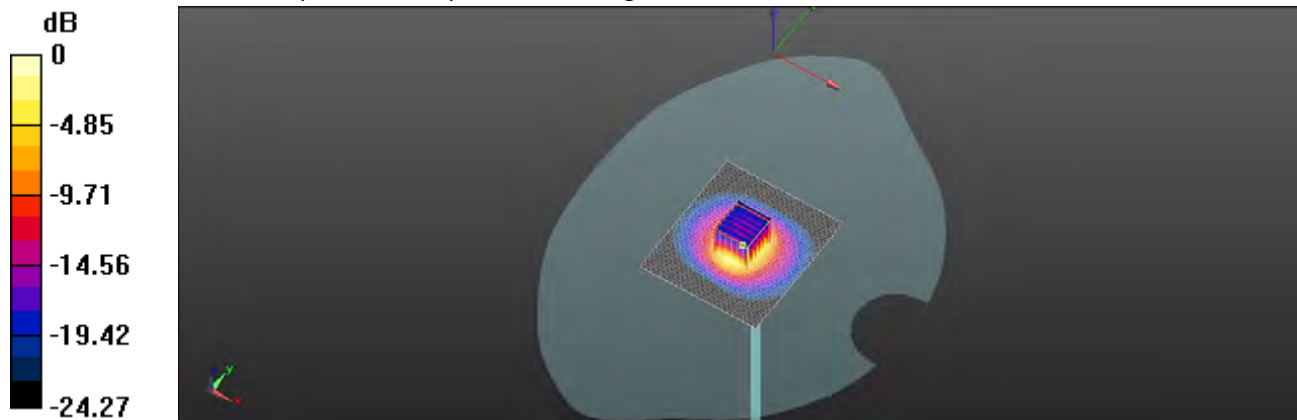
Peak SAR (extrapolated) = 17.9 W/kg

SAR(1 g) = 6.6 W/kg; SAR(10 g) = 2.41 W/kg

Smallest distance from peaks to all points 3 dB below = 8.6 mm

Ratio of SAR at M2 to SAR at M1 = 67.4%

Maximum value of SAR (measured) = 11.9 W/kg



0 dB = 11.9 W/kg = 10.76 dBW/kg

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9.APPENDIXES

Refer to separated files for the following appendixes.

- 9.1 SAR_Appendix G Photographs
- 9.2 SAR_Appendix H DAE & Probe Cal. Certificate
- 9.3 SAR_Appendix I Phantom Description & Dipole Cal. Certificate

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