FCC TAS validation – Part 2: Tests under dynamic transmit power scenarios

FCC ID	:	**A4RGPQQ7**
Equipment	:	**Phone**
Model Name	:	**GPQQ7**
Applicant	:	**Google LLC 1600 Amphitheatre Parkway, Mountain View, CA, 94043 USA**
Standard	:	**FCC 47 CFR Part 2 (2.1093)**

The product was received on Jan. 30, 2026 and testing was started from Mar. 28, 2026 and completed on May. 22, 2026. We, SPORTON INTERNATIONAL INC., would like to declare that the tested sample provide by manufacturer and the test data has been evaluated in accordance with the test procedures given in 47 CFR Part 2.1093 and FCC KDB and has been pass the FCC requirement.

The test results in this report apply exclusively to the tested model / sample. Without written approval of SPORTON INTERNATIONAL INC. Laboratory, the test report shall not be reproduced except in full.

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History of this test report

Report No.	Version	Description	Issued Date
FA5N0809-01D	01	Initial issue of report	May. 05, 2026
FA5N0809-01D	02	Update section 4.3, 4.8, 4.10, 6.6	May. 24, 2026

1. Overview

The device support Mediatek developed TA-SAR/TA-PD Gen2 algorithm.
FCC regulation allows time-averaged RF power to demonstrate compliance with RF exposure safety limits. Because RF exposure is correlated to transmission power (TX power), e.g., lower RF exposure is correlated to lower TX power, the TX power can be controlled to meet FCC RF exposure limits defined specific absorption rate (SAR) limit for transmit frequencies < 6GHz and power density (PD) limit for transmit frequencies > 6GHz. For SAR limit, the proposed Time-Averaged Specific Absorption Rate (TA-SAR) algorithm manages TX power to always ensure that the time-averaged RF exposure is compliant with the FCC SAR requirement. For PD limit, the proposed Time-Averaged Power Density (TA-PD) algorithm controls TX power to ensure that the time-averaged RF exposure is compliant with the FCC PD requirement. In the FCC regulation and October 2018 TCB Workshop notes, the time averaging window of SAR is no more than 100 seconds for transmit frequencies less than 3GHz, no more than 60 seconds for transmit frequencies between 3GHz and 6GHz. The averaging window of PD is no more than 30 seconds for transmit frequencies between 6GHz and 10GHz, no more than 4 seconds for transmit frequencies between 24GHz and 42GHz, and no more than 2 seconds for transmit frequencies between 42GHz and 95GHz.

This document describes the test plan, test procedures, measurement setup, and measurement results for the verification of the proposed TA-SAR/TA-PD algorithm being able to make RF exposure meet the FCC requirement. The operating parameters for the algorithm validation are described in Chapter 2. The overview of the test proposal is given in TA-SAR/TA-PD algorithm document Chapter 3. The test procedures for the conducted power measurements and SAR measurements are described in TA-SAR/TA-PD algorithm document Chapter 4. The test procedures for the radiated power measurements and PD measurements are described in TA-SAR/TA-PD algorithm document Chapter 5. For the TA-SAR algorithm validation, the measurement setup for the conducted power tests and the corresponding measurement results are included in report section 4, while the nearfield SAR measurement setup and the test results are included in report section 5. For the TA-PD algorithm validation, the measurement setup for the radiated power tests and the corresponding measurement results are included in report section 6, while the near-field PD measurement setup and the test results are included in report section 7.

2. Operating Parameters for Algorithm Validation

The device support Mediatek developed TA-SAR/TA-PD algorithm to control instantaneous TX power for transmit frequencies less and larger than 6GHz respectively, so that the total time-averaged RF exposures (i.e., SAR, PD, and SAR+PD exposure) of WWAN are less than the FCC requirement.

The basic concept of WWAN algorithm is the same, if time-averaged TX power approaches a predefined TX power limit which is mapped from SAR or PD limit, the instantaneous TX power will be contrained to ensure that the time-averaged TX power is less than the predefined TX limit at all times. The following parameters listed in Table 2-1 is essential for TA-SAR algorithm operation.

Table 2-1 TA-SAR operating parameters for WWAN

Operating parameters	Description
P_{sub6_limit}	• Maximum time-averaged TX power limit (corresponding to SAR_design_limit, which is less than or equal to FCC limit in consideration of the sub6 device uncertainty, simultaneous transmission, etc.) for different bands of 2G, 3G, LTE, and NR FR1. • For a band, SAR_design_limit can be defined differently for a single-TX test case or a multi-TX test case (e.g., ENDC) due to the conservative consideration, and therefore Psub6_limit would be different correspondingly.
$P_{UE_backoff_offset}$	Parameter for calculating $P_{UE_backoff}$ $P_{UE_backoff} = \min(P_{UE_max}, P_{sub6_limit} - P_{UE_backoff_offset})$ P_{UE_max} is maximum TX power at which a UE can possibly transmit.
$P_{UE_max_cust_offset}$	Parameter for calculating $P_{UE_max_cust}$ $P_{UE_max_cust} = \min(P_{UE_max}, P_{sub6_limit} + P_{UE_max_cust_offset})$

When the operating center frequency is above 6GHz, the following parameters, listed in Tables 2-2 is essential for the TA-PD algorithm operation.

Table 2-2 TA-PD operating parameters for WWAN

Operating parameters	Description
P_{PD_Limit} *[beam]*	The time-averaged maximum power level limit (corresponding to PD_design_limit, which is less than or equal to FCC limit in consideration of the device uncertainty, simultaneous transmission, etc.) for different bands/beams.
$P_{UE_backoff_offset}$ *[beam]*	Parameter for calculating $P_{UE_backoff}$ *[beam]* $P_{UE_backoff}$ *[beam]* = min (P_{UE_max}, P_{PD_Limit} *[beam]* - $P_{UE_backoff_offset}$ *[beam]*), where P_{UE_max} is maximum TX power at which a UE can possibly transmit.
$P_{UE_max_cust_offset}$ *[beam]*	Parameter for calculating $P_{UE_max_cust}$ $P_{UE_max_cust}$ *[beam]* = min (P_{UE_max}, P_{PD_Limit} *[beam]* + $P_{UE_max_cust_offset}$ *[beam]*)

Table 2-3 Algorithm time-averaging window recommended in TCBC WS of October 2018

Interim Guidance	Frequency (GHz)	Maximum Averaging Time (sec)
SAR	< 3	100
	3 – 6	60
MPE	6 - 10	30
	10 - 16	14
	16 – 24	8
	24 – 42	4
	42 – 95	2

3. Overview of TA-SAR/TA-PD Test Proposal

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

- **Scenario 1**: test under different TA-SAR parameters to verify that the TA-SAR Gen2 algorithm meets compliance requirements with different combinations of operating parameters.
- **Scenario 2**: test under time-varying TX power to verify that the TA-SAR algorithm ensures SAR compliance through dynamic TX power.
- **Scenario 3**: test under call drop and re-establishment conditions to ensure that the TA-SAR algorithm can control continuity and maintain SAR compliance
- **Scenario 4**: test under RAT/band handover to ensure that the TA-SAR algorithm can control continuity and maintain SAR compliance
- **Scenario 5**: test under different ECIs (Exposure Condition Index) to ensure that the TA-SAR algorithm behaves as expected during ECI switching from one ECI to another. (e.g., head→ body worn)
- **Scenario 6**: test under different transmission antennas to ensure that the TA-SAR algorithm works correctly during antenna switching from one antenna to another
- **Scenario 7**: test under different time windows to ensure that the TA-SAR algorithm functions correctly during time window switching from one time window setting to another. (e.g., time window 100s→60s)
- **Scenario 8**: test under SAR exposure switching between two active radio sets (radio set 1 only, radio set 1+radio set 2, and radio set 2 only) to ensure that the TA-SAR algorithm can control continuity and maintain SAR compliance.

For TA-SAR validation, description of the conducted power measurement test procedures is included in MTK TA-SAR algorithm document, and description of the SAR measurement test procedures is included in MTK TA-SAR algorithm document. In each of the test scenarios, certain test sequence, described in MTK TA-SAR algorithm document, is applied.

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

- **Scenario 1**: test under time-varying TX power to verify that the TA-PD algorithm ensures PD compliance through dynamic TX power.
- **Scenario 2**: test under different transmission beams to ensure TA-PD algorithm control works correctly during beam switching from one beam to another.
- **Scenario 3**: ttest under SAR-and-PD exposure switching to ensure TA-SAR/TA-PD algorithm control correctness and prove the normalized total RF exposure is less than 1.
- **Scenario 4**: test under Multi-SPLSR-group vs. PD exposure switching to ensure TA-SAR/TA-PD algorithm control correctness and prove the normalized total RF exposure is less than 1.

For the TA-PD algorithm validation, the description of the radiated-power measurement test procedures is included in MTK TA-PD algorithm document, and the description of the PD measurement test procedures is included in MTK TA-PD algorithm document.

4. TA-SAR Validation via Conducted Power Measurements

4.1 Measurement Setup

The call boxes KeySight UXM (supporting sub6 NR and LTE) and Rohde & Schwarz CMW500 (supporting LTE, WCDMA, C2K and 2G) are used to validate the proposed TA-SAR mechanism. Figure below shows the block diagram of the measurement bench, which supports the following test scenarios.

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

For these measurements, RF port of the call box is connected to the EUT's antenna port through a directional coupler, 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

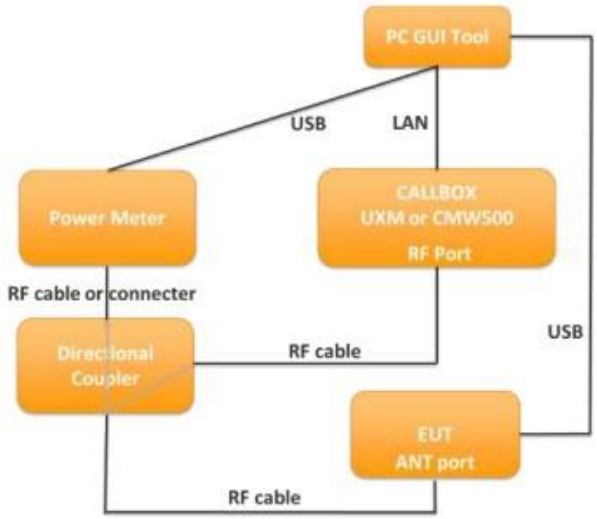


Figure of 5 TA-SAR Gen2 conductive power test setup block diagram for scenarios 1/2/3/5 for WWAN

Figure below shows the block diagram of the measurement bench, which supports test scenario 6 (antenna switching) and test scenario 7 (time window switching). For these measurements, the RF port of the call box is connected with a 1-to-2 power divider and two EUT's antenna ports are individually connected with a RF cable, which allows the call box to transmit/receive signals from the two different system configurations set in these test scenarios. as seen in the figure.

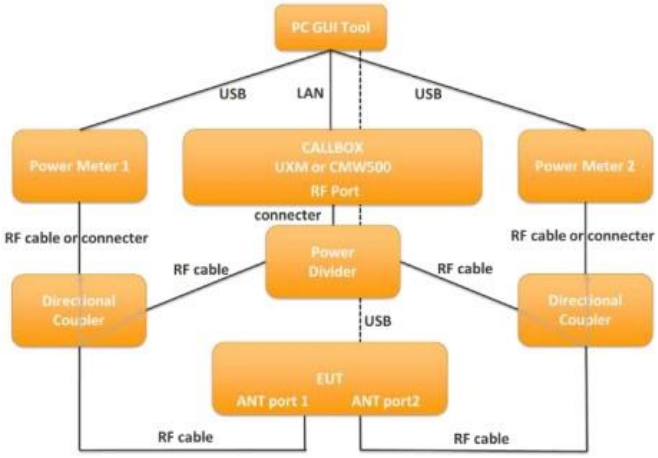


Figure of TA-SAR conductive power test setup block diagram for scenarios 6/7 for WWAN

Figure below shows the setup of WWAN for test scenario 4 (band handover) with different RATs and test scenario 8 (SAR exposure switching). Since two RATs/bands need to be controlled in these two scenarios, 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 transmits signals through one antenna port.

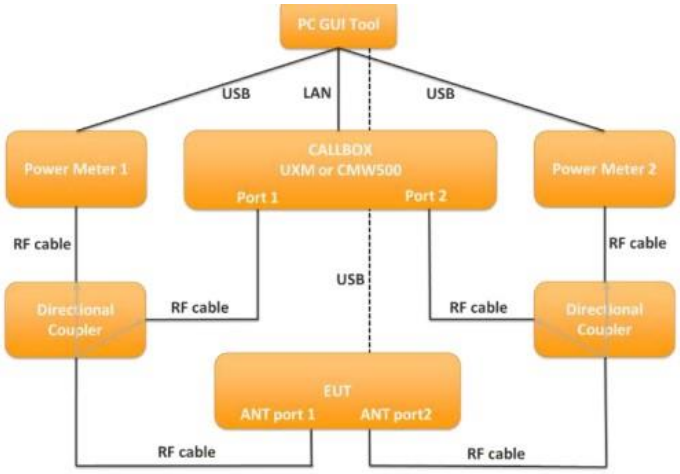


Figure of TA-SAR conductive power test setup block diagram for scenarios 4/8 for WWAN

Figure below shows the setup for test scenario 8 (SAR exposure switching) with three antennas transmitting at the same time. Since three bands (or two bands) need to be controlled individually in this scenario, the three RF ports of the call box are individually connected to the three antenna ports of the EUT through three directional couplers. The EUT can transmit signals of a specific band via each connected port.

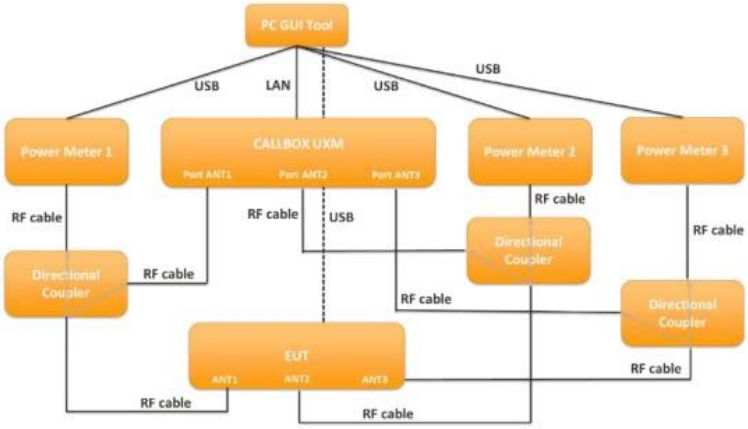


Figure of TA-SAR conductive power test setup block diagram for scenario 8, 3TX for WWAN

4.2 Test Sequences for all scenarios

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

Test sequence 0: EUT's TX power is requested to be maximum.

Test sequence 1: EUT's TX power is requested to be at power less than Psub6_limit – 0.5dB for 300s, then at maximum power for 200s, and finally at Psub6_limit – 2.5dB for the remaining time.

Test sequence 2: EUT's TX power to vary with time. This sequence is generated based on the measured PUE_max, measured Psub6_limit and calculated PUE_backoff (= measured Psub6_limit in dBm PUE_backoff_offset in dB) of the EUT.

The test sequences 0, 1, and 2 are illustrated in Figure 4-2-1/2/3, respectively. Furthermore, the three test sequences are respectively tabulated in Table 4-2-1/2/3.

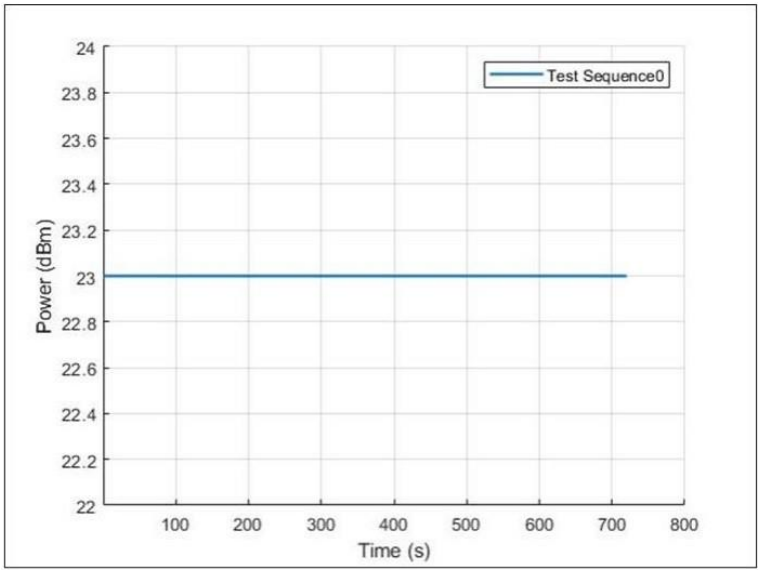


Figure 4-2-1 Test sequence 0

Table 4-2-1 Test sequence 0

Time	Duration	Power (dBm)	Note
720	720	23	PUE_max

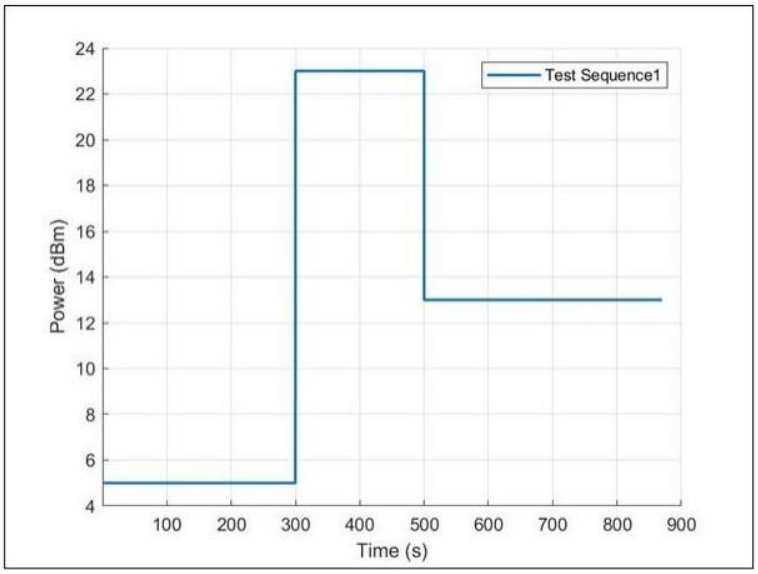


Figure 4-2-2 Test sequence 1

Table 4-2-2 Test sequence 1

Time	Duration	Power (dBm)	Note
300	300	5	< Psub6_limit – 0.5dB
500	200	12	PUE_max
870	370	13	Psub6_limit – 2.5dB

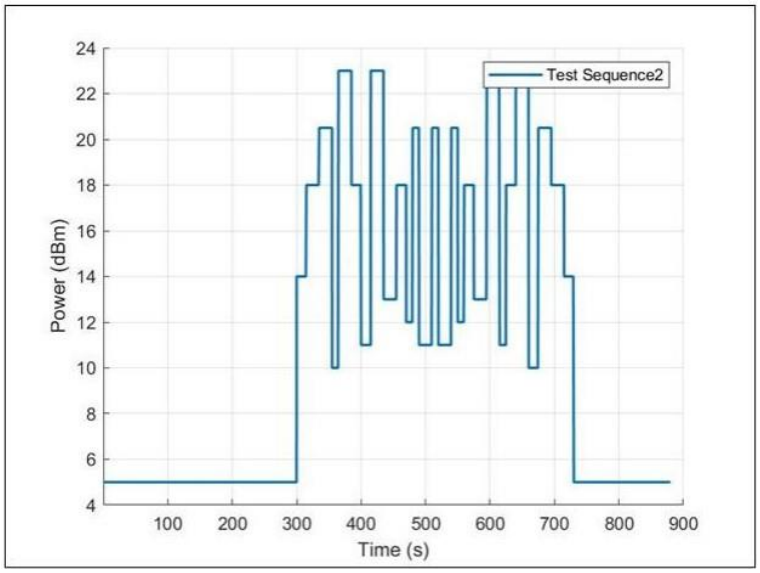


Figure 4-2-3 Test sequence 2

Table 4-2-3 Test sequence 2

Time	Duration	Power (dBm)	Note
300	300	5	< Psub6_limit – 0.5dB
315	15	14	Psub6_limit - 4dB
335	20	18	Psub6_limit
355	20	20.5	(Psub6_limit+PUE_max)/2
365	10	10	Psub6_limit - 8dB
385	20	23	PUE_max
400	15	18	Psub6_limit
415	15	11	Psub6_limit - 7dB
435	20	23	PUE_max
455	20	13	Psub6_limit - 5dB
470	15	18	Psub6_limit
480	10	12	Psub6_limit - 6dB
490	10	20.5	(Psub6_limit+PUE_max)/2
510	20	11	Psub6_limit - 7dB
520	10	20.5	(Psub6_limit+PUE_max)/2
540	20	11	Psub6_limit - 7dB
550	10	20.5	(Psub6_limit+PUE_max)/2
560	10	12	Psub6_limit - 6dB
575	15	18	Psub6_limit
595	20	13	Psub6_limit - 5dB
615	20	23	PUE_max
625	10	11	Psub6_limit - 7dB
640	15	18	Psub6_limit
660	20	23	PUE_max
675	15	10	Psub6_limit - 8dB
695	20	20.5	Psub6_limit+PUE_max)/2
715	20	18	Psub6_limit
730	15	14	Psub6_limit - 4dB
870	140	5	< Psub6_limit – 0.5dB

4.3 Power Limit Table and Test Configurations

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

Table of Summary table of power limit (P_{sub6_limit}) for all supported RAT

Wireless Tech.	Band	Mode	Antenna	Duty cycle	Head		Hotspot	Body-worn/Extremity		P Max Time-average power (dBm)
					ECI 2	ECI 3	ECI 6	ECI 4	ECI 5	
					Standalone	Simultaneous	Simultaneous	Standalone	Simultaneous	
					P limit					
					Time-average power (dBm)					
GSM	B850	1TX	Ant0	12.50%	25.90	24.30	21.20	21.20	21.20	23.50
GPRS	B850	1TX	Ant0	12.50%	25.90	24.30	21.20	21.20	21.20	23.50
GPRS	B850	2TX	Ant0	25.00%	25.90	24.30	21.20	21.20	21.20	25.30
GPRS	B850	3TX	Ant0	37.50%	25.90	24.30	21.20	21.20	21.20	26.10
GPRS	B850	4TX	Ant0	50.00%	25.90	24.30	21.20	21.20	21.20	26.30
EGPRS	B850	1TX	Ant0	12.50%	25.90	24.30	21.20	21.20	21.20	17.30
EGPRS	B850	2TX	Ant0	25.00%	25.90	24.30	21.20	21.20	21.20	19.30
EGPRS	B850	3TX	Ant0	37.50%	25.90	24.30	21.20	21.20	21.20	20.10
EGPRS	B850	4TX	Ant0	50.00%	25.90	24.30	21.20	21.20	21.20	20.30
GSM	B850	1TX	Ant1	12.50%	23.40	22.30	24.00	25.10	24.00	23.10
GPRS	B850	1TX	Ant1	12.50%	23.40	22.30	24.00	25.10	24.00	23.10
GPRS	B850	2TX	Ant1	25.00%	23.40	22.30	24.00	25.10	24.00	25.30
GPRS	B850	3TX	Ant1	37.50%	23.40	22.30	24.00	25.10	24.00	26.10
GPRS	B850	4TX	Ant1	50.00%	23.40	22.30	24.00	25.10	24.00	26.30
EGPRS	B850	1TX	Ant1	12.50%	23.40	22.30	24.00	25.10	24.00	17.10
EGPRS	B850	2TX	Ant1	25.00%	23.40	22.30	24.00	25.10	24.00	19.30
EGPRS	B850	3TX	Ant1	37.50%	23.40	22.30	24.00	25.10	24.00	20.10
EGPRS	B850	4TX	Ant1	50.00%	23.40	22.30	24.00	25.10	24.00	20.30
GSM	B1900	1TX	Ant2	12.50%	24.70	24.70	18.50	19.90	18.50	20.50
GPRS	B1900	1TX	Ant2	12.50%	24.70	24.70	18.50	19.90	18.50	20.50
GPRS	B1900	2TX	Ant2	25.00%	24.70	24.70	18.50	19.90	18.50	21.90
GPRS	B1900	3TX	Ant2	37.50%	24.70	24.70	18.50	19.90	18.50	23.20
GPRS	B1900	4TX	Ant2	50.00%	24.70	24.70	18.50	19.90	18.50	23.40
EGPRS	B1900	1TX	Ant2	12.50%	24.70	24.70	18.50	19.90	18.50	16.40
EGPRS	B1900	2TX	Ant2	25.00%	24.70	24.70	18.50	19.90	18.50	18.40
EGPRS	B1900	3TX	Ant2	37.50%	24.70	24.70	18.50	19.90	18.50	19.20
EGPRS	B1900	4TX	Ant2	50.00%	24.70	24.70	18.50	19.90	18.50	19.40
GSM	B1900	1TX	Ant0	12.50%	36.30	36.30	16.10	16.80	16.10	19.60
GPRS	B1900	1TX	Ant0	12.50%	36.30	36.30	16.10	16.80	16.10	19.60
GPRS	B1900	2TX	Ant0	25.00%	36.30	36.30	16.10	16.80	16.10	21.20
GPRS	B1900	3TX	Ant0	37.50%	36.30	36.30	16.10	16.80	16.10	22.50
GPRS	B1900	4TX	Ant0	50.00%	36.30	36.30	16.10	16.80	16.10	22.70
EGPRS	B1900	1TX	Ant0	12.50%	36.30	36.30	16.10	16.80	16.10	15.60
EGPRS	B1900	2TX	Ant0	25.00%	36.30	36.30	16.10	16.80	16.10	17.70
EGPRS	B1900	3TX	Ant0	37.50%	36.30	36.30	16.10	16.80	16.10	18.50
EGPRS	B1900	4TX	Ant0	50.00%	36.30	36.30	16.10	16.80	16.10	18.70
WCDMA	B2	PC3	Ant2	100.00%	25.90	25.90	18.70	20.10	18.70	24.00
WCDMA	B2	PC3	Ant0	100.00%	35.90	35.90	12.90	14.30	12.90	24.00
WCDMA	B4	PC3	Ant2	100.00%	26.70	26.70	19.30	20.40	19.30	24.00
WCDMA	B4	PC3	Ant0	100.00%	34.40	34.40	13.60	15.00	13.60	24.00

WCDMA	B5	PC3	Ant0	100.00%	28.70	28.70	20.90	20.90	20.90	24.20
WCDMA	B5	PC3	Ant1	100.00%	22.70	22.70	23.10	23.50	23.10	24.20
LTE	B2	PC3	Ant2	100.00%	26.00	26.00	18.30	19.70	18.30	24.00
LTE	B2	PC3	Ant0	100.00%	37.30	37.30	13.10	14.50	13.10	24.00
LTE	B2	PC3	Ant1	100.00%	18.50	17.40	18.60	19.30	18.60	24.00
LTE	B2	PC3	Ant5	100.00%	17.30	16.10	16.40	17.70	16.40	24.00
LTE	B4	PC3	Ant2	100.00%	26.50	26.50	19.30	20.60	19.30	24.00
LTE	B4	PC3	Ant0	100.00%	34.00	34.00	13.70	15.00	13.70	24.00
LTE	B4	PC3	Ant1	100.00%	17.70	17.00	21.60	22.40	21.60	24.00
LTE	B4	PC3	Ant5	100.00%	17.60	16.90	16.60	19.40	16.60	23.70
LTE	B5 / 5B	PC3	Ant0	100.00%	28.00	27.30	20.50	21.20	20.50	24.10
LTE	B5 / 5B	PC3	Ant1	100.00%	21.30	20.50	22.50	23.20	22.50	24.10
LTE	B7 / 7C	PC3	Ant2	100.00%	22.80	21.60	15.90	17.30	15.90	24.00
LTE	B7 / 7C	PC3	Ant0	100.00%	32.90	32.90	14.00	16.30	14.00	24.00
LTE	B12	PC3	Ant0	100.00%	29.60	28.90	22.30	25.30	22.30	24.10
LTE	B12	PC3	Ant1	100.00%	22.50	21.80	24.10	25.40	24.10	24.10
LTE	B13	PC3	Ant0	100.00%	30.00	29.30	20.70	22.40	20.70	24.10
LTE	B13	PC3	Ant1	100.00%	24.10	22.50	22.50	25.90	22.50	24.10
LTE	B14	PC3	Ant0	100.00%	29.90	29.20	21.90	22.40	21.90	24.10
LTE	B14	PC3	Ant1	100.00%	22.30	21.60	21.60	23.40	21.60	24.10
LTE	B17	PC3	Ant0	100.00%	29.60	28.90	22.30	25.30	22.30	24.10
LTE	B17	PC3	Ant1	100.00%	22.50	21.80	24.10	25.40	24.10	24.10
LTE	B25	PC3	Ant2	100.00%	26.00	26.00	18.30	19.70	18.30	24.00
LTE	B25	PC3	Ant0	100.00%	37.30	37.30	13.10	14.50	13.10	24.00
LTE	B25	PC3	Ant1	100.00%	18.50	17.40	18.60	19.30	18.60	24.00
LTE	B25	PC3	Ant5	100.00%	17.30	16.10	16.40	17.70	16.40	24.00
LTE	B26	PC3	Ant0	100.00%	28.00	27.30	20.50	21.20	20.50	24.10
LTE	B26	PC3	Ant1	100.00%	21.30	20.50	22.50	23.20	22.50	24.10
LTE	B30	PC3	Ant2	100.00%	24.30	23.20	16.30	17.70	16.30	23.60
LTE	B30	PC3	Ant0	100.00%	34.20	34.20	14.60	16.00	14.60	22.90
LTE	B38 / 38C	PC3	Ant2	63.30%	23.30	21.50	16.20	17.50	16.20	22.00
LTE	B38	PC2	Ant2	43.30%	23.30	21.50	16.20	17.50	16.20	22.30
LTE	B38 / 38C	PC3	Ant0	63.30%	35.30	35.30	14.60	17.20	14.60	21.90
LTE	B38	PC2	Ant0	43.30%	35.30	35.30	14.60	17.20	14.60	22.30
LTE	B38 / 38C	PC3	Ant1	63.30%	17.10	16.40	17.10	19.50	17.10	22.00
LTE	B38	PC2	Ant1	43.30%	17.10	16.40	17.10	19.50	17.10	22.30
LTE	B38 / 38C	PC3	Ant5	63.30%	15.50	14.60	15.40	16.90	15.40	22.00
LTE	B38	PC2	Ant5	43.30%	15.50	14.60	15.40	16.90	15.40	22.30
LTE	B41 / 41C	PC3	Ant2	63.30%	23.30	21.50	16.20	17.50	16.20	22.00
LTE	B41	PC2	Ant2	43.30%	23.30	21.50	16.20	17.50	16.20	22.30
LTE	B41 / 41C	PC3	Ant0	63.30%	35.30	35.30	14.60	17.20	14.60	21.90
LTE	B41	PC2	Ant0	43.30%	35.30	35.30	14.60	17.20	14.60	22.30
LTE	B41 / 41C	PC3	Ant1	63.30%	17.10	16.40	17.10	19.50	17.10	22.00
LTE	B41	PC2	Ant1	43.30%	17.10	16.40	17.10	19.50	17.10	22.30
LTE	B41 / 41C	PC3	Ant5	63.30%	15.50	14.60	15.40	16.90	15.40	22.00
LTE	B41	PC2	Ant5	43.30%	15.50	14.60	15.40	16.90	15.40	22.30
LTE	B48	PC3	Ant6	63.30%	27.00	27.00	14.80	16.20	14.80	18.30
LTE	B48	PC3	Ant7	63.30%	25.10	25.10	14.30	15.70	14.30	17.30
LTE	B48	PC3	Ant1	63.30%	17.00	15.90	15.90	17.80	15.90	18.50
LTE	B48	PC3	Ant5	63.30%	15.70	14.60	17.90	19.30	17.90	19.80
LTE	B66 / 66C / 66B	PC3	Ant2	100.00%	26.50	26.50	19.30	20.60	19.30	24.00
LTE	B66 / 66C / 66B	PC3	Ant0	100.00%	34.00	34.00	13.70	15.00	13.70	24.00
LTE	B66 / 66C / 66B	PC3	Ant1	100.00%	17.70	17.00	21.60	22.40	21.60	24.00
LTE	B66 / 66C / 66B	PC3	Ant5	100.00%	17.60	16.90	16.60	19.40	16.60	23.70
LTE	B71	PC3	Ant0	100.00%	30.30	29.60	22.00	24.90	22.00	24.10
LTE	B71	PC3	Ant1	100.00%	23.60	22.60	23.10	26.90	23.10	24.10

NR	n2	PC3	Ant2	100.00%	26.60	26.60	19.50	20.40	19.50	24.00
NR	n2	PC3	Ant0	100.00%	38.20	38.20	14.30	15.40	14.30	24.00
NR	n2	PC3	Ant1	100.00%	18.40	17.60	19.10	19.80	19.10	24.00
NR	n2	PC3	Ant5	100.00%	17.40	16.00	16.60	18.00	16.60	24.00
NR	n5	PC3	Ant0	100.00%	28.60	27.90	21.20	21.30	21.20	24.10
NR	n5	PC3	Ant1	100.00%	22.20	21.10	23.00	23.70	23.00	24.10
NR	n7	PC3	Ant2	100.00%	23.10	22.40	16.10	17.50	16.10	24.00
NR	n7	PC3	Ant0	100.00%	32.80	32.80	15.00	16.40	15.00	24.00
NR	n12	PC3	Ant0	100.00%	30.30	29.50	23.10	25.10	23.10	24.10
NR	n12	PC3	Ant1	100.00%	23.60	22.90	24.00	26.80	24.00	24.10
NR	n13	PC3	Ant0	100.00%	29.30	28.60	20.60	22.10	20.60	24.10
NR	n13	PC3	Ant1	100.00%	23.90	22.80	22.80	25.90	22.80	24.10
NR	n14	PC3	Ant0	100.00%	28.90	28.20	21.90	21.90	21.90	24.10
NR	n14	PC3	Ant1	100.00%	22.00	21.20	21.60	24.00	21.60	24.10
NR	n25	PC3	Ant2	100.00%	26.60	26.60	19.50	20.40	19.50	24.00
NR	n25	PC3	Ant0	100.00%	38.20	38.20	14.30	15.40	14.30	24.00
NR	n25	PC3	Ant1	100.00%	18.40	17.60	19.10	19.80	19.10	24.00
NR	n25	PC3	Ant5	100.00%	17.40	16.00	16.60	18.00	16.60	24.00
NR	n26	PC3	Ant0	100.00%	28.60	27.90	21.20	21.30	21.20	24.10
NR	n26	PC3	Ant1	100.00%	22.20	21.10	23.00	23.70	23.00	24.10
NR	n30	PC3	Ant2	100.00%	25.10	23.20	16.90	18.30	16.90	23.60
NR	n30	PC3	Ant0	100.00%	34.90	34.90	14.60	16.00	14.60	23.60
NR	n38	PC3	Ant2	100.00%	22.80	21.90	16.50	18.00	16.50	24.00
NR	n38	PC3	Ant0	100.00%	33.00	33.00	14.60	16.00	14.60	23.90
NR	n38	PC3	Ant1	100.00%	17.00	16.30	16.40	18.70	16.40	24.00
NR	n38	PC3	Ant5	100.00%	14.70	13.30	14.20	16.30	14.20	24.00
NR	n41 / n41C / n41B	PC3	Ant2	100.00%	22.80	21.90	16.50	18.00	16.50	24.00
NR	n41	PC2	Ant2	50.00%	22.80	21.90	16.50	18.00	16.50	22.90
NR	n41	PC1P5	Ant2	25.00%	22.80	21.90	16.50	18.00	16.50	19.90
NR	n41 / n41C / n41B	PC3	Ant0	100.00%	32.90	32.90	14.60	16.00	14.60	23.90
NR	n41	PC2	Ant0	50.00%	32.90	32.90	14.60	16.00	14.60	22.90
NR	n41	PC1P5	Ant0	25.00%	32.90	32.90	14.60	16.00	14.60	19.90
NR	n41 / n41C / n41B	PC3	Ant1	100.00%	17.00	16.30	16.40	18.70	16.40	24.00
NR	n41	PC2	Ant1	50.00%	17.00	16.30	16.40	18.70	16.40	22.90
NR	n41	PC1P5	Ant1	25.00%	17.00	16.30	16.40	18.70	16.40	19.90
NR	n41 / n41C / n41B	PC3	Ant5	100.00%	14.70	13.30	14.20	16.30	14.20	24.00
NR	n41	PC2	Ant5	50.00%	14.70	13.30	14.20	16.30	14.20	22.90
NR	n41	PC1P5	Ant5	25.00%	14.70	13.30	14.20	16.30	14.20	19.90
NR	n48	PC3	Ant6	100.00%	26.80	26.80	16.30	18.80	16.30	20.30
NR	n48	PC3	Ant7	100.00%	26.10	26.10	16.70	17.10	16.70	19.30
NR	n48	PC3	Ant1	100.00%	17.90	17.00	18.20	20.00	18.20	20.50
NR	n48	PC3	Ant5	100.00%	19.40	17.80	19.40	20.10	19.40	21.80
NR	n66	PC3	Ant2	100.00%	26.90	26.90	19.50	20.70	19.50	24.00
NR	n66	PC3	Ant0	100.00%	36.00	36.00	14.20	15.50	14.20	24.00
NR	n66	PC3	Ant1	100.00%	18.80	18.10	21.70	22.40	21.70	24.00
NR	n66	PC3	Ant5	100.00%	18.80	17.40	17.30	19.20	17.30	24.00
NR	n70	PC3	Ant2	100.00%	27.20	27.20	19.80	20.70	19.80	23.80
NR	n70	PC3	Ant0	100.00%	33.30	33.30	14.80	15.50	14.80	23.80
NR	n70	PC3	Ant1	100.00%	19.30	17.90	22.80	23.50	22.80	23.80
NR	n70	PC3	Ant5	100.00%	18.70	18.00	17.50	18.90	17.50	22.30
NR	n71	PC3	Ant0	100.00%	30.30	29.60	21.90	25.30	21.90	24.10
NR	n71	PC3	Ant1	100.00%	23.50	22.70	23.80	25.20	23.80	24.10
NR	n77 / n77C	PC3	Ant6	100.00%	24.70	24.00	14.70	16.10	14.70	24.10
NR	n77	PC2	Ant6	50.00%	24.70	24.00	14.70	16.10	14.70	23.10
NR	n77	PC1P5	Ant6	25.00%	24.70	24.00	14.70	16.10	14.70	20.10
NR	n77 / n77C	PC3	Ant7	100.00%	25.20	22.20	14.10	15.50	14.10	23.60

NR	n77	PC2	Ant7	50.00%	25.20	22.20	14.10	15.50	14.10	22.60
NR	n77	PC1P5	Ant7	25.00%	25.20	22.20	14.10	15.50	14.10	19.60
NR	n77 / n77C	PC3	Ant1	100.00%	15.00	14.20	13.40	15.30	13.40	24.00
NR	n77	PC2	Ant1	50.00%	15.00	14.20	13.40	15.30	13.40	23.00
NR	n77	PC1P5	Ant1	25.00%	15.00	14.20	13.40	15.30	13.40	20.00
NR	n77 / n77C	PC3	Ant5	100.00%	15.00	13.40	16.70	18.10	16.70	23.60
NR	n77	PC2	Ant5	50.00%	15.00	13.40	16.70	18.10	16.70	22.60
NR	n77	PC1P5	Ant5	25.00%	15.00	13.40	16.70	18.10	16.70	19.60
NR	n78	PC3	Ant6	100.00%	24.70	24.00	14.70	16.10	14.70	24.10
NR	n78	PC2	Ant6	50.00%	24.70	24.00	14.70	16.10	14.70	23.10
NR	n78	PC1P5	Ant6	25.00%	24.70	24.00	14.70	16.10	14.70	20.10
NR	n78	PC3	Ant7	100.00%	25.20	22.20	14.10	15.50	14.10	23.60
NR	n78	PC2	Ant7	50.00%	25.20	22.20	14.10	15.50	14.10	22.60
NR	n78	PC1P5	Ant7	25.00%	25.20	22.20	14.10	15.50	14.10	19.60
NR	n78	PC3	Ant1	100.00%	15.00	14.20	13.40	15.30	13.40	24.00
NR	n78	PC2	Ant1	50.00%	15.00	14.20	13.40	15.30	13.40	23.00
NR	n78	PC1P5	Ant1	25.00%	15.00	14.20	13.40	15.30	13.40	20.00
NR	n78	PC3	Ant5	100.00%	15.00	13.40	16.70	18.10	16.70	23.20
NR	n78	PC2	Ant5	50.00%	15.00	13.40	16.70	18.10	16.70	22.20
NR	n78	PC1P5	Ant5	25.00%	15.00	13.40	16.70	18.10	16.70	19.20
NTN	B23	PC3	Ant5	100.00%				19.10		23.10
NTN	B255	PC3	Ant5	100.00%				19.70		23.10

Table for Sub-6GHz TA-SAR validation test case list

Test Case #	Test Scenario	Test Configuration
1	1,Range of TA-SAR-parameters	WCDMA B2
2	2.Time-varting TX power	GSM850
3		GSM1900
4		WCDMA B2
5		WCDMA B5
6		LTE B25
7		LTE B26
8		FR1 n26
9		FR1 n77
10	3.Call disconnection and re-establishment	WCDMA B2
11	4. Band handover / 6. Antenna Switch	LTE B25 Ant 5 to WCDMA B5 Ant 1
12	5. ECI(Exposure Condition Index)	WCDMA B2 ECI 4 to ECI 6
13	7.Time window switching 60s-100s-60s	LTE B7 to LTE B48
14	7.Time window switching 100s-60s-100s	LTE B48 to LTE B7
15	8.SAR exposure switching	LTE B25 to FR1 n77
16	IoT NTN Max power	NTN B23

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

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

Test Case	Test Scenario	Test Band	Configure	Test Position Gap (mm)	ANT	ECI	Channel	Part 1 @Plimit 1-g / 10g SAR (W/kg)	Part 2 Test Result 1-g / 10g SAR (W/kg)	1g/10g SAR Limit. (W/kg)
1	1. Range of TA-SAR parameters	WCDMA_B2	RMC 12.2Kbps	Bottom Edge_5mm	0	6	9400	0.689	0.646	1.6
2	1. IoT-NTN Max power	NTN Band 23	3.75K_BPSK_1_46	Right Edge,0mm	5	4	25600	1.98	1.54	4.0
3	2. Time-varying TX power Seq 1	GPRS 850	GPRS 4 Tx slots	Back_5mm	1	4	189	0.709	0.612	1.6
4	2. Time-varying TX power Seq 2	GPRS 850	GPRS 4 Tx slots	Back_5mm	1	4	189	0.709	0.582	1.6
5	2. Time-varying TX power Seq 1	GPRS 1900	GPRS 4 Tx slots	Bottom Edge_5mm	0	6	512	0.736	0.784	1.6
6	2. Time-varying TX power Seq 2	GPRS 1900	GPRS 4 Tx slots	Bottom Edge_5mm	0	6	512	0.736	0.77	1.6
7	2. Time-varying TX power Seq 1	WCDMA_B2	RMC 12.2Kbps	Bottom Edge_5mm	0	6	9400	0.689	0.553	1.6
8	2. Time-varying TX power Seq 2	WCDMA_B2	RMC 12.2Kbps	Bottom Edge_5mm	0	6	9400	0.689	0.572	1.6
9	2. Time-varying TX power Seq 1	WCDMA_B5	RMC 12.2Kbps	Right Cheek_0mm	1	3	4132	0.63	0.541	1.6
10	2. Time-varying TX power Seq 2	WCDMA_B5	RMC 12.2Kbps	Right Cheek_0mm	1	3	4132	0.63	0.528	1.6
11	2. Time-varying TX power Seq 1	LTE_B25	QPSK_20M_1_0	Bottom Edge_5mm	0	6	26340	0.764	0.652	1.6
12	2. Time-varying TX power Seq 2	LTE_B25	QPSK_20M_1_0	Bottom Edge_5mm	0	6	26340	0.764	0.693	1.6
13	2. Time-varying TX power Seq 1	LTE_B26	QPSK_15M_36_39	Back_5mm	1	6	26865	0.774	0.657	1.6
14	2. Time-varying TX power Seq 2	LTE_B26	QPSK_15M_36_39	Back_5mm	1	6	26865	0.774	0.625	1.6
15	2. Time-varying TX power Seq 1	NR_n26	BPSK_20M_1_1	Back_5mm	1	6	166300	0.72	0.621	1.6
16	2. Time-varying TX power Seq 2	NR_n26	BPSK_20M_1_1	Back_5mm	1	6	166300	0.72	0.609	1.6
17	2. Time-varying TX power Seq 1	NR_n77	BPSK_100M_1_137	Right Edge_5mm	7	6	633332	0.691	0.589	1.6
18	2. Time-varying TX power Seq 2	NR_n77	BPSK_100M_1_137	Right Edge_5mm	7	6	633332	0.691	0.645	1.6
19	3. Call disconnection and re-establishment	WCDMA_B2	RMC 12.2Kbps	Bottom Edge_5mm	0	6	9400	0.689	0.664	1.6
Test Case	Test Scenario	Test Band	Configure	Test Position Gap (mm)	ANT	ECI	Channel	Part 1 @Plimit 1-g SAR (W/kg)	Part 2 Test Result Exposure Ratio	Exposure Limit
20	4. Band/RAT handover	LTE_B25	QPSK_20M_1_0	Right Edge_5mm	5	6	26340	0.829	0.454	1
		WCDMA_B5	RMC 12.2Kbps	Back_5mm	1	6	4182	0.816		
21	5. Change in operating state	WCDMA_B2	RMC 12.2Kbps	Back_5mm	0	4	9400	0.509	0.334	1
		WCDMA_B2	RMC 12.2Kbps	Bottom Edge_5mm	0	6	9400	0.689		
22	7. Time window switching (100-60-100)	LTE_B7	QPSK_20M_50_0	Right Edge_5mm	2	6	21100	0.751	0.457	1
		LTE_B48	QPSK_20M_50_0	Right Edge_5mm	7	6	56150	0.777		
23	7. Time window switching (60-100-60)	LTE_B48	QPSK_20M_50_0	Right Edge_5mm	7	6	56150	0.777	0.47	1
		LTE_B7	QPSK_20M_50_0	Right Edge_5mm	2	6	21100	0.751		
24	8. SAR exposure switching (ENDC)	LTE_B25	QPSK_20M_1_0	Bottom Edge_5mm	0	6	26340	0.764	0.402	1
		NR_n77	BPSK_100M_135_138	Left Edge_5mm	6	6	656000	0.507		

Table of Test configurations of radio technologies and worst-case measured Plimit and Pmax

Test Case	Test Scenario	Test Band	Configure	Test Position Gap (mm)	ANT	ECI	Channel	Pmax Setting	Plimit Setting	Measured Pmax	Measured Plimit	PUE max cust offset	PUE backoff offset	Unce.
1	1. Range of TA-SAR parameters	WCDMA_B2	RMC 12.2Kbps	Bottom Edge_5mm	0	6	9400	24	12.9	24.1	12.4	10	3	1
2	1. IoT-NTN Max power	NTN Band 23	3.75K_BPSK_1_46	Right Edge,0mm	5	4	25600	23.1	19.1	22.71	18.65	2	57	1.5
3	2. Time-varying TX power Seq 1	GPRS 850	GPRS 4 Tx slots	Back_5mm	1	4	189	26.3	25.1	26.7	24.54	10	3	1
4	2. Time-varying TX power Seq 1	GPRS 850	GPRS 4 Tx slots	Back_5mm	1	4	189	26.3	25.1	26.7	24.54	10	3	1
5	2. Time-varying TX power Seq 1	GPRS 1900	GPRS 4 Tx slots	Bottom Edge_5mm	0	6	512	22.7	16.1	22.05	15.52	10	3	1
6	2. Time-varying TX power Seq 1	GPRS 1900	GPRS 4 Tx slots	Bottom Edge_5mm	0	6	512	22.7	16.1	22.05	15.52	10	3	1
7	2. Time-varying TX power Seq 2	WCDMA_B2	RMC 12.2Kbps	Bottom Edge_5mm	0	6	9400	24	12.9	24.1	12.4	10	3	1
8	2. Time-varying TX power Seq 2	WCDMA_B2	RMC 12.2Kbps	Bottom Edge_5mm	0	6	9400	24	12.9	24.1	12.4	10	3	1
9	2. Time-varying TX power Seq 2	WCDMA_B5	RMC 12.2Kbps	Right Cheek_0mm	1	3	4132	24.2	22.7	24.38	23.04	10	3	1
10	2. Time-varying TX power Seq 2	WCDMA_B5	RMC 12.2Kbps	Right Cheek_0mm	1	3	4132	24.2	22.7	24.38	23.04	10	3	1
11	2. Time-varying TX power Seq 1	LTE_B25	QPSK_20M_1_0	Bottom Edge_5mm	0	6	26340	24	13.1	24.48	13.5	10	3	1
12	2. Time-varying TX power Seq 1	LTE_B25	QPSK_20M_1_0	Bottom Edge_5mm	0	6	26340	24	13.1	24.48	13.5	10	3	1
13	2. Time-varying TX power Seq 1	LTE_B26	QPSK_15M_36_39	Back_5mm	1	6	26865	24.1	22.5	24.61	23.02	10	3	1
14	2. Time-varying TX power Seq 1	LTE_B26	QPSK_15M_36_39	Back_5mm	1	6	26865	24.1	22.5	24.61	23.02	10	3	1
15	2. Time-varying TX power Seq 2	NR_n26	BPSK_20M_1_1	Back_5mm	1	6	166300	24.1	23	24.09	22.54	10	3	1
16	2. Time-varying TX power Seq 2	NR_n26	BPSK_20M_1_1	Back_5mm	1	6	166300	24.1	23	24.09	22.54	10	3	1
17	2. Time-varying TX power Seq 2	NR_n77	BPSK_100M_1_137	Right Edge_5mm	7	6	633332	24	14.1	23.1	14.27	10	3	1
18	2. Time-varying TX power Seq 2	NR_n77	BPSK_100M_1_137	Right Edge_5mm	7	6	633332	24	14.1	23.1	14.27	10	3	1
19	3. Call disconnection and re-establishment	WCDMA_B2	RMC 12.2Kbps	Bottom Edge_5mm	0	6	9400	24	12.9	24.1	12.4	10	3	1
20	4. Band/RAT handover	LTE_B25	QPSK_20M_1_0	Right Edge_5mm	5	6	26340	24	16.4	23.84	16.85	10	3	1
		WCDMA_B5	RMC 12.2Kbps	Back_5mm	1	6	4182	24.2	23.1	24.37	22.46	10	3	1
21	5. Change in operating state	WCDMA_B2	RMC 12.2Kbps	Bottom Edge_5mm	0	4	9400	24	14.3	24.1	13.8	10	3	1
		WCDMA_B2	RMC 12.2Kbps	Back_5mm	0	6	9400	24	12.9	24.1	12.4	10	3	1
22	7. Time window switching (100-60-100)	LTE_B7	QPSK_20M_50_0	Right Edge_5mm	2	6	21100	23	15.9	23.16	16.28	10	3	1
		LTE_B48	QPSK_20M_50_0	Right Edge_5mm	7	6	56150	16.3	14.3	16.61	13.87	10	3	1
23	7. Time window switching (60-100-60)	LTE_B48	QPSK_20M_50_0	Right Edge_5mm	7	6	56150	16.3	14.3	16.61	13.87	10	3	1
		LTE_B7	QPSK_20M_50_0	Right Edge_5mm	2	6	21100	23	15.9	23.16	16.28	10	3	1
24	8. SAR exposure switching (ENDC)	LTE_B25	QPSK_20M_1_0	Bottom Edge_5mm	0	6	26340	24	13.1	24.02	13.57	10	3	1
		NR_n77	BPSK_100M_135_138	Left Edge_5mm	6	6	656000	24.1	14.7	23.41	14.54	10	3	1

4.4 Measurement Results for Scenario1: Range of TA-SAR Parameters

- **Test Case 1: Range of TA-SAR Parameters for WCDMA B2**

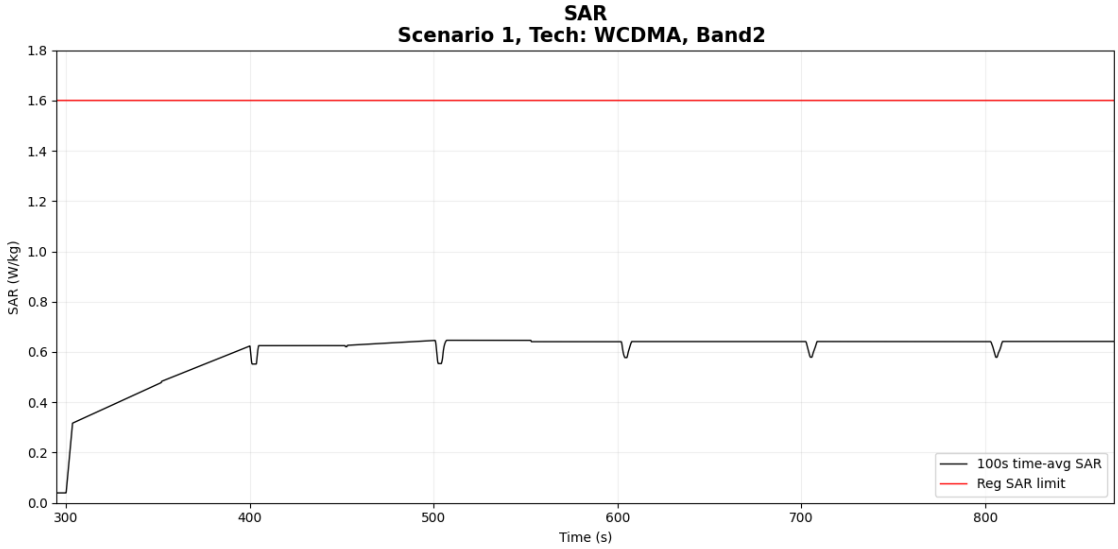


Figure of Time-averaged SAR

Validation result: pass

4.5 Measurement Results for Scenario1: NTN Max Power

- **Test Case 2: Max Power result for NTN B23**

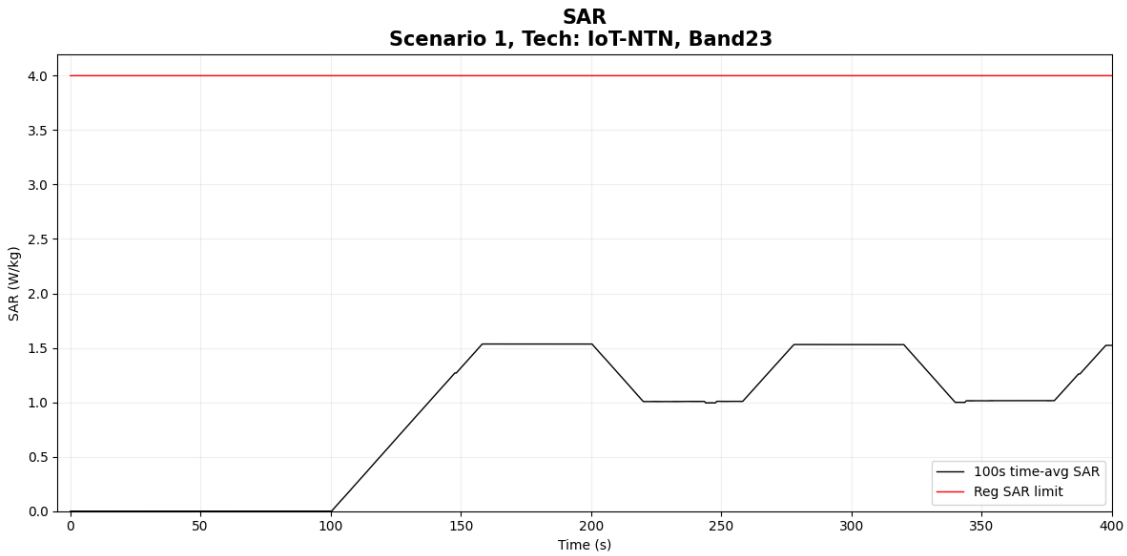


Figure of Time-averaged SAR

Validation result: pass

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

- **Test Case 3: GSM850 result for test sequence 1**

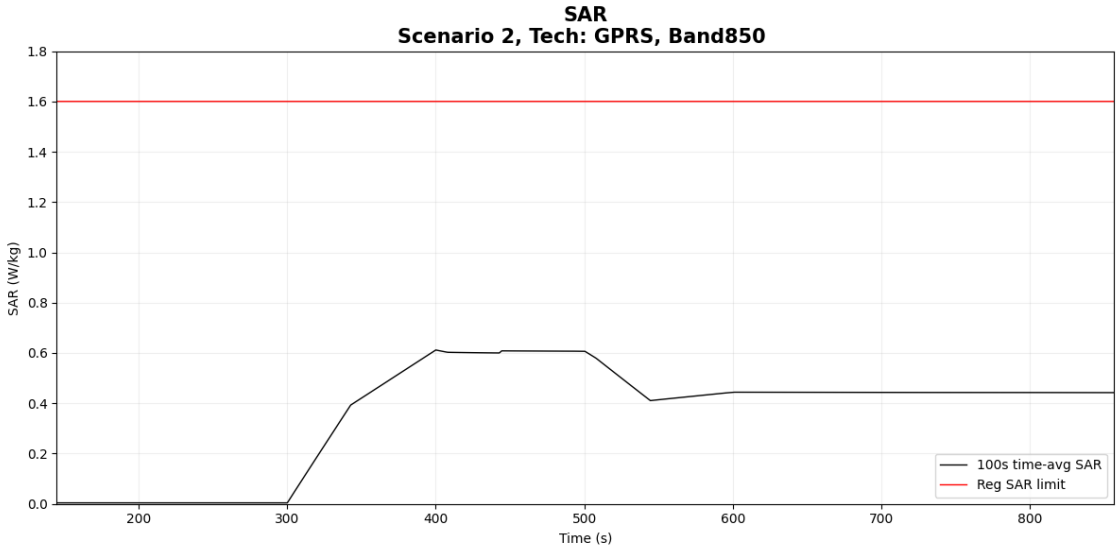


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 4: GSM850 result for test sequence 2**

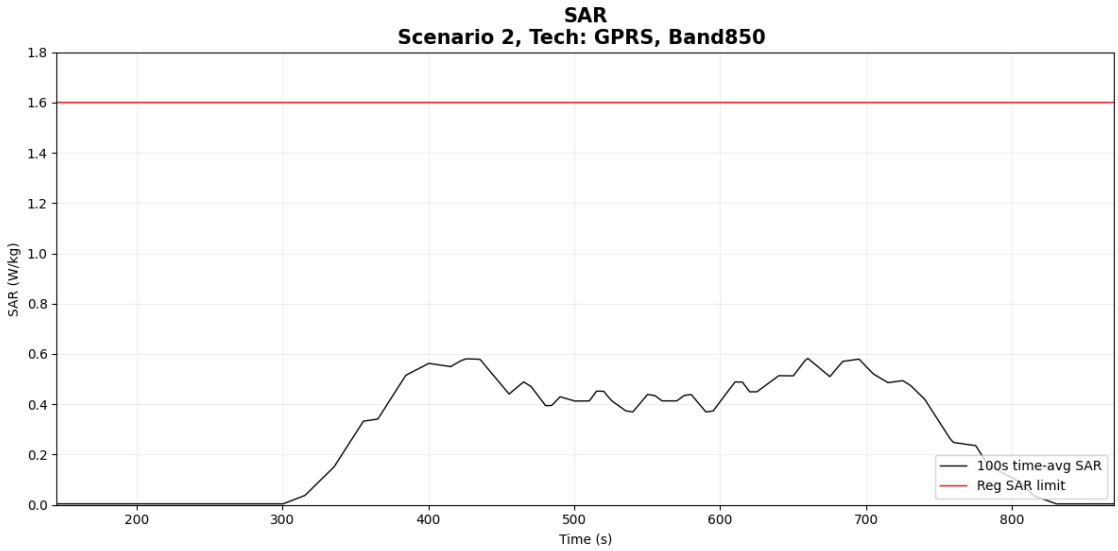


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 5: GSM1900 result for test sequence 1**

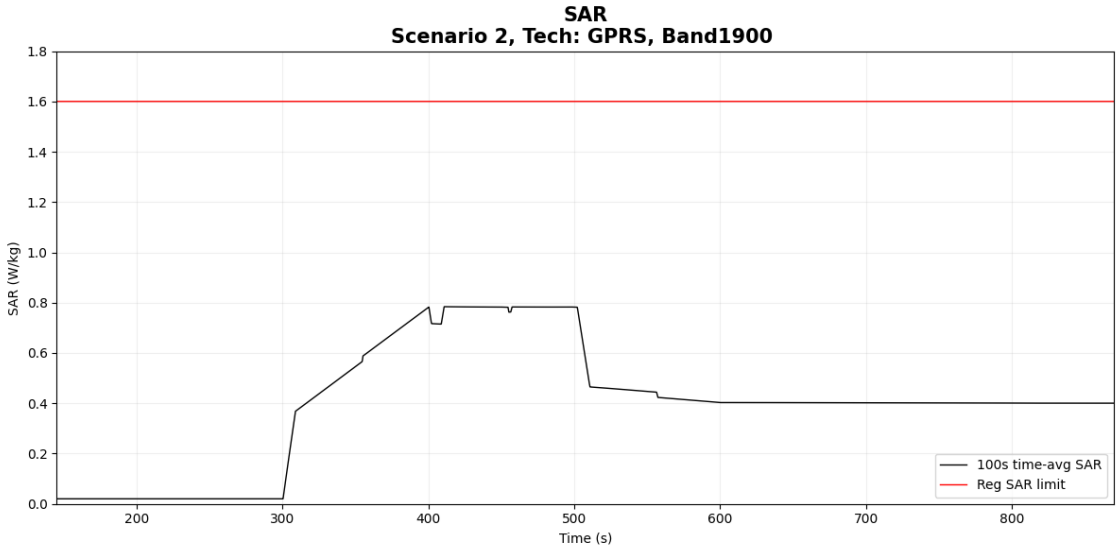


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 6: GSM1900 result for test sequence 2**

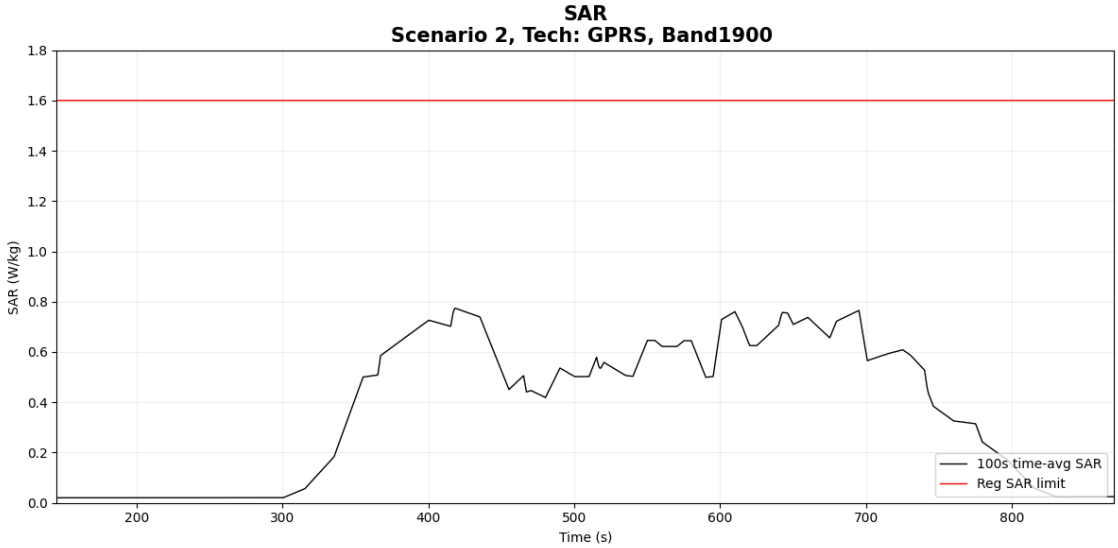


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 7: UMTS B2 result for test sequence 1**

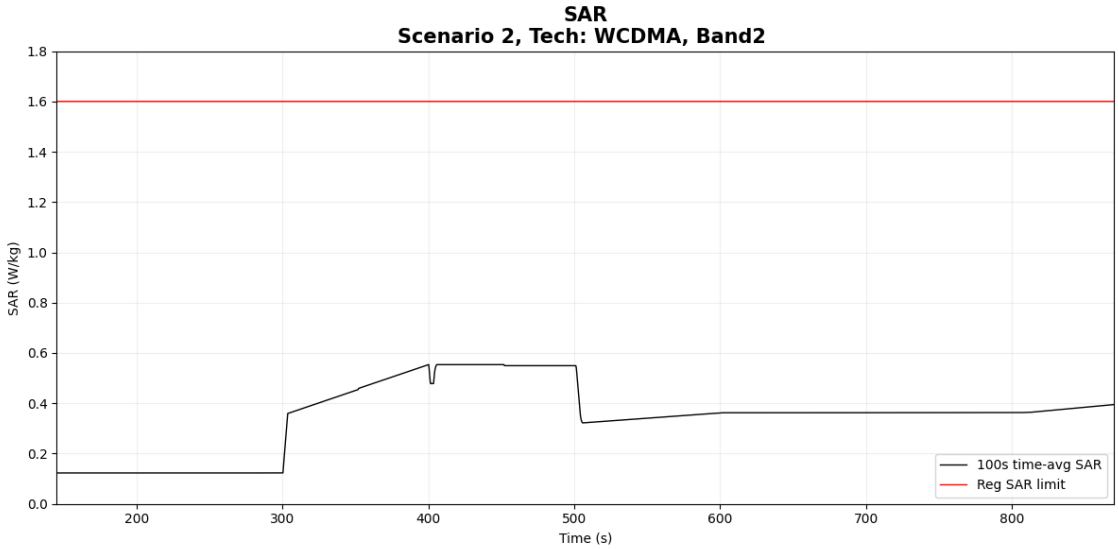


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 8: UMTS B2 result for test sequence 2**

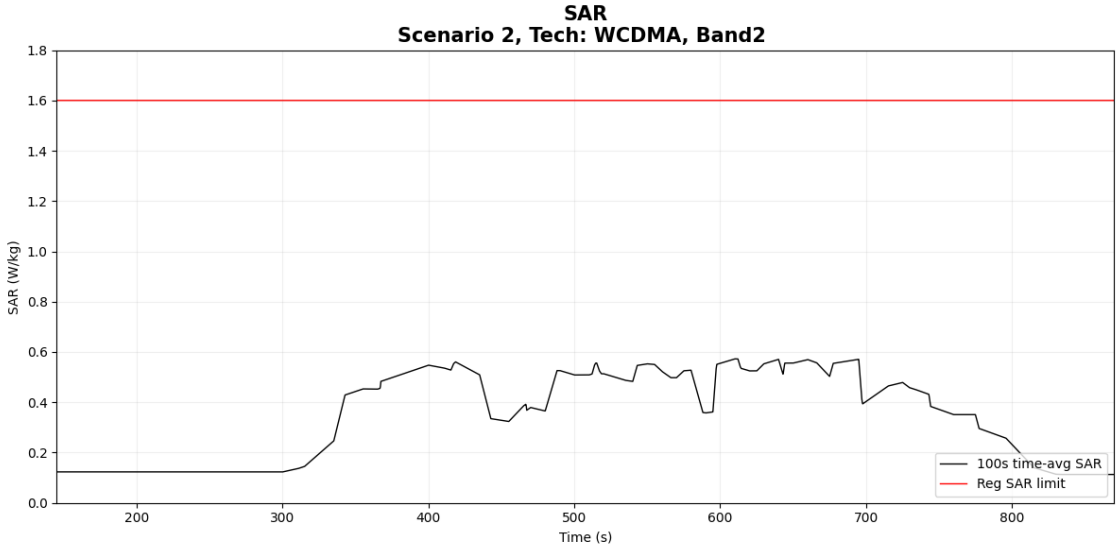


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 9: UMTS B5 result for test sequence 1**

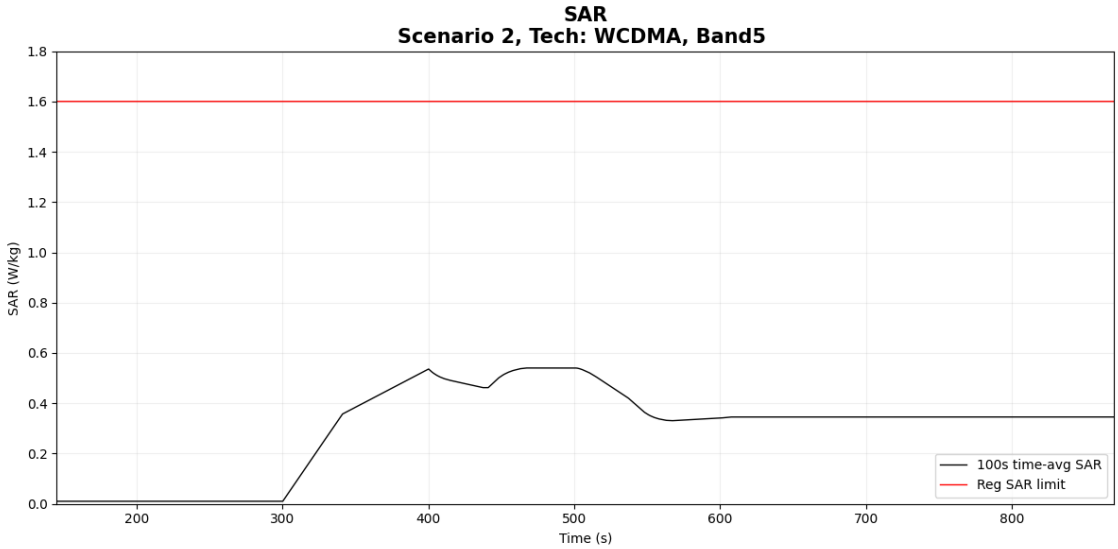


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 10: UMTS B5 result for test sequence 2**

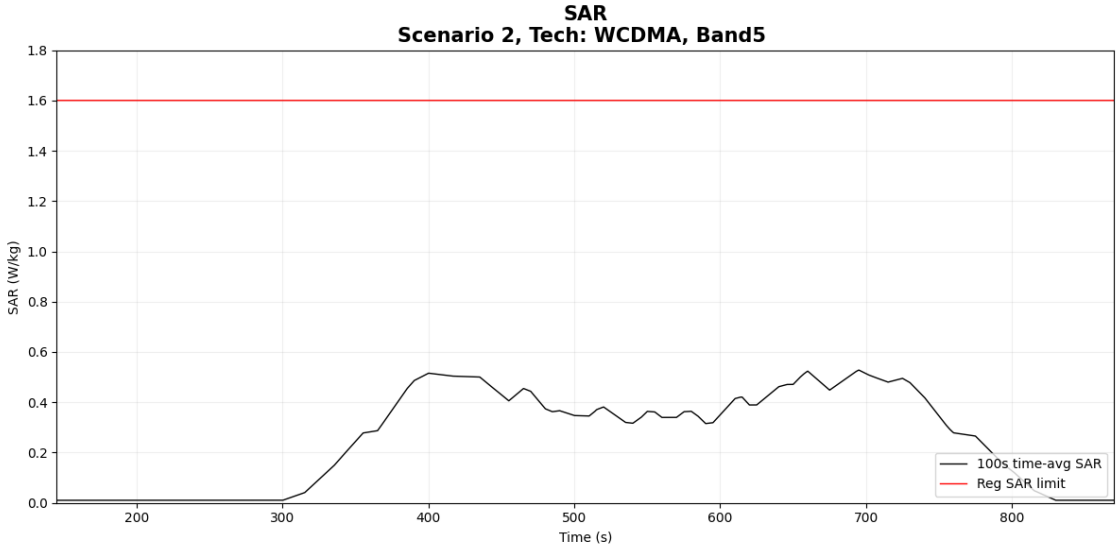


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 11: LTE B25 result for test sequence 1**

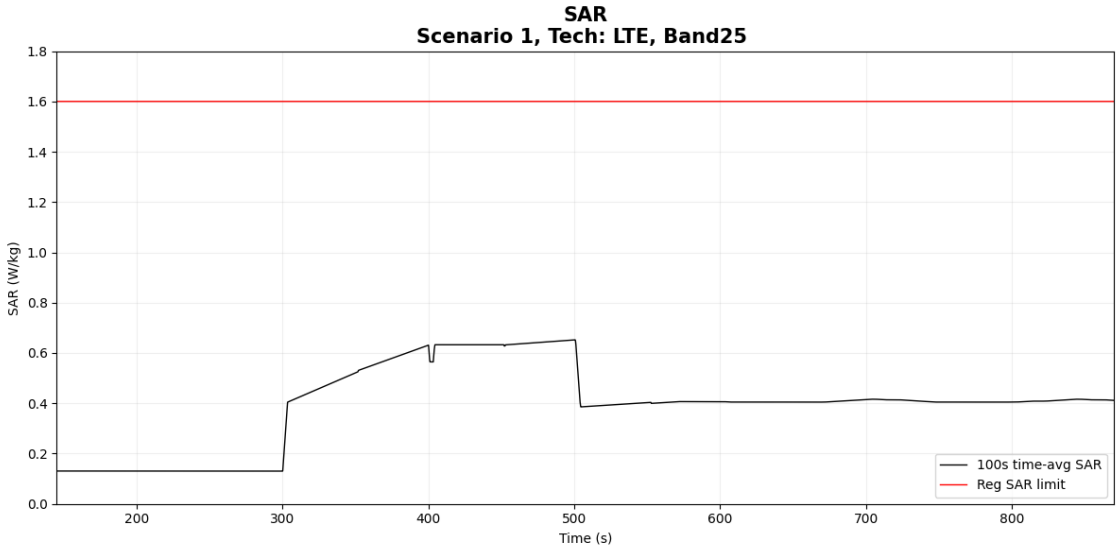


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 12: LTE B25 result for test sequence 2**

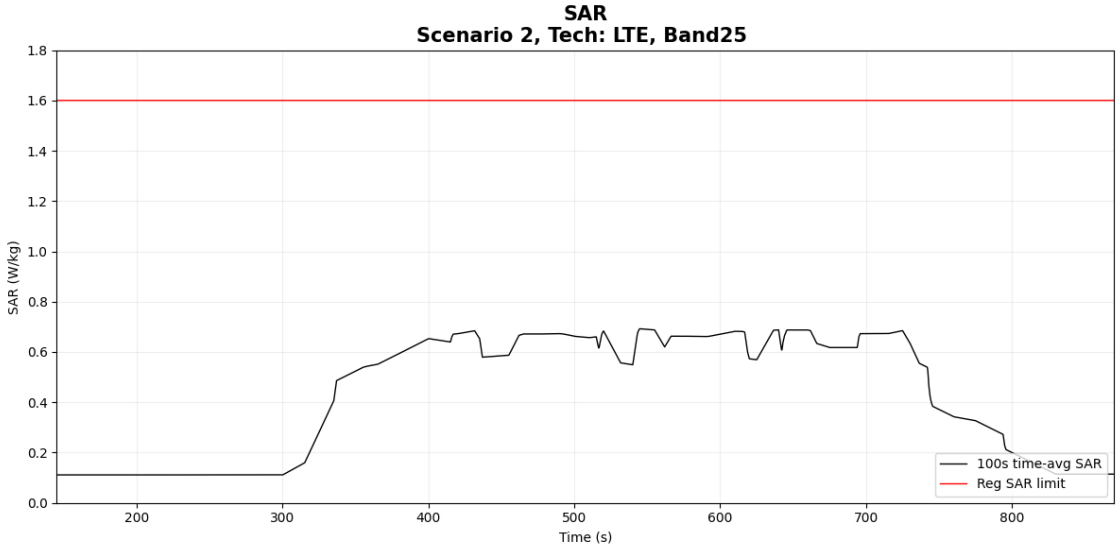


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 13: LTE B26 result for test sequence 1**

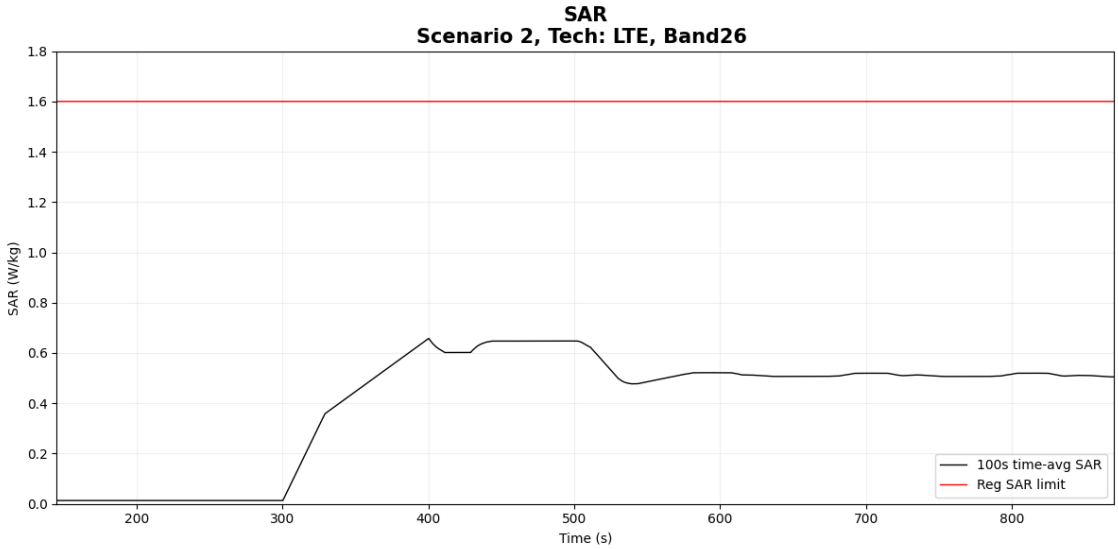


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 14: LTE B26 result for test sequence 2**

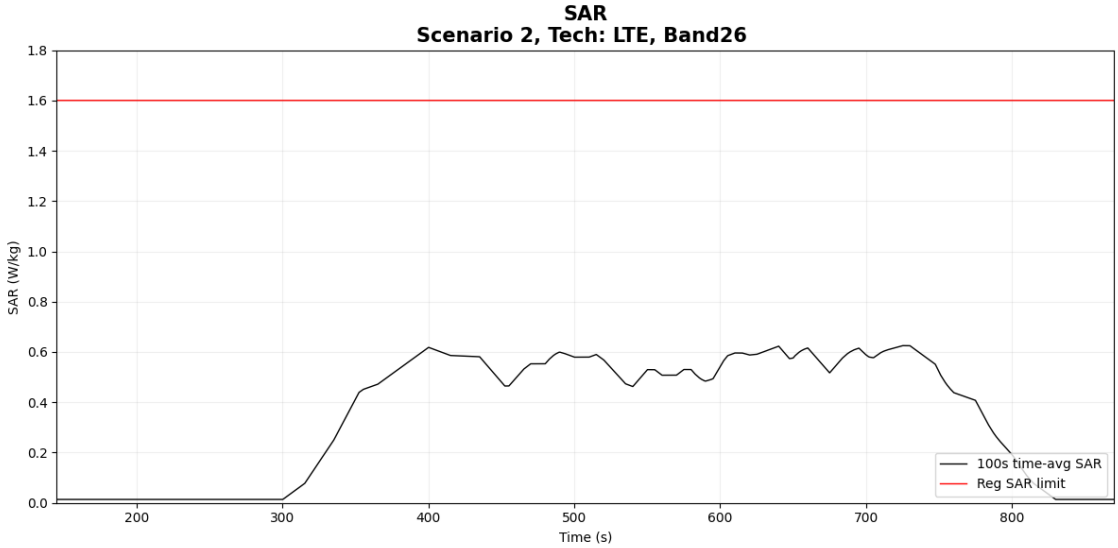


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 15: FR1 n26 result for test sequence 1**

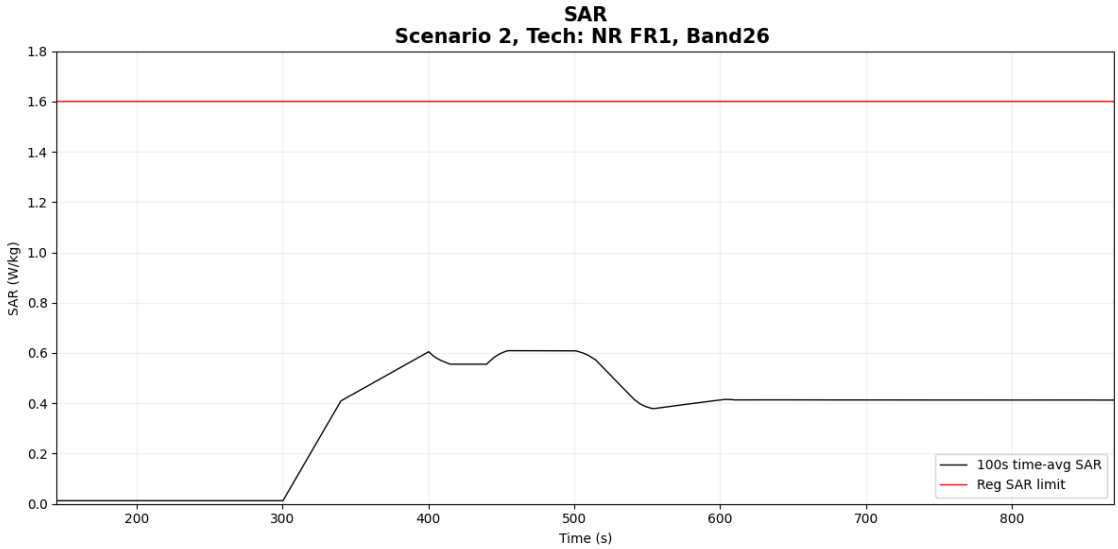


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 16: FR1 n26 result for test sequence 2**

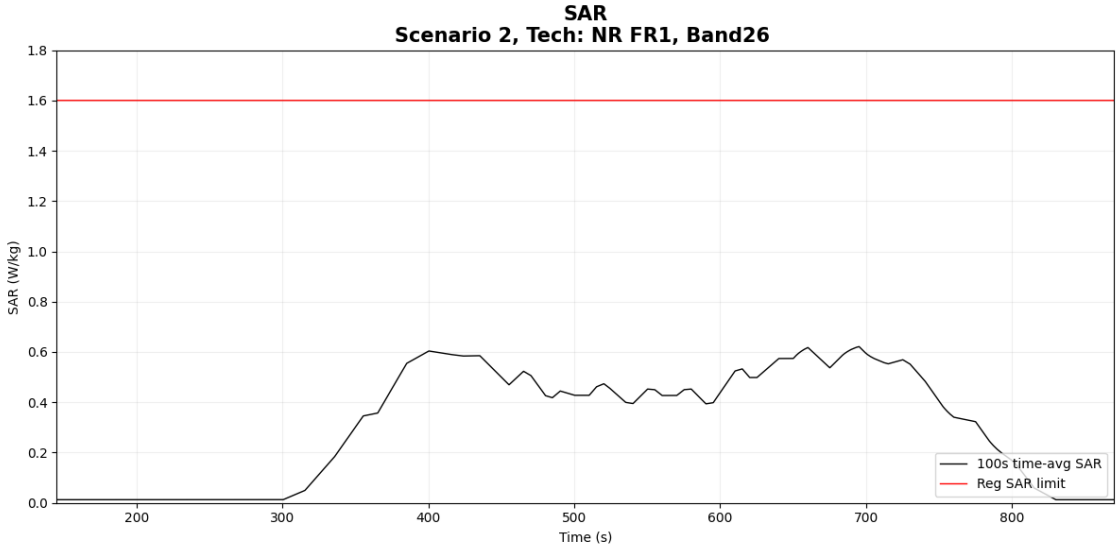


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 17: FR1 77 result for test sequence 1**

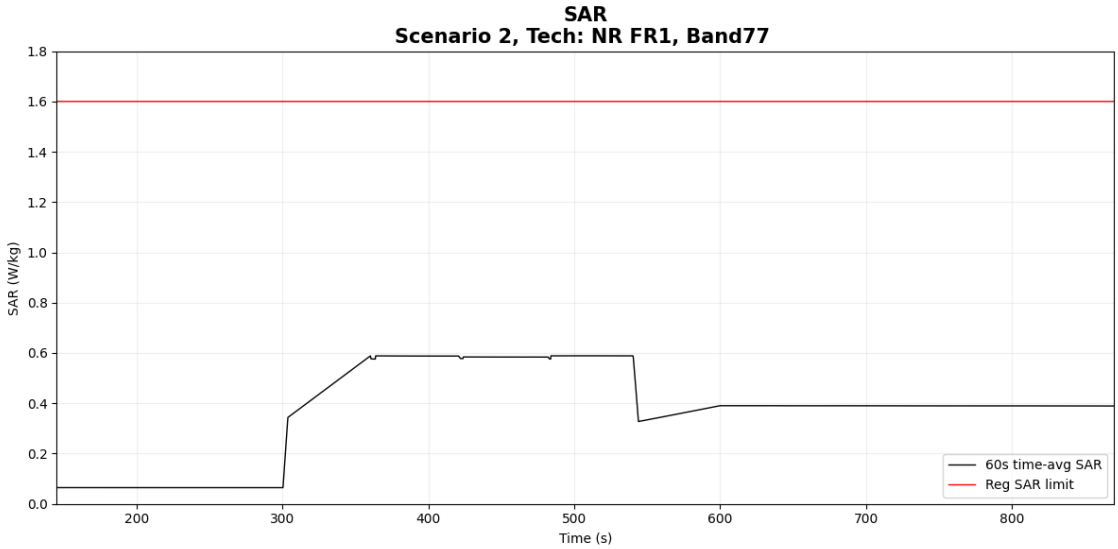


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 18: FR1 n77 result for test sequence 2**

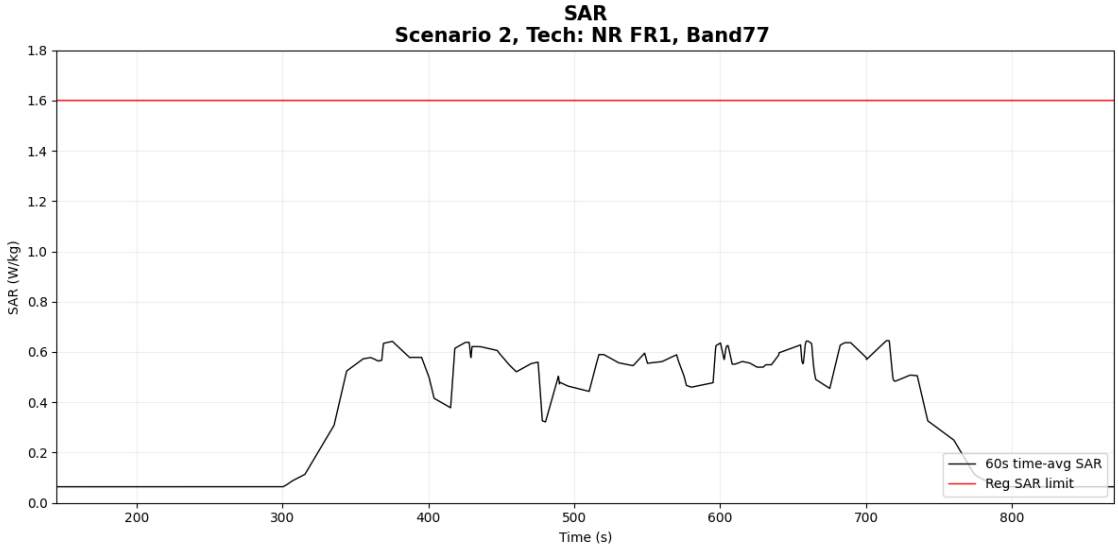


Figure of Time-averaged SAR

Validation result: pass

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

- **Test Case 19: WCDMA B2 for call drop**

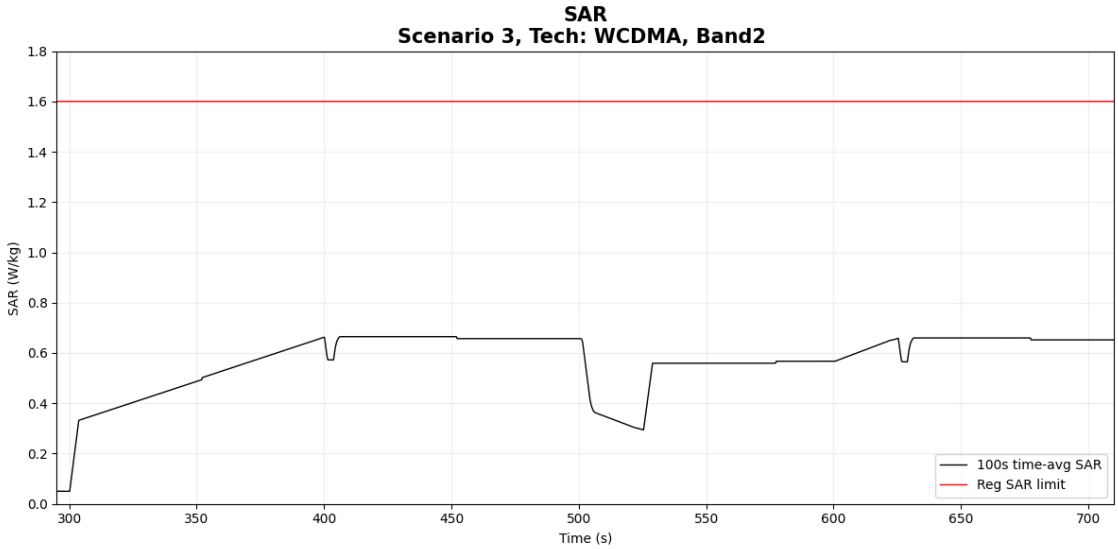


Figure of Time-averaged SAR

Validation result: pass

4.8 Conducted Power Measurement Results for Scenario 4: Band Handover

- **Test Case 20: LTE B25 to UMTS B5 for band handover**

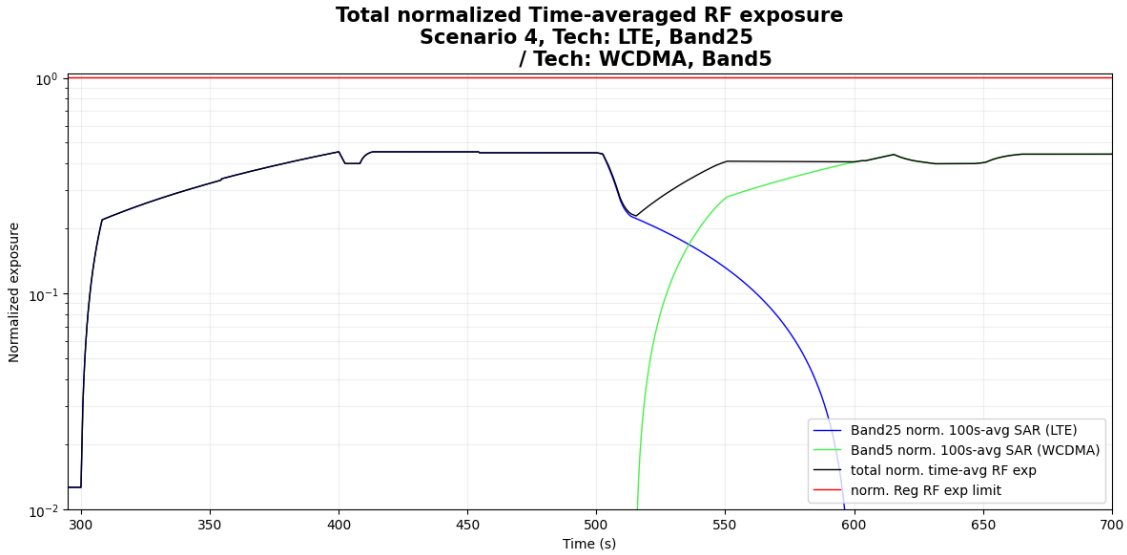


Figure of Normalized time-averaged RF Exposure

Validation result: pass

4.9 Conducted Power Measurement Results for Scenario 5: ECI Change

- **Test Case 21: WCDMA B2 for ECI change**

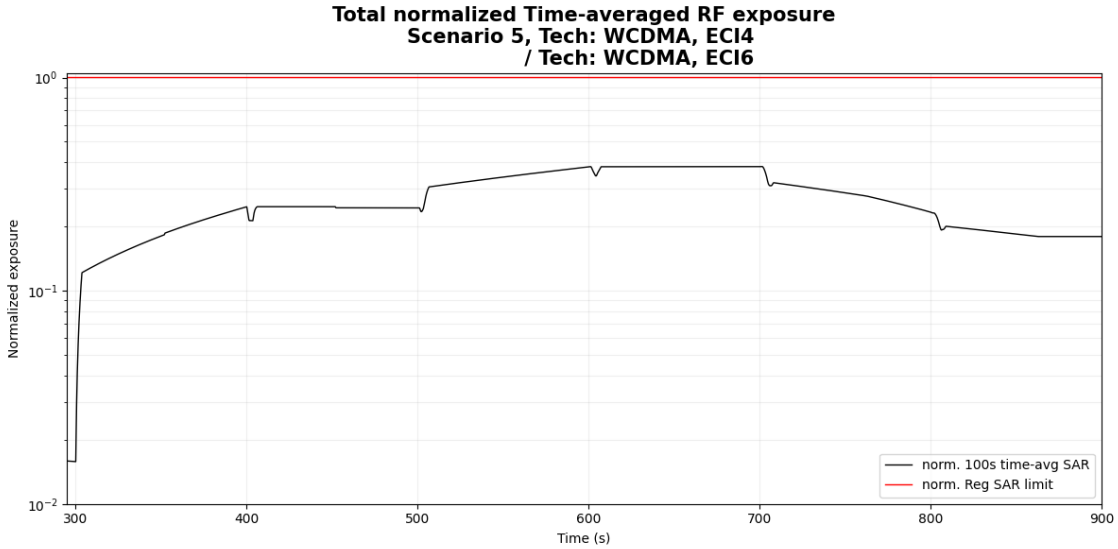


Figure of Normalized time-averaged RF Exposure

Validation result: pass

4.10 Conducted Power Measurement Results for Scenario 7: Time Window Switching

- **Test Case 22: Change in time-window from 100s to 60s to 100s**

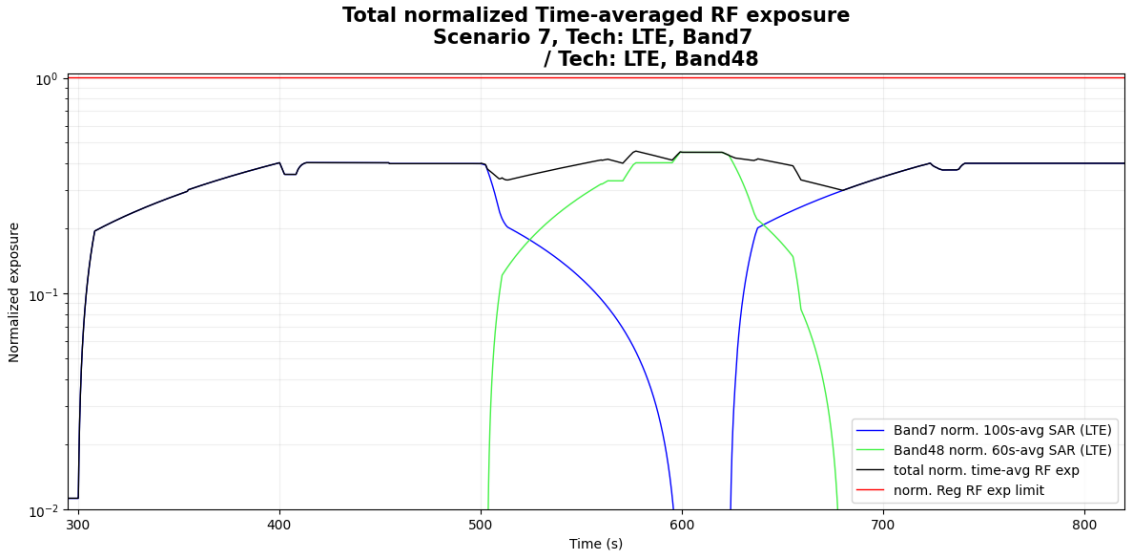


Figure of Normalized time-averaged RF Exposure

Validation result: pass

- **Test Case 23: Change in time-window from 60s to 100s to 60s**

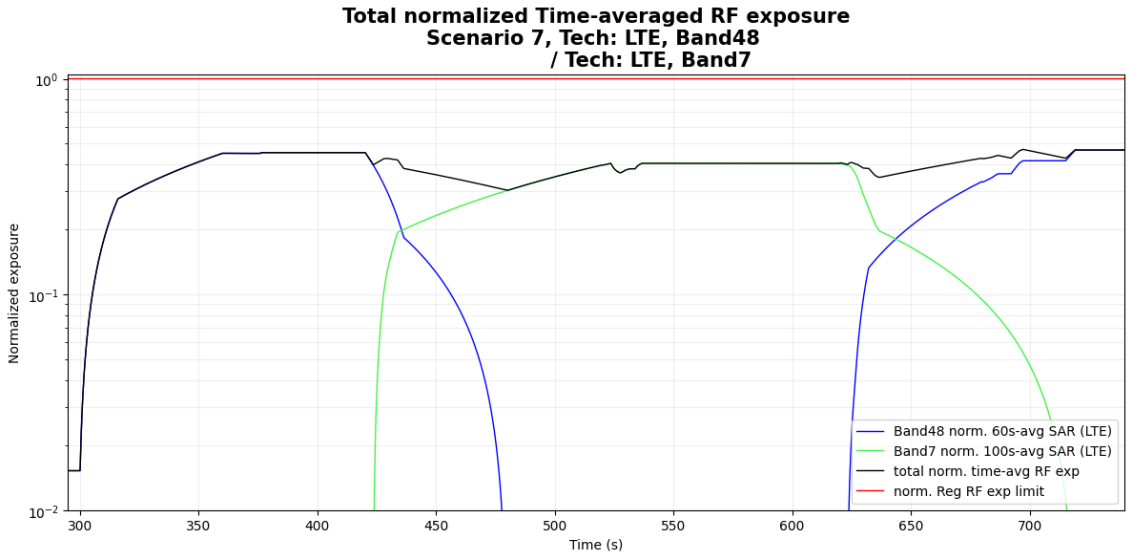


Figure of Normalized time-averaged RF Exposure

Validation result: pass

4.11 Conducted Power Measurement Results for Scenario 8: SAR Exposure Switching

- **Test Case 24: SAR Exposure Switch for LTE B25 to FR1 n77**

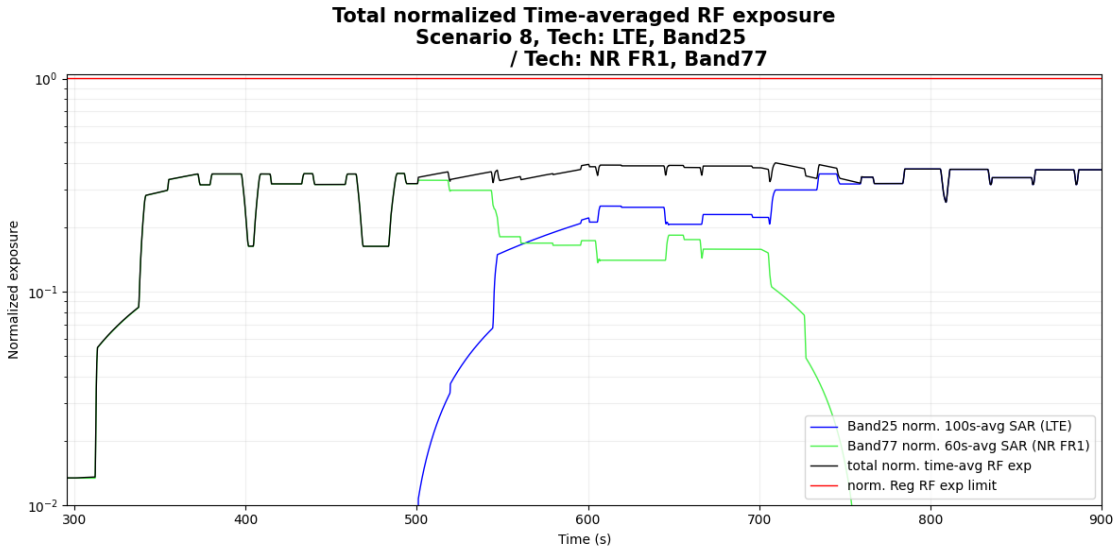


Figure of Normalized time-averaged RF Exposure

Validation result: pass

5. TA-SAR Validation via SAR Measurements

5.1 Measurement Setup

The measurement setup is similar to normal fixed power SAR measurement. The difference in SAR measurement setup for time averaging feature validation is that the call box operates under the close loop power control mode and is connected to the PC, so that the PC can control the call box based on the test sequence to configure EUT's TX target power. The same test procedure used in the 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 the call box antenna and the EUT is well calibrated. The test setup is illustrated in Figure 5-1, and its photos are shown in Figure 5-2 and Figure 5-3.

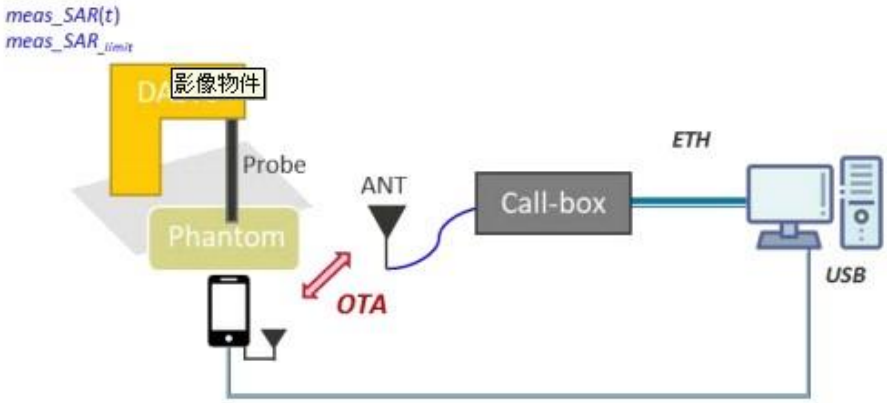


Figure 5-1 TA-SAR wireless test environment

Figure 5-2 DASY6 TA-SAR test environment with call box and PC

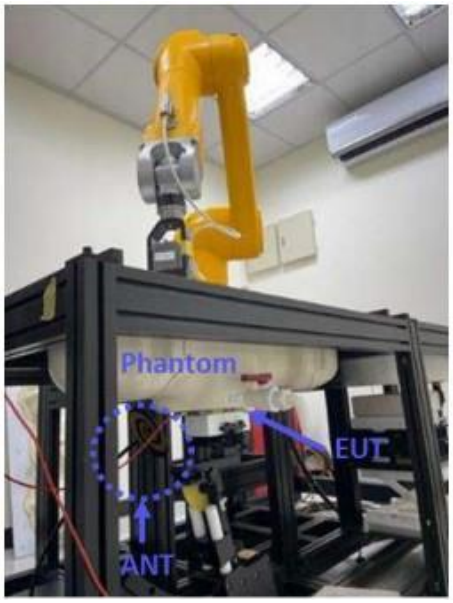


Figure 5-3 The other view of DASY6 TA-SAR test environment

5.2 SAR Measurement Results for Scenario 2: Time-Varying TX Power

In this scenario, Mediatek's TA-SAR algorithm is tested under more dynamic power test sequences. Test sequence #1 and test sequence #2 are include in section 4.2. All of the test cases for this scenario are relegated in Table 5-1 and the test procedure follows TA-SAR/TA-PD algorithm document. The measurement setup is shown in Figure 5-1, Figure 5-2 and Figure 5-3. The summary of the final validation results is given on table 5-1, which concludes that Mediatek's TA-SAR algorithm can maintain the time-averaged SAR always below the requirement for all test cases.

Table 5-1 Operating parameters for different TA-SAR parameters setting

Test Case	Test Scenario	Test band	Mode	Test Position/ Gap (mm)	ANT	ECI	Channel	Pmax Setting	Plimit Setting	Measured Pmax	Measured Plimit	PUE max cust offset	PUE backoff offset	Unce.	Part 1 @Plimit 1-g SAR (W/kg)	Part 2 Test Result 1-g SAR (W/kg)	1g SAR Limit. (W/kg)
1	Time-varying TX power Seq 1	GPRS 850	GPRS 4 Tx slots	Back_5mm	1	4	189	26.3	25.1	26.7	24.54	10	3	1	0.709	0.581	1.6
2	Time-varying TX power Seq 2	GPRS 850	GPRS 4 Tx slots	Back_5mm	1	4	189	26.3	25.1	26.7	24.54	10	3	1	0.709	0.577	1.6
3	Time-varying TX power Seq 1	GPRS 1900	GPRS 4 Tx slots	Bottom Edge_5mm	0	6	512	22.7	16.1	22.05	15.52	10	3	1	0.736	0.619	1.6
4	Time-varying TX power Seq 2	GPRS 1900	GPRS 4 Tx slots	Bottom Edge_5mm	0	6	512	22.7	16.1	22.05	15.52	10	3	1	0.736	0.618	1.6
5	Time-varying TX power Seq 1	WCDMA_B2	RMC 12.2Kbps	Bottom Edge_5mm	0	6	9400	24	12.9	24.1	12.4	10	3	1	0.689	0.578	1.6
6	Time-varying TX power Seq 2	WCDMA_B2	RMC 12.2Kbps	Bottom Edge_5mm	0	6	9400	24	12.9	24.1	12.4	10	3	1	0.689	0.540	1.6
7	Time-varying TX power Seq 1	WCDMA_B5	RMC 12.2Kbps	Right Cheek_0mm	1	3	4132	24.2	22.7	24.38	23.04	10	3	1	0.63	0.54	1.6
8	Time-varying TX power Seq 2	WCDMA_B5	RMC 12.2Kbps	Right Cheek_0mm	1	3	4132	24.2	22.7	24.38	23.04	10	3	1	0.63	0.532	1.6
9	Time-varying TX power Seq 1	LTE_B25	QPSK_20M_1_0	Bottom Edge_5mm	0	6	26340	24	13.1	24.48	13.5	10	3	1	0.764	0.71	1.6
10	Time-varying TX power Seq 2	LTE_B25	QPSK_20M_1_0	Bottom Edge_5mm	0	6	26340	24	13.1	24.48	13.5	10	3	1	0.764	0.662	1.6
11	Time-varying TX power Seq 1	LTE_B26	QPSK_15M_36_39	Back_5mm	1	6	26865	24.1	22.5	24.61	23.02	10	3	1	0.774	0.653	1.6
12	Time-varying TX power Seq 2	LTE_B26	QPSK_15M_36_39	Back_5mm	1	6	26865	24.1	22.5	24.61	23.02	10	3	1	0.774	0.71	1.6
13	Time-varying TX power Seq 1	NR_n26	BPSK_20M_1_1	Back_5mm	1	6	166300	24.1	23	24.09	22.54	10	3	1	0.72	0.609	1.6
14	Time-varying TX power Seq 2	NR_n26	BPSK_20M_1_1	Back_5mm	1	6	166300	24.1	23	24.09	22.54	10	3	1	0.72	0.618	1.6
15	Time-varying TX power Seq 1	NR_n77	BPSK_100M_135_0	Right Edge_5mm	5	6	633332	24	14.1	23.1	14.27	10	3	1	0.691	0.417	1.6
16	Time-varying TX power Seq 2	NR_n77	BPSK_100M_135_0	Right Edge_5mm	5	6	633332	24	14.1	23.1	14.27	10	3	1	0.691	0.604	1.6

- **Test Case 1: GSM850 result for sequence 1**

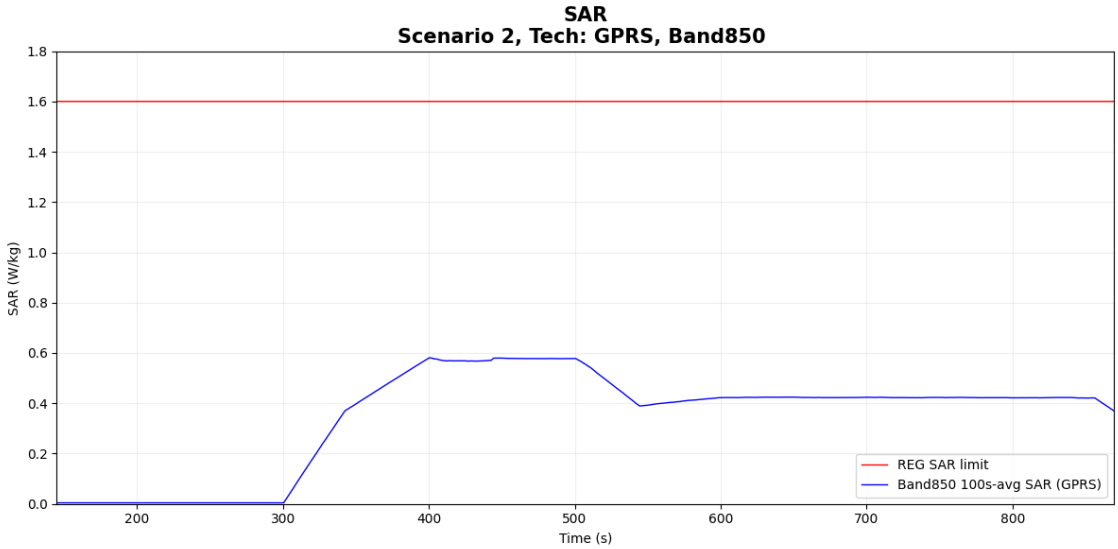


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 2: GSM850 result for sequence 2**

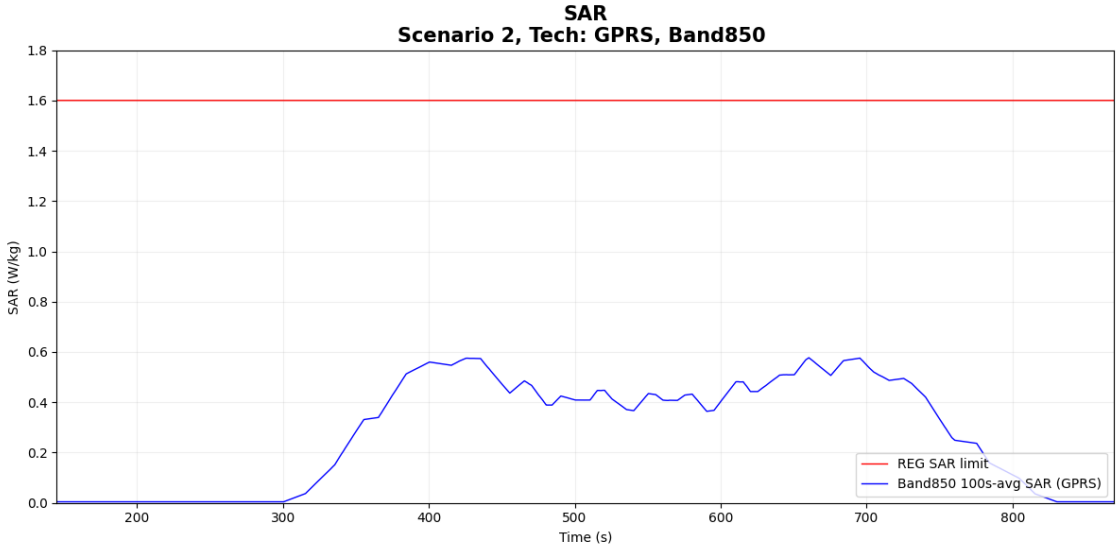


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 3: GSM1900 result for sequence 1**

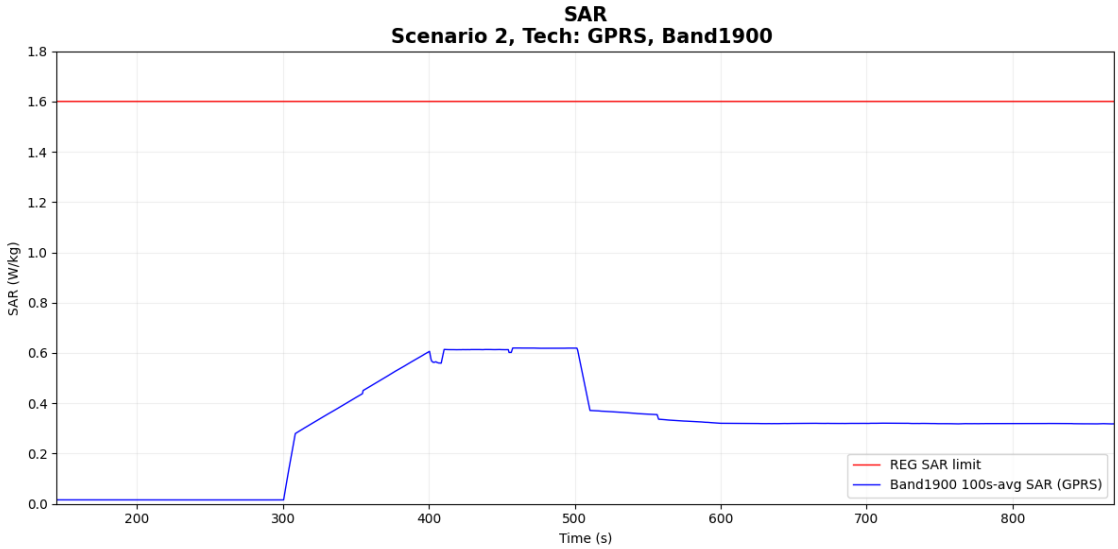


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 4: GSM1900 result for sequence 2**

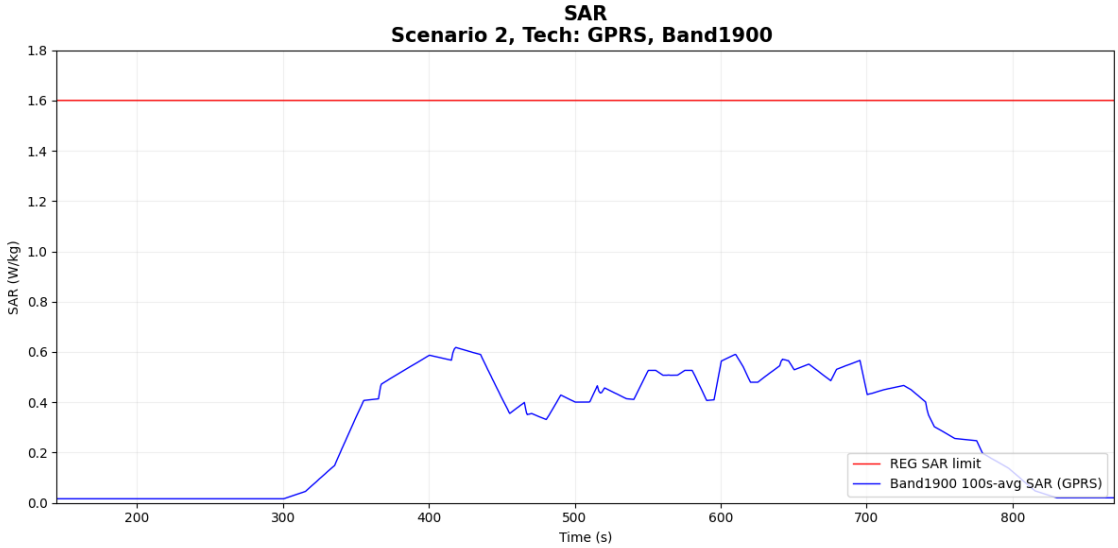


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 5: UMTS B2 result for sequence 1**

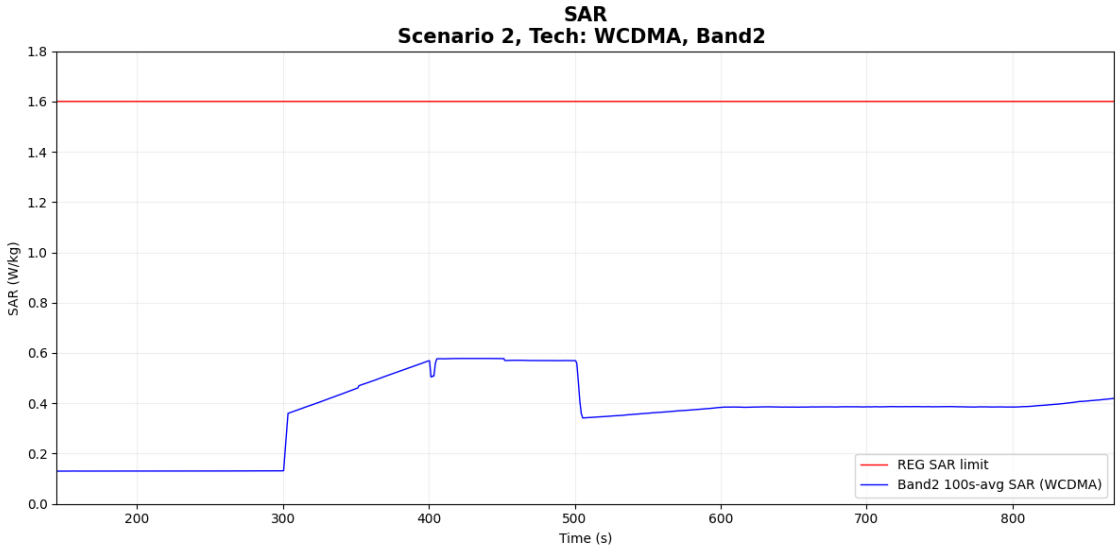


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 6: UMTS B2 result for sequence 2**

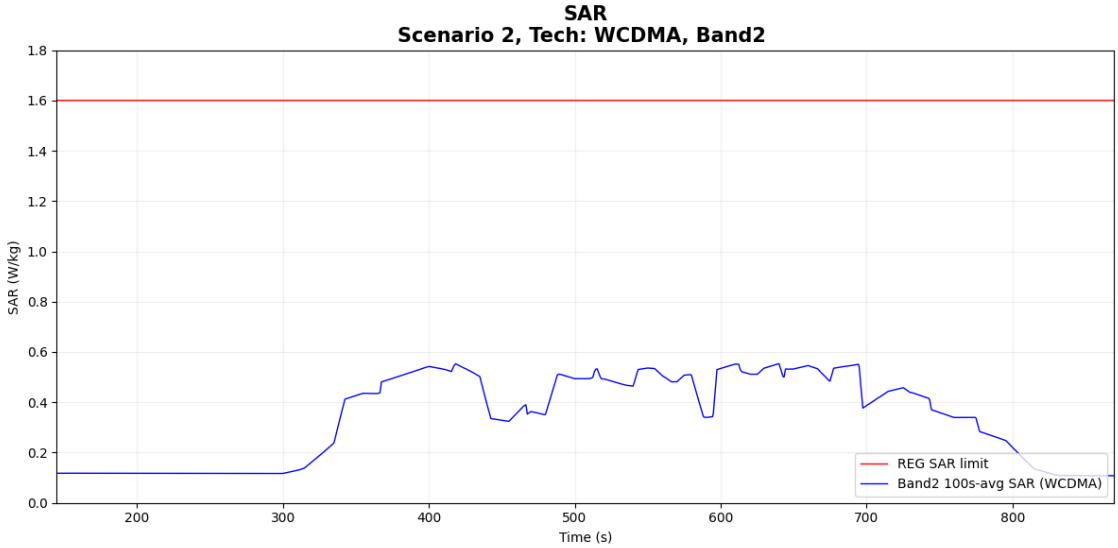


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 7: UMTS B5 result for sequence 1**

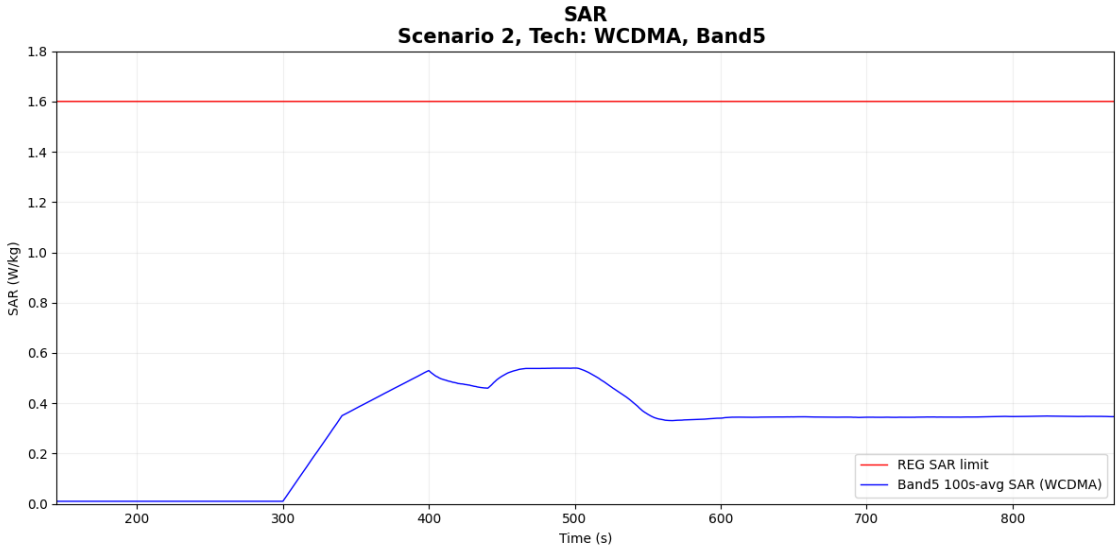


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 8: UMTS B5 result for sequence 2**

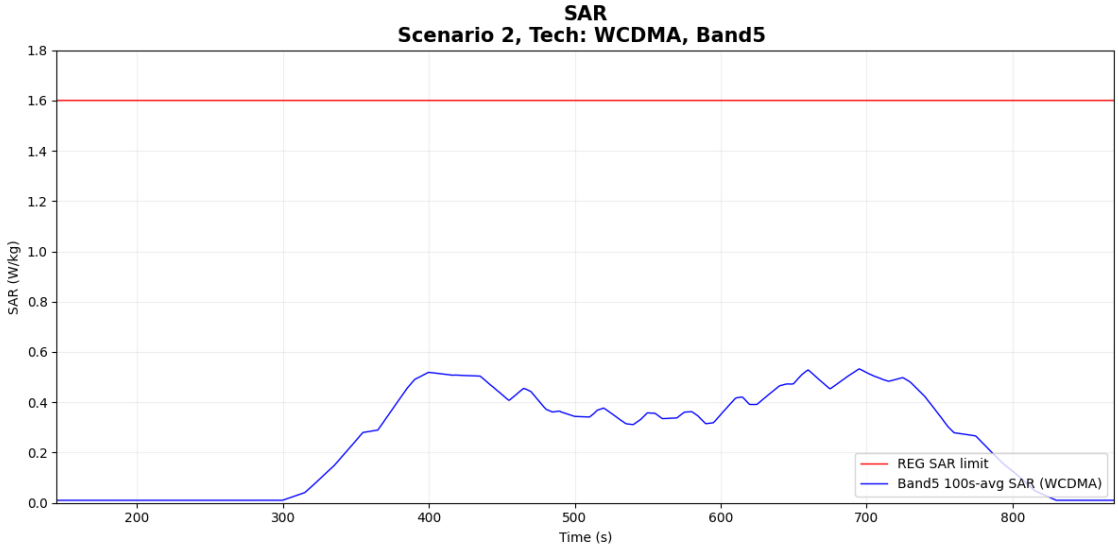


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 9: LTE B25 result for sequence 1**

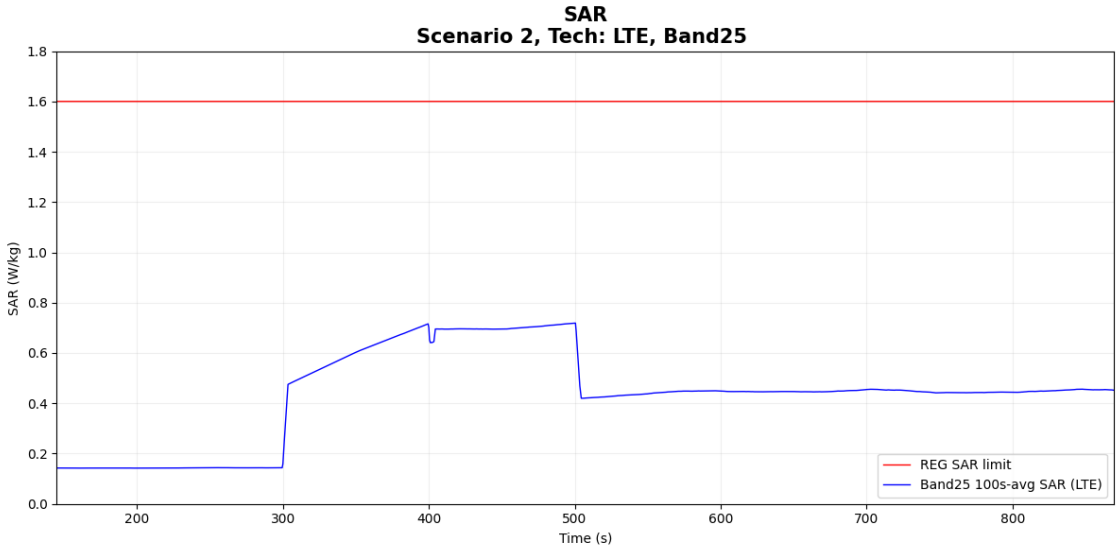


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 10: LTE B25 result for sequence 2**

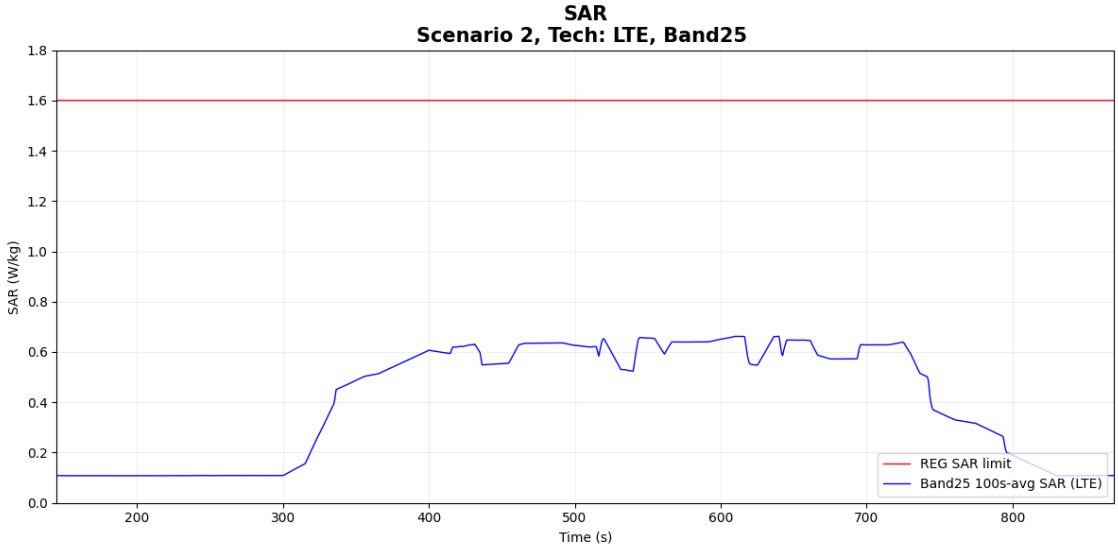


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 11: LTE B26 result for sequence 1**

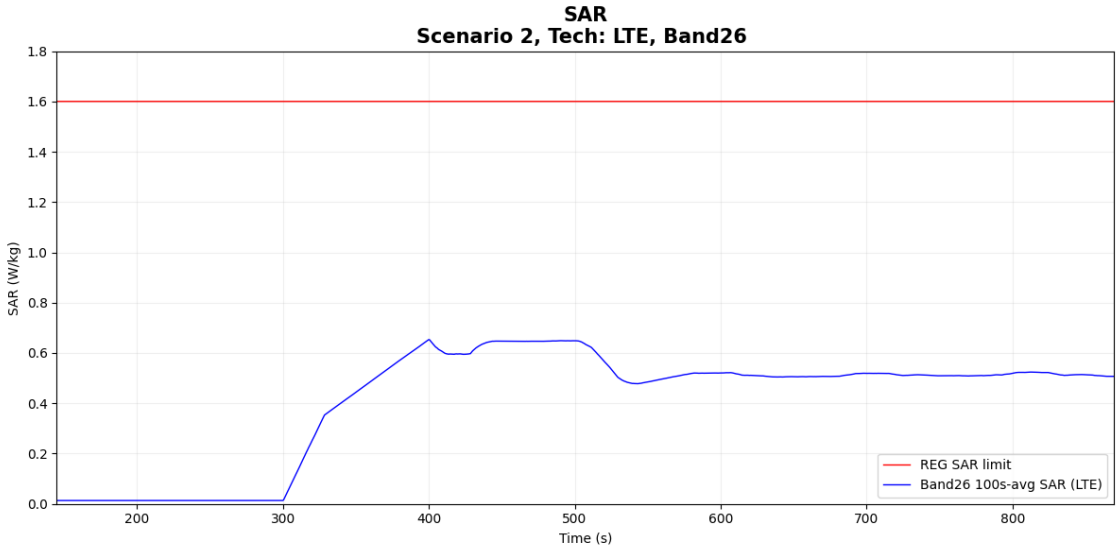


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 12: LTE B26 result for sequence 2**

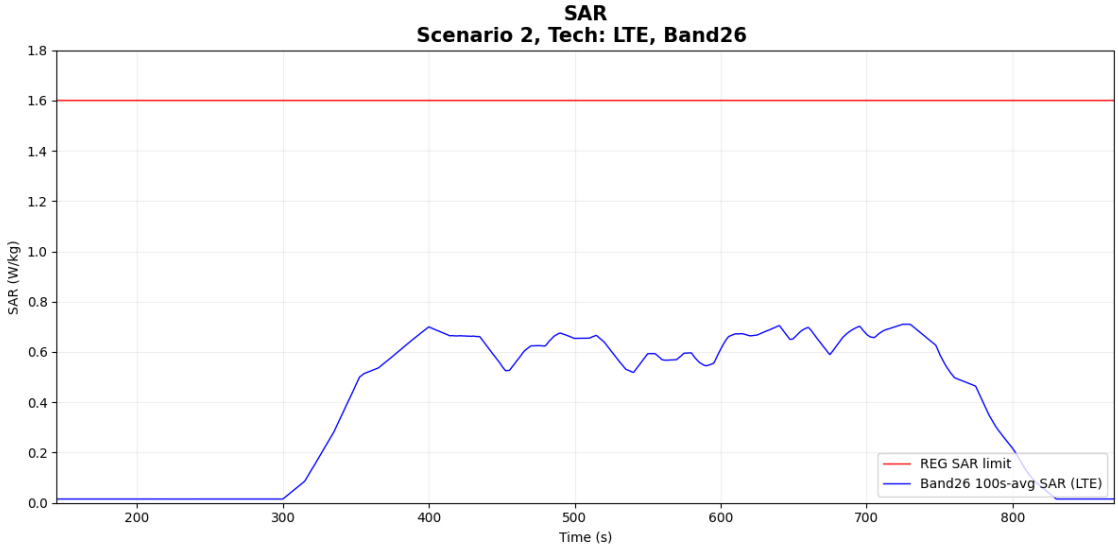


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 13: FR1 n26 result for sequence 1**

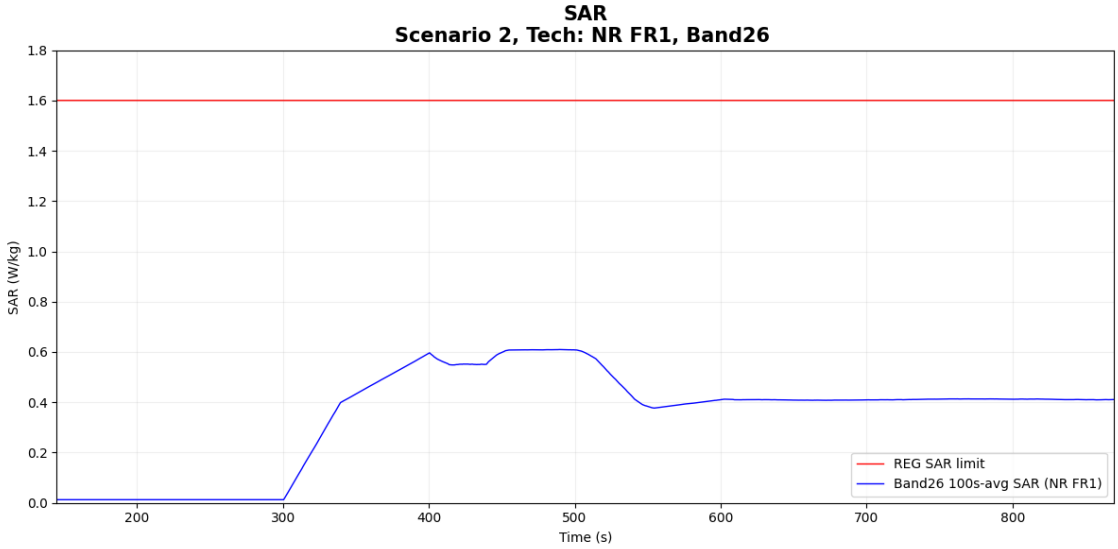


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 14: FR1 n26 result for sequence 2**

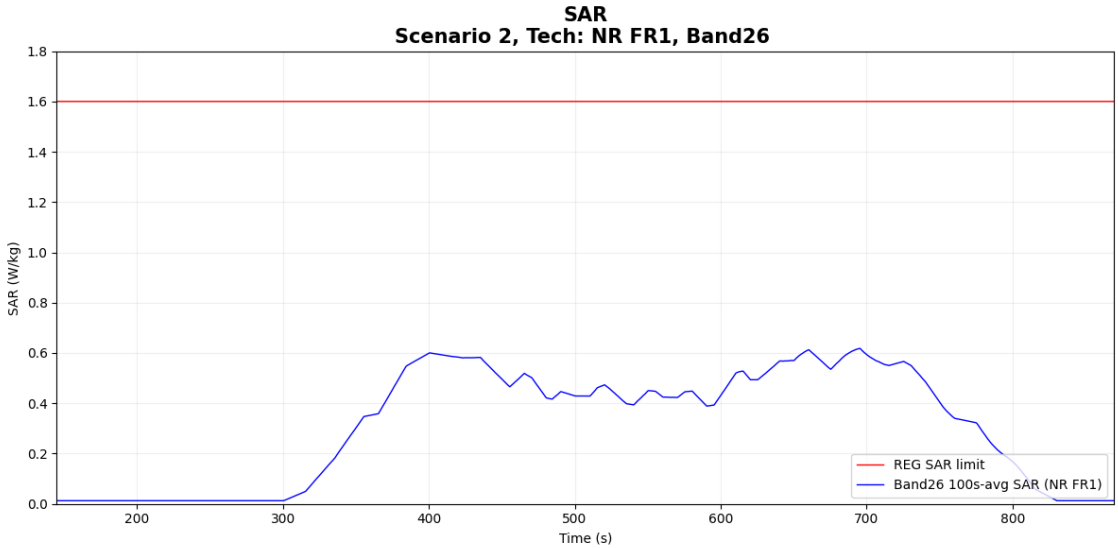


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 15: FR1 n77 result for sequence 1**

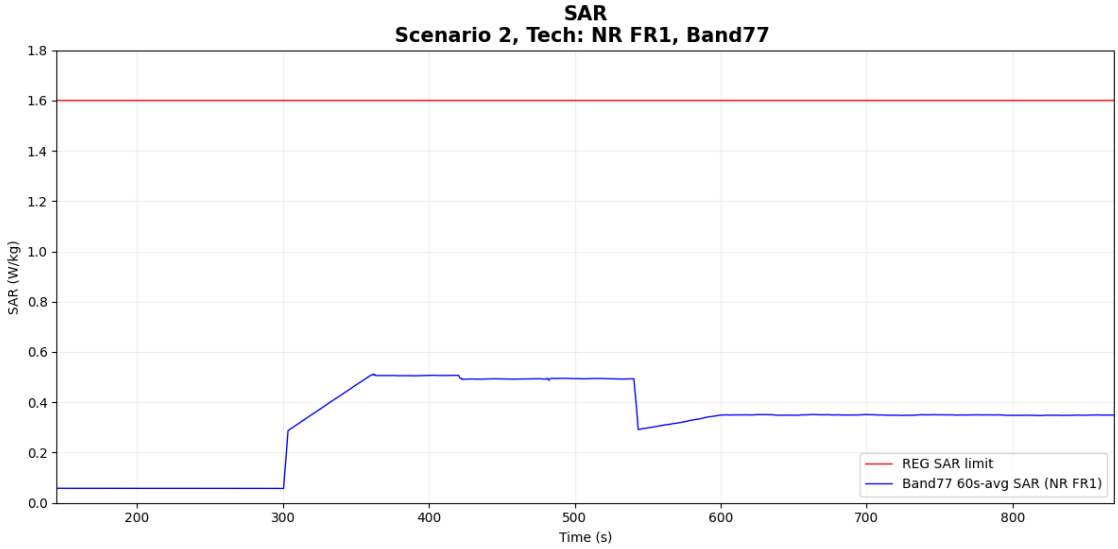


Figure of Time-averaged SAR

Validation result: pass

- **Test Case 16: FR1 n77 result for sequence 2**

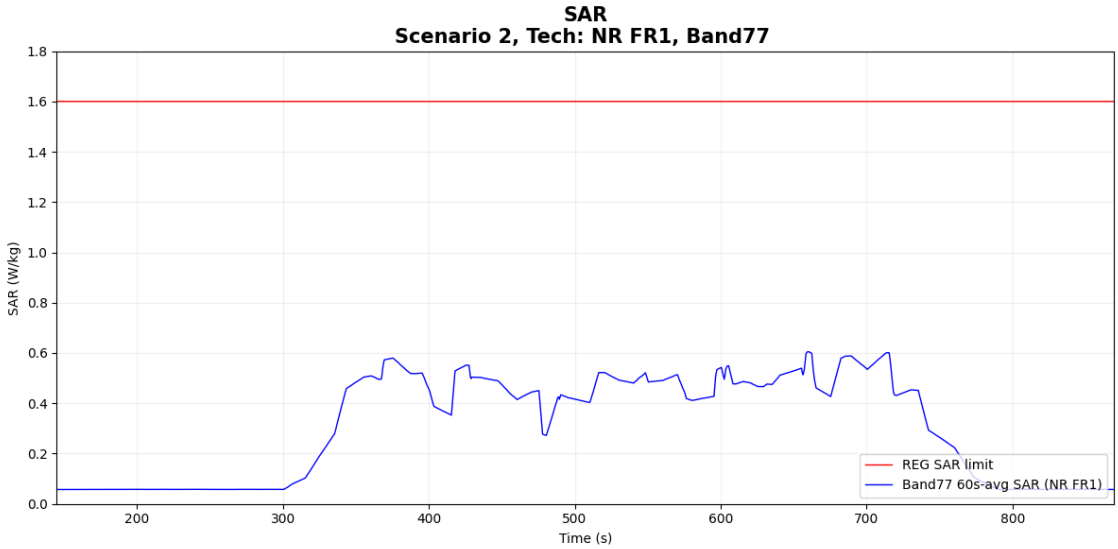


Figure of Time-averaged SAR

Validation result: pass

6. TA-SAR/TA-PD Joint Validation via Radiated Power Measurements

6.1 Measurement Setup

The schematic of measurement setup is shown in Figure below, where a Keysight UXM is used as signaling callbox to establish mmW and LTE links. For mmW path, the UXM callbox with two RF radio heads can generate mmW signals and in turn connect to two horn antennas for H- and V-polarizations to establish wireless phone call with a device in direct far field chamber. In order to capture and record the mmW time-varying power, a mmW coupler is used to provide a divided path from the radiated power by device to UXM callbox for Rohde & Schwarz NR50S power meter to measure power. The isolation of coupler should be considered for providing sufficient attenuation from the callbox signal to the power meter. For LTE path, the LTE port of callbox are connected to the RF port of device via a coupler to measure the conducted LTE time-varying power by using Rohde & Schwarz NR8S power meter. Furthermore, the ATE tool is installed in PC to control device by USB and control two power meters by GPIB. The path losses from device through direct far field chamber to power meter should be calibrated for power accuracy.

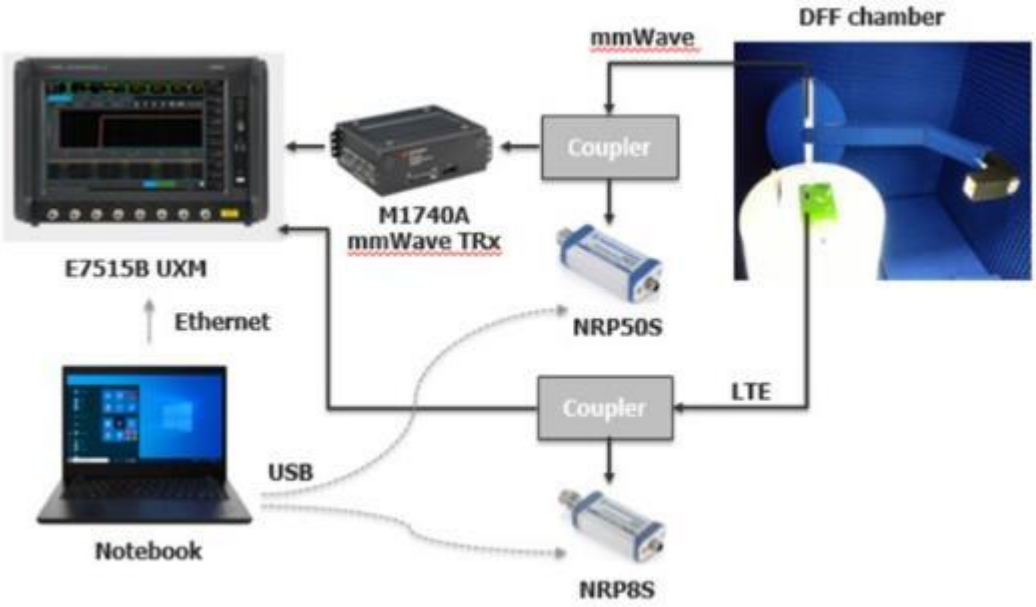


Figure of TA-PD radiated power measurement setup-1

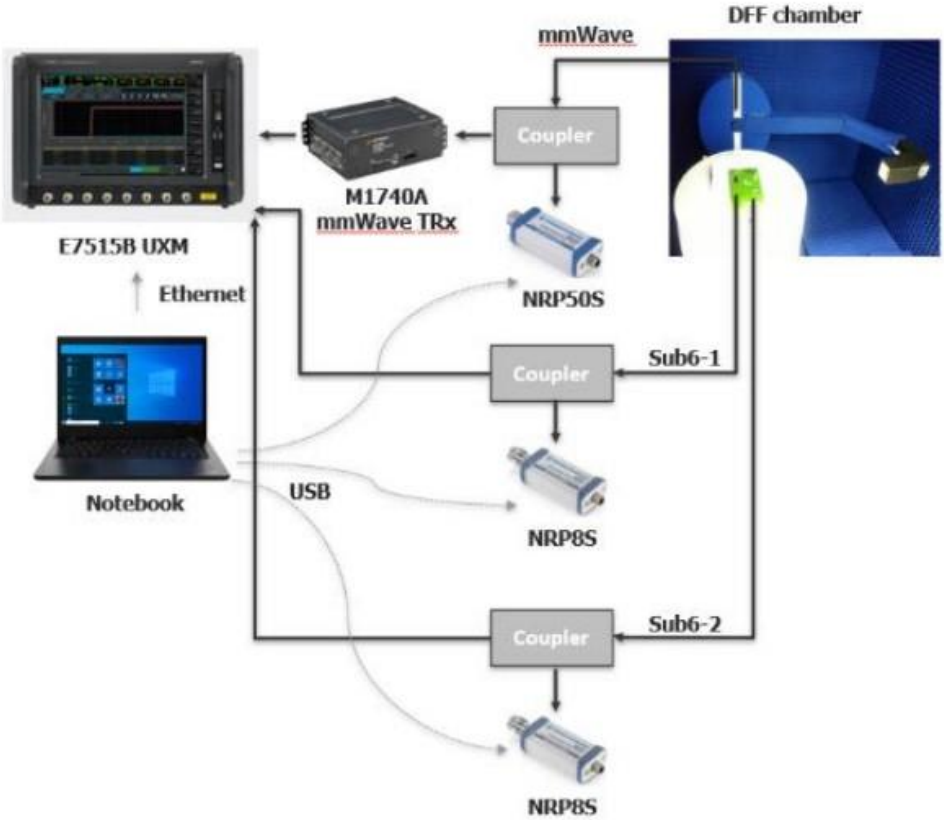


Figure of TA-PD radiated power measurement setup-2

6.1.1 mmWave Radiated Power Measurement

mmWave NR uses beamforming technology to enhance uplink performance, and each beam's EIRP is different. So, the power limit is beam dependent. To quantify PD in the following test scenarios, the scaling method proposed in Chapter 5 is used, that is, PD of a time instance is calculated from a reference worst-case 4cm^2 PD with a scaling factor based on the measured EIRP. It is noted that TA-PD is independent of the used antenna module and beams. Without loss of generality, module head-0 is selected and its two beams with the largest and smallest PD are selected as well to demonstrate the proposed TA-PD algorithm in the following test scenarios. Below is a summarized table for the two beams' EIRPs and corresponding PDs under their individual input power limit settings. It is noted that P_{FR2_limit} = input.power.limit + 10xlog10(N), where N is "Feed No." of each beam ID.

based on MTK TA-SAR/TA-PD algorithm document the selection criteria in Chapter 5, the selected test configurations for TA-SAR/TA-PD joint validation are descripted as below:

Table for FR2 TA-PD validation test case list

Test Case	Test Scenario	Test Configuration
1	1.Range of TA-PD Parameter	LTE B25 + n261 Plane B sub-module Beam 1
2	2.Time-varying TX power	LTE B25 + n258 Plane B sub-module Beam 24
3		LTE B25 + n260 Plane B sub-module Beam 19
4		LTE B25 + n261 Plane B sub-module Beam 1
5	5.Beam switching	n261 Plane B sub-module Beam 1 to Beam 25
6	6. SAR vs .PD exposure switching	FR1 n25 + n261 Plane B sub-module Beam 1
7	8. Multi-SPLSR-group vs. PD exposure switching	LTE B25 + FR1 n77 + FR2 n261 Plane B sub-module Beam 1

Table 6-1 Selections for LTE + mmW NR validation measurements

Test Case	Test Scenario	Test band	Ant	Beam ID	ECI	Channel	Freq (MHz)	Mode	Duty cycle	Position	at Input.power.limit (W/m2)
1	1.Range of TA-PD Parameter	LTE Band 25	Ant 0	-	6	26340	1880	QPSK/20M/50/0	100	Bottom Edge,5mm	-
		N261	Plane B sub-module	1	-	2077915	27924.96	DFT-QPSK/100M/66/0	100	Back (S2)_Visor,2mm	3.02
2	2.Time-varying TX power	LTE Band 25	Ant 0	-	6	26340	1880	QPSK/20M/50/0	100	Bottom Edge,5mm	-
		N258	Plane B sub-module	24	-	2043749	25875	DFT-QPSK/100M/66/0	100	Back (S2)_Visor,2mm	2.34
3		LTE Band 25	Ant 0	-	6	26340	1880	QPSK/20M/50/0	100	Bottom Edge,5mm	-
		N260	Plane B sub-module	19	-	2254165	38499.96	DFT-QPSK/100M/66/0	100	Back (S2)_Visor,2mm	2.17
4		LTE Band 25	Ant 0	-	6	26340	1880	QPSK/20M/50/0	100	Bottom Edge,5mm	-
		N261	Plane B sub-module	1	-	2077915	27924.96	DFT-QPSK/100M/66/0	100	Back (S2)_Visor,2mm	3.02
5	5.Beam switching	LTE Band 25	Ant 0	-	6	26340	1880	QPSK/20M/50/0	100	Bottom Edge,5mm	-
		N261	Plane B sub-module	1	-	2077915	27924.96	DFT-QPSK/100M/66/0	100	Back (S2)_Visor,2mm	3.02
		N261	Plane B sub-module	25	-	2077915	27924.96	DFT-QPSK/100M/66/0	100	Back (S2)_Visor,2mm	2.17
6	6.SAR vs. PD exposure switching	NR5R Band 25	Ant 0	-	6	376500	1882.5	BPSK/40M/108/0	100	Bottom Edge,5mm	-
		N261	Plane B sub-module	1	-	2077915	27924.96	DFT-QPSK/100M/66/0	100	Back (S2)_Visor,2mm	3.02
7	8.Multi-SPLSR group vs PD exposure switching	LTE Band 25	Ant 0	-	6	26340	1880	QPSK/20M/50/0	100	Bottom Edge,5mm	-
		NR5G n77	Ant 7	-	6	633332	3499.98	BPSK/100M1/137	100	Right Edge,5mm	-
		N261	Plane B sub-module	1	-	2077915	27924.96	DFT-QPSK/100M/66/0	100	Back (S2)_Visor,2mm	3.02

Table 6-2 Measured *Plimit* and *Pmax* of selected radio configuration

Test case	LTE Band	Test band	ECI	Pmax Setting (dBm)	Plimit setting (dBm)	Measurement Pmax (dBm)	Measurement Plimit (dBm)	PEU_max_cust (dBm)	PEU_backoff (dBm)
-	LTE	Band 25	6	24.00	13.10	23.95	12.84	10	3
-	NR5G	n25	6	24.00	14.30	23.56	14.10	10	3
-	NR5G	n77	6	23.60	14.10	22.91	13.36	10	3
Test case	**Test Scenario**	**Test band**	**Test seq.**	**Beam ID**	**Input Power limit (dBm)**	**PEU_max_cust (dBm)**	**PEU_backoff (dBm)**		
1	1.Range of TA-PD Parameter	N261	0	1	-2.34	1.5	1.5		
2	2.Time-varying TX power	N258	0	24	-1.13	1.5	1.5		
3		N260	0	19	0.57	1.5	1.5		
4		N261	0	1	-2.34	1.5	1.5		
5	5.Beam switching	N261	0	1	-2.34	1.5	1.5		
		N261	0	25	-2.50	1.5	1.5		
6	6.SAR vs.PD exposure switching	N261	0	1	-2.34	1.5	1.5		
7	8.Multi-SPLSR group vs PD exposure switching	N261	0	1	-2.34	1.5	1.5		

6.2 Radiated Power Measurement Results for Scenario 1: Range of TA-PD Parameters

In this scenario, two TA-PD parameters are swept to validate Mediatek's TA-PD algorithm. The parameter settings for mmW NR and anchor LTE are summarized in Tables 6-2, and the test procedure follows MTK TA-SAR/TA-PD algorithm document. The high-level summary of the final validation results is given in the last column of the table, which concludes that Mediatek's TA-PD algorithm can maintain TER below the limit for all test cases.

- **Test Case 1: Range of TA-PD Parameter Result for LTE B25 + n261**

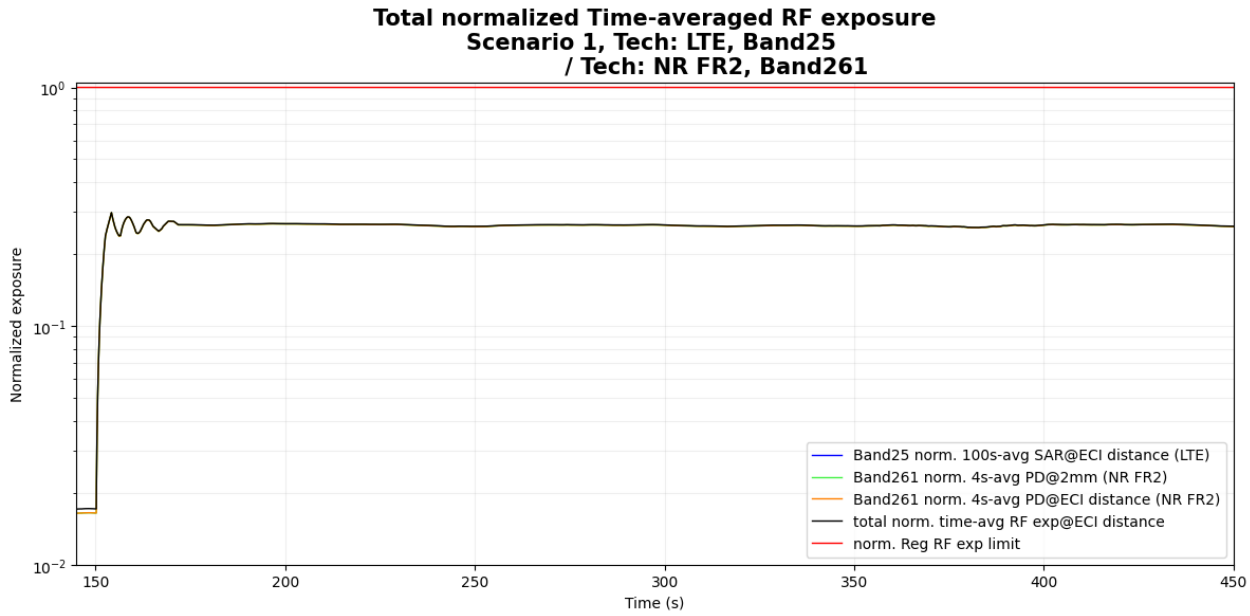


Figure of Total Normalized Time-averaged RF exposure

limit of total RF exposure (normalized)	1.0
Max total normalized time-averaged RF exposure	0.299
Validation result: pass	

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

In this scenario, Mediatek's TA-SAR/TA-PD algorithm is tested under more dynamic power test sequences. The parameter settings for mmW NR and anchor LTE are summarized in Tables 6-2, and the test procedure follows MTK TA-SAR/TA-PD algorithm document. 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/TA-PD algorithm can maintain TER below the limit for all test cases.

- **Test Case 2: Time-Varying TX Power Result for LTE B25 + n258**

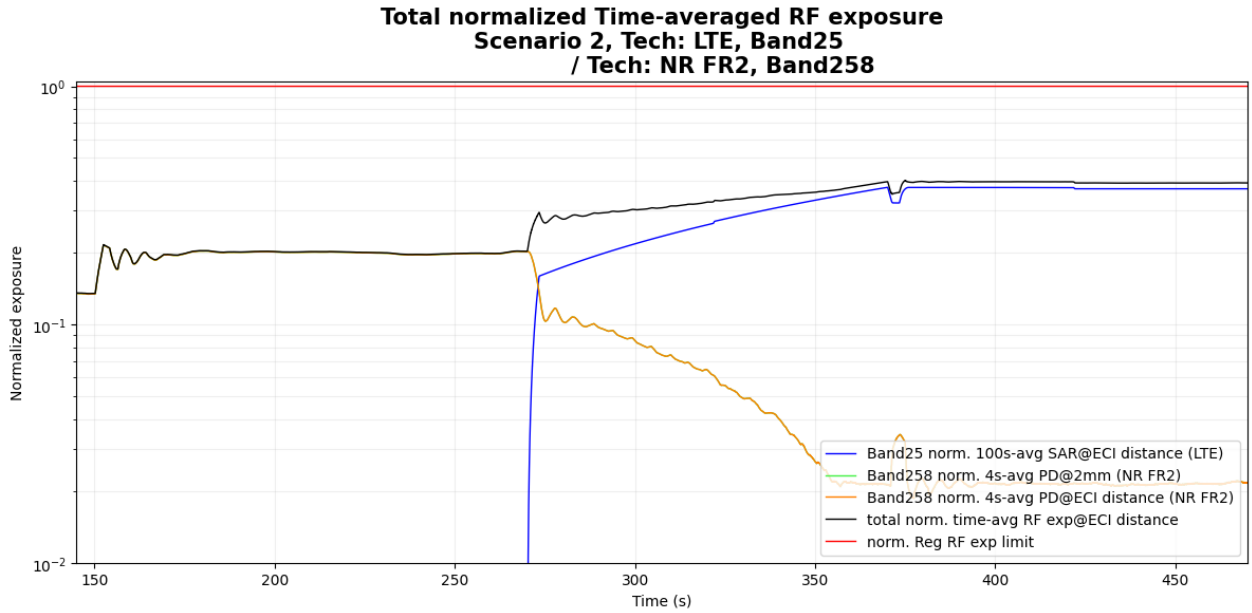


Figure of Total Normalized Time-averaged RF exposure

limit of total RF exposure (normalized)	1.0
Max total normalized time-averaged RF exposure	0.403
Validation result: pass	

- **Test Case 3: Time-Varying TX Power Result for LTE B25 + n260**

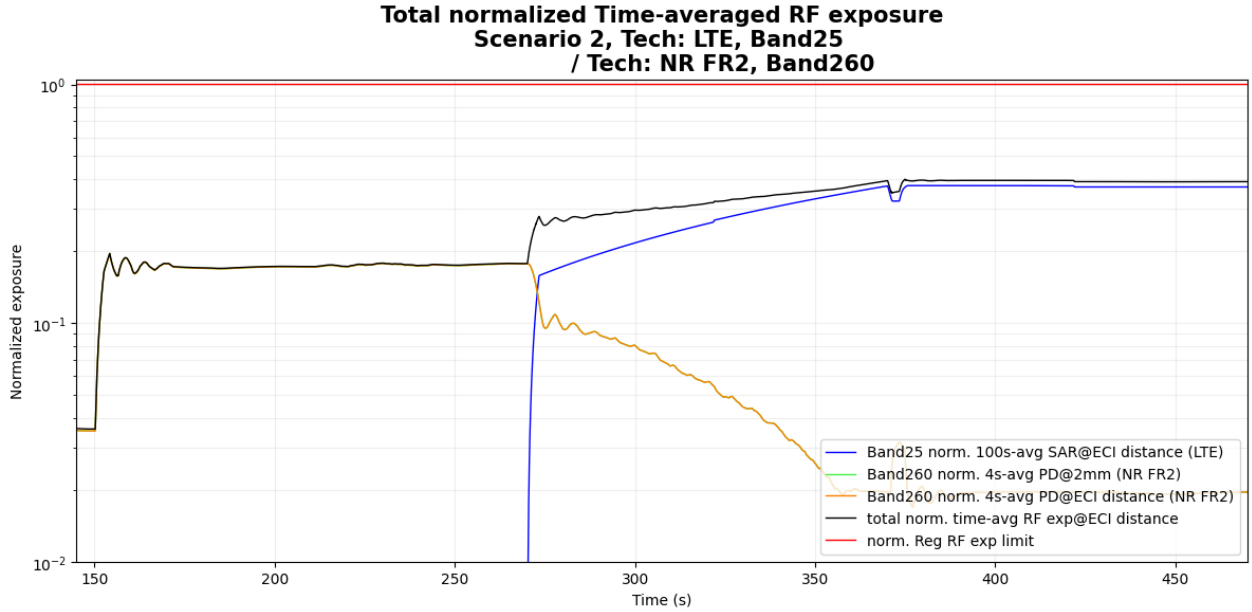


Figure of Total Normalized Time-averaged RF exposure

limit of total RF exposure (normalized)	1.0
Max total normalized time-averaged RF exposure	0.400
Validation result: pass	

- **Test Case 4: Time-Varying TX Power Result for LTE B25 + n261**

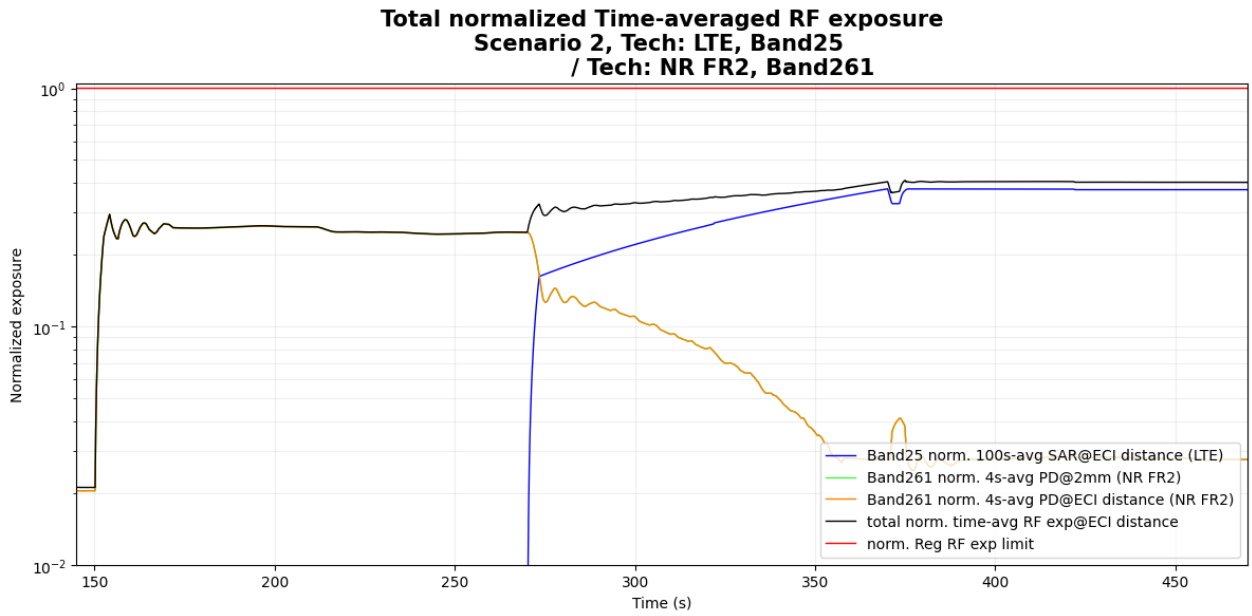


Figure of Total Normalized Time-averaged RF exposure

limit of total RF exposure (normalized)	1.0
Max total normalized time-averaged RF exposure	0.410
Validation result: pass	

6.4 Radiated Power Measurement Results for Scenario 5: Beam Switching

In this scenario, the test power sequence #0 (i.e., maximum TX power is requested by a call box) is used, and the beam is manually changed after pre-defined period. The parameter settings for mmW NR and anchor LTE are summarized in Tables 6-2, and the test procedure follows MTK TA-SAR/TA-PD algorithm document. The high-level summary of the final validation results is given in the last column of the table, which concludes that Mediatek's TA-PD algorithm can maintain TER power below the limit for all test cases.

- **Test Case 5: Beam Switch result for LTE B25 + n261**

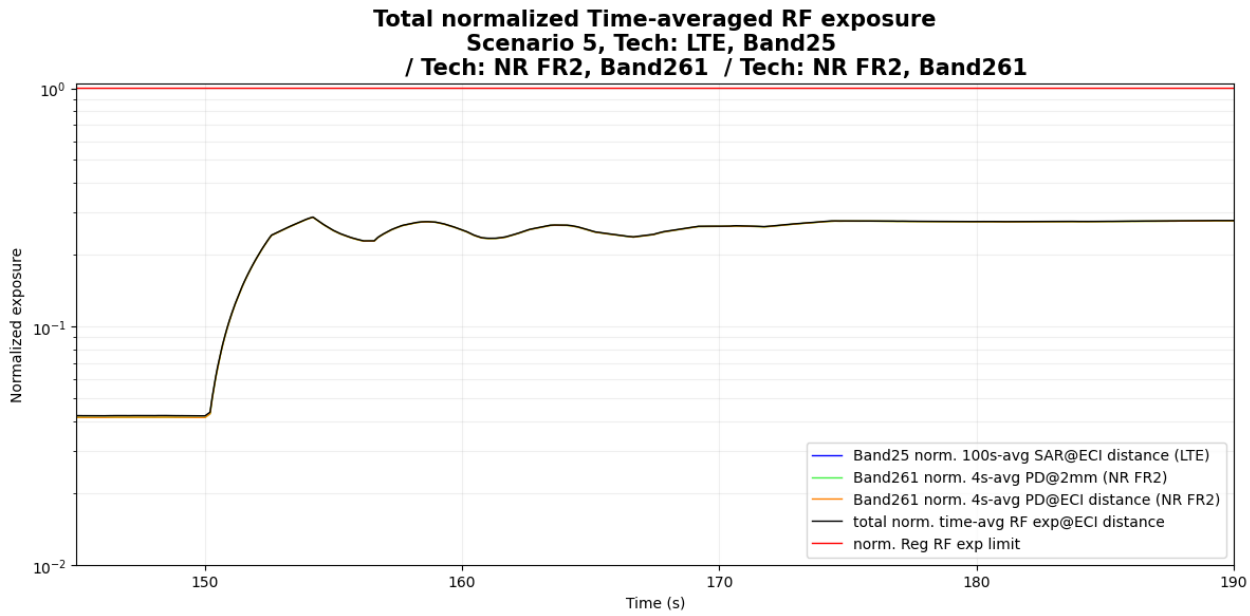


Figure of Total Normalized Time-averaged RF exposure

limit of total RF exposure (normalized)	1.0
Max total normalized time-averaged RF exposure	0.288
Validation result: pass	

6.5 Radiated Power Measurement Results for Scenario 6: SAR vs. PD Exposure Switching

In this scenario, the test power sequence #0 (i.e., maximum TX power is requested by a call box) is used for mmWave, and during the test the LTE TX power level is alternated to be maximum and minimum at specific time instances. The parameter settings for mmW NR and anchor LTE are summarized in Tables 6-2, and the test procedure follows MTK TA-SAR/TA-PD algorithm document 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/TA-PD algorithm can maintain TER below the limit for all test cases.

- **Test Case 6: SAR vs.PD exposure switching result for FR1 n25 + n261**

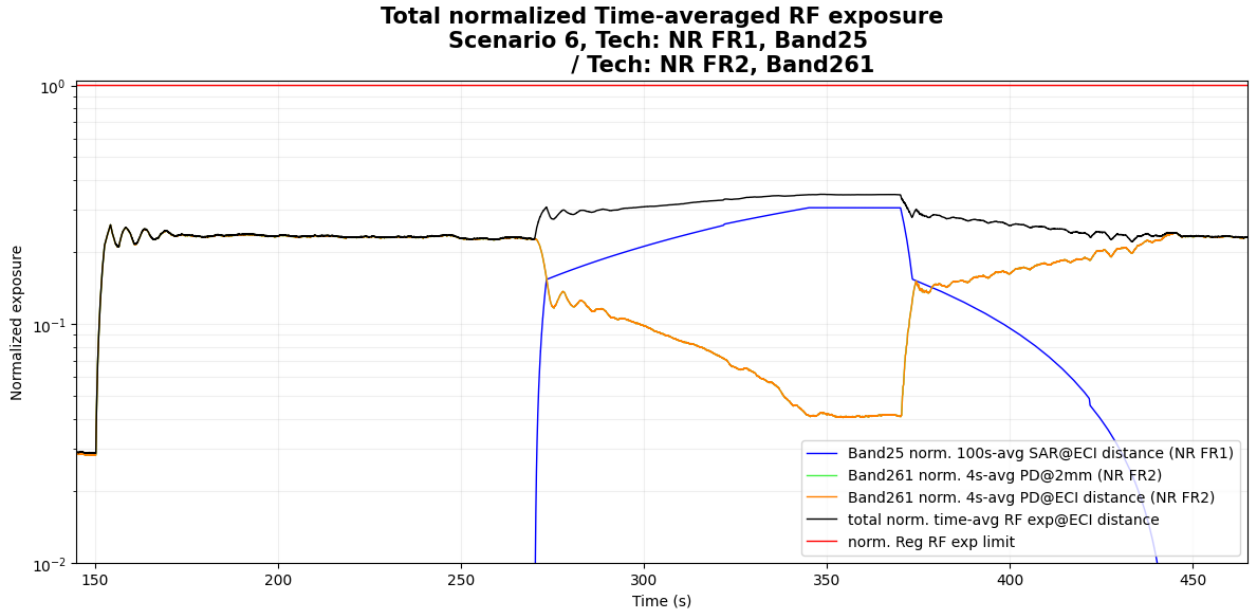


Figure of Total Normalized Time-averaged RF exposure

limit of total RF exposure (normalized)	1.0
Max total normalized time-averaged RF exposure	0.350
Validation result: pass	

6.6 Radiated Power Measurement Results for Scenario 8: Multi-SPLSR-group vs. PD Exposure Switching

In this scenario, the test power sequence #0 (i.e., maximum TX power is requested by a call box), and during the test SPLSR_group 0/1 TX power level is alternated to be maximum and minimum at specific time instances. The parameter settings for mmW NR and anchor SPLSR_group 0/1 are summarized in Table 6-2, and the test procedure follows MTK TA-SAR/TA-PD algorithm documen section 5.9.2. 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/TA-PD Gen2 algorithm can maintain TER below the limit for all test cases.

- **Test Case 7: Multi-SPLSR-group vs. PD Exposure Switching result for LTE B25 + FR1 n77 + n261**

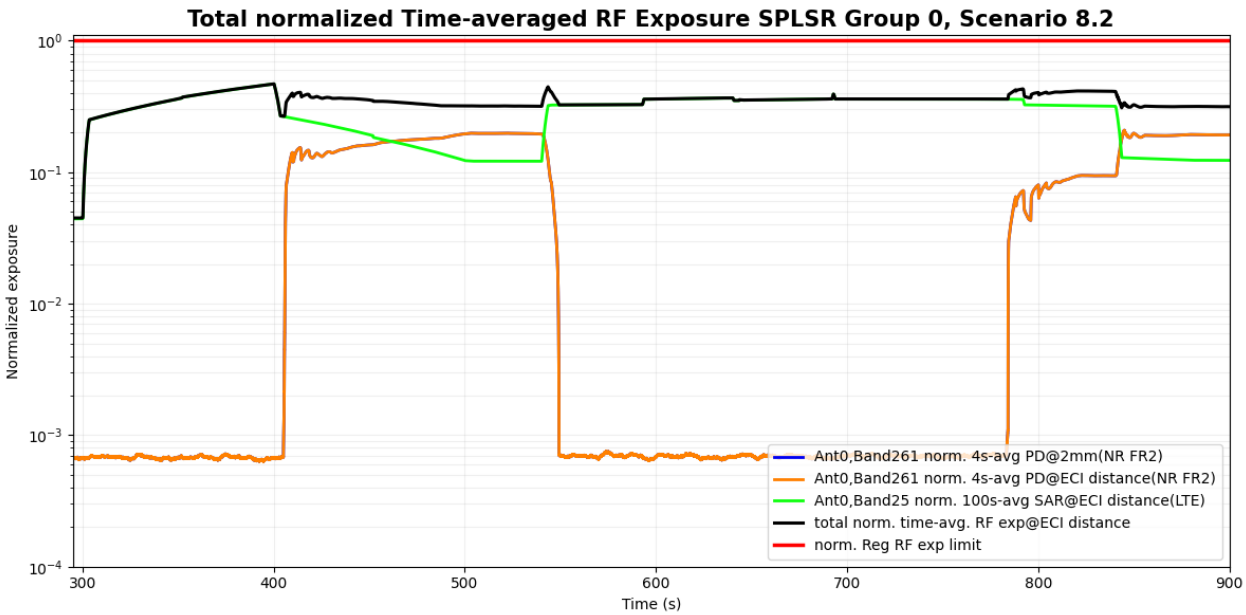


Figure of Total Normalized Time-averaged RF exposure for SPLSR Group 0

limit of total RF exposure (normalized)	1.0
Max total normalized time-averaged RF exposure	0.470
Validation result: pass	

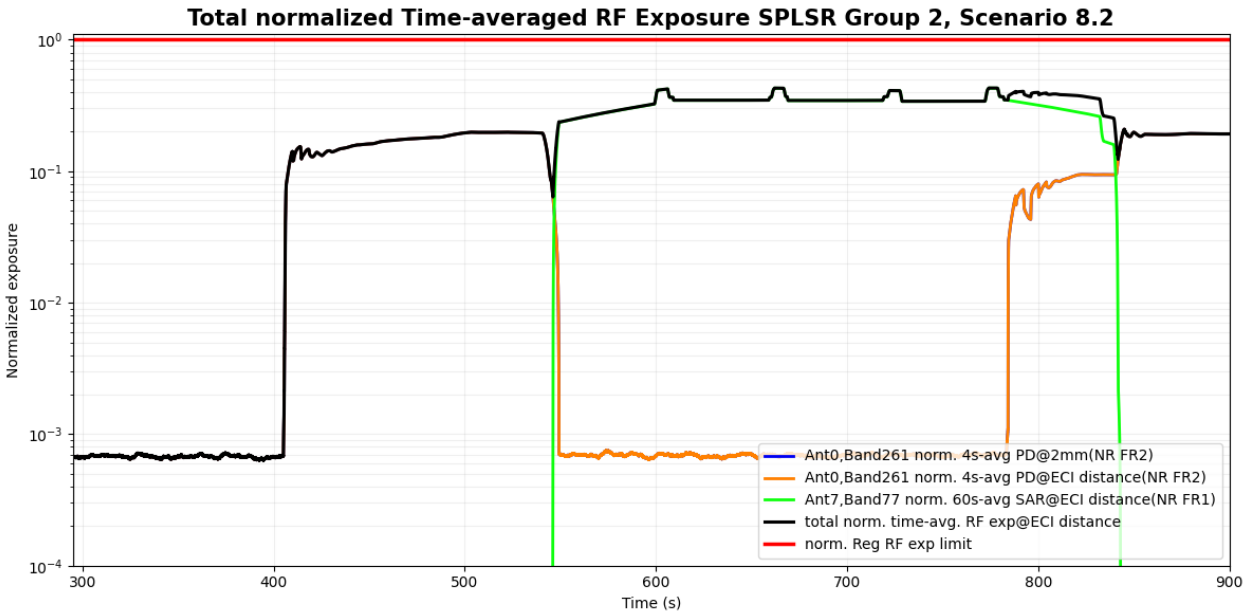


Figure of Total Normalized Time-averaged RF exposure for SPLSR Group 1

FCC limit of total RF exposure (normalized)	1.0
Max total normalized time-averaged RF exposure	0.429
Validation result: pass	

7. TA-SAR/TA-PD Joint Validation via PD Measurements

7.1 Measurement Setup

In this section, the near-field measurements are conducted in an FCC certified lab (i.e., SPORTON), and the measurement setup is shown below. The call box Keysight UXM is connected to the PC using Ethernet interface and its LTE connection port is connected to the EUT's LTE antenna port. The power meter is connected to the PC by a USB interface for LTE power measurement. Mediatek's automation tool is used to control the EUT and call box to establish an ENDC link (LTE+mmWave) and at the same time the power meter is triggered to record LTE conducted power. Based on a test sequence defined in section 5.1, once the mmWave link is established, LTE TX power of the EUT is set at -17dBm for a predefined period and then set to be max power level by using "all-up bits" command of the call box. During the whole test period, the mmWave TX power of the EUT is always requested to be maximum all the time.

Time-averaged E-field measurements are performed by using a EUmmWV3 mmWave probe at the peak location of fast area scan. The first step for this test is a reference single-point power density ($PD_{sp,ref}$) measurement by DASY6, in which the EUT transmits at a static power level with the selected beam, whose input power is set at its *input.power.limit*. Once the TA-PD algorithm is enabled, DASY6 records the relative single-point PD over time ($PD_{sp,relative}(t)$) with respect to $PD_{sp,ref}$ during the user specified time interval. As a result, the time-averaging PD is derived based on $PD(t)=PD_{sp,relative}(t) \times PD_design_target$, where PD_design_target is the 4cm^2 PD of the selected beam under its *input.power.limit*. The spec of the EUmmWV3 probe and how DASY6 converts the E-field measurement to PD are detailed in Appendix C.

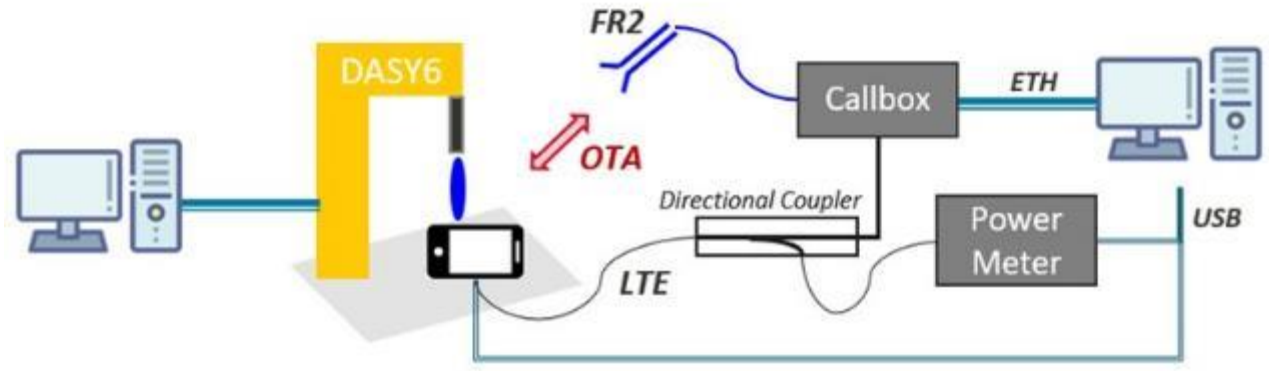


Figure of TA-PD near-field measurement setup diagram

7.2 PD Measurement Results for Scenario 2: Time-Varying TX Power

In this scenario, Mediatek's TA-SAR/TA-PD algorithm is tested under more dynamic power test sequences. The parameter settings for mmW NR and anchor LTE are summarized in Tables 6-2 and the test procedure follows MTK TA-SAR/TA-PD algorithm document. 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/TA-PD algorithm can maintain TER below the FCC limit for all test cases.

The following figure illustrates the normalized time-averaged exposures for LTE (1gSAR), mmW ($4cm^2$PD), as well as total normalized time-averaged exposure over time converted from the measured conducted TX power and measured E-field by using the equation listed in MTK TA-SAR/TA-PD algorithm document.

- **Test Case 1: Time-varying TX power for n258**

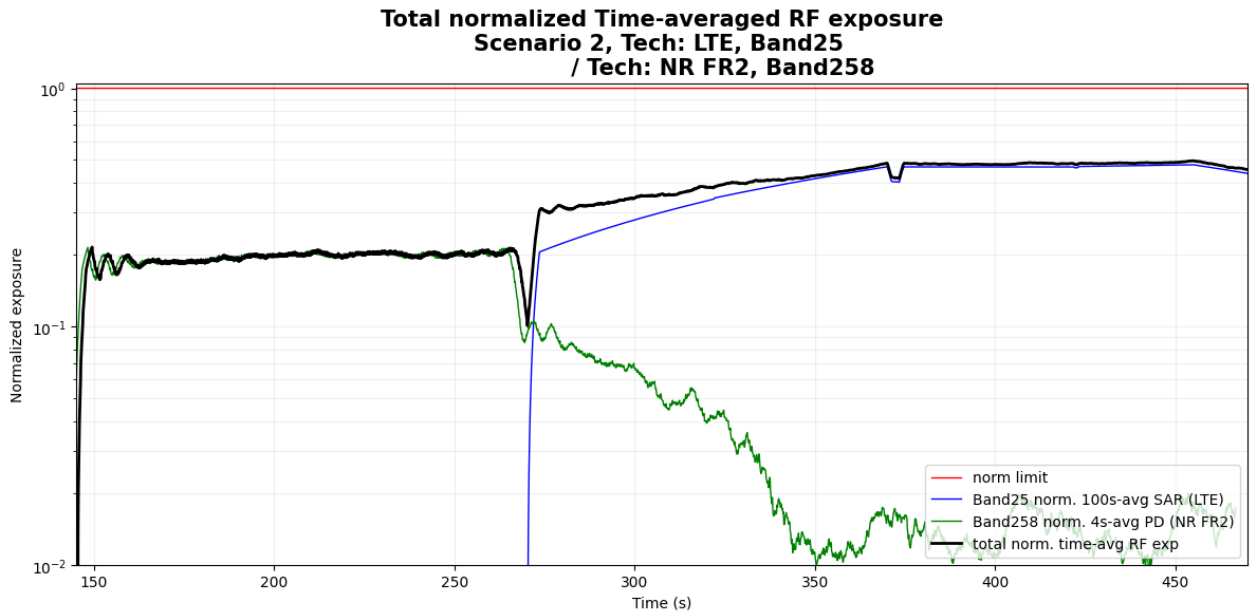


Figure of Total Normalized Time-averaged RF exposure

limit of total RF exposure (normalized)	1.0
Max total normalized time-averaged RF exposure	0.497
Validation result: pass	

- **Test Case 2: Time-varying TX power for n260**

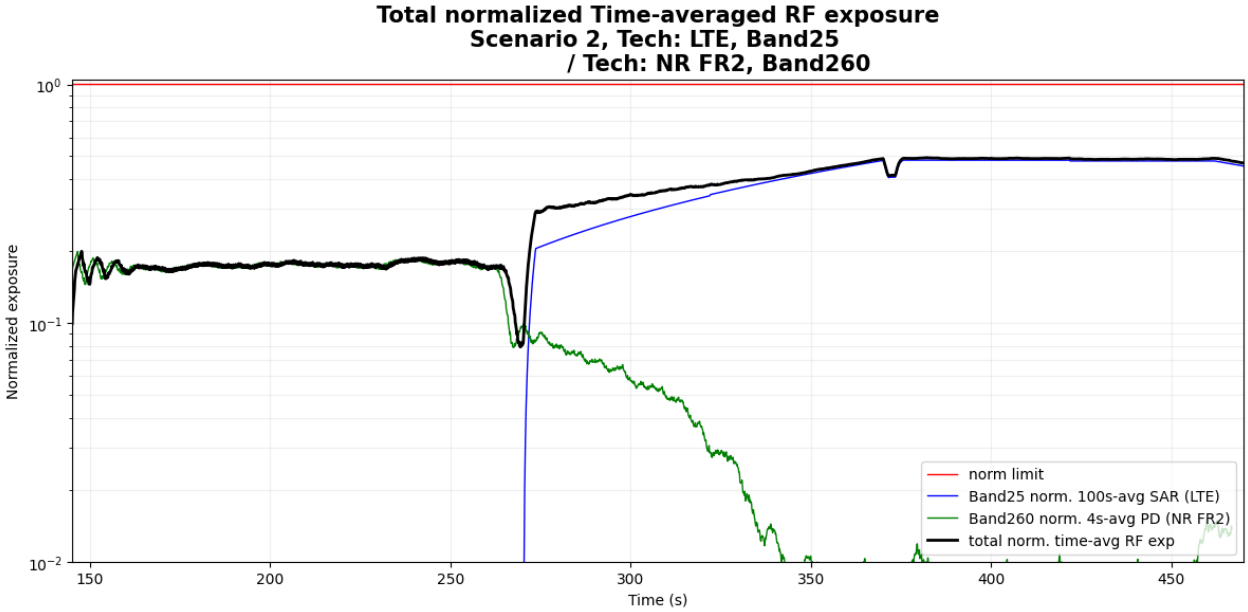


Figure of Total Normalized Time-averaged RF exposure

limit of total RF exposure (normalized)	1.0
Max total normalized time-averaged RF exposure	0.493
Validation result: pass	

- **Test Case 3: Time-varying TX power for n261**

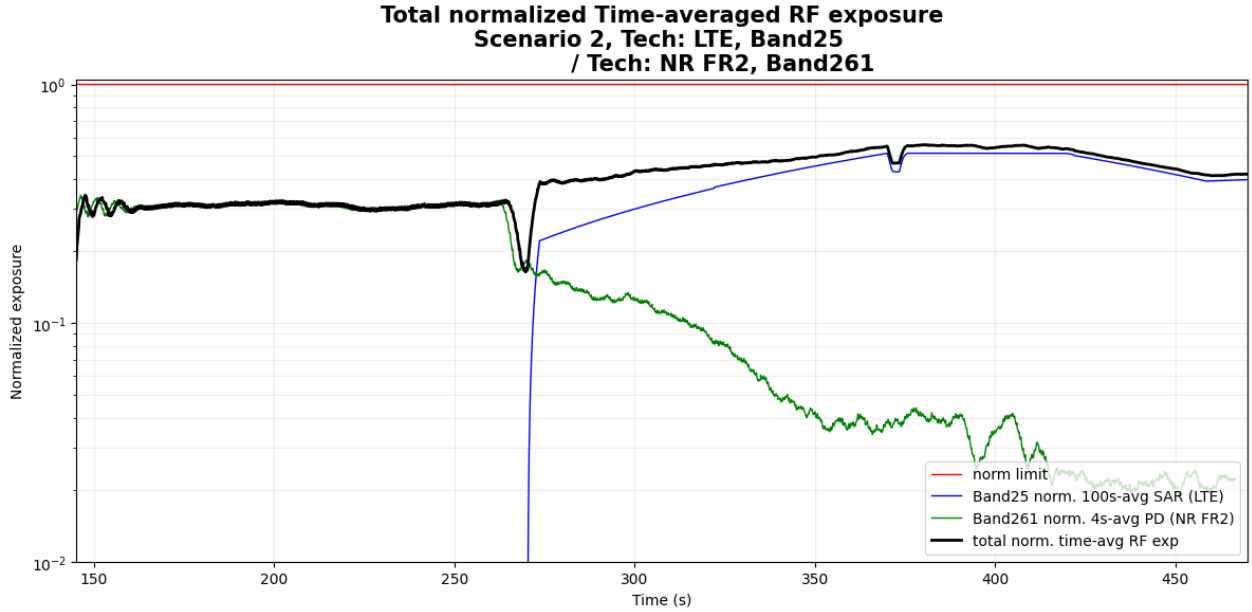


Figure of Total Normalized Time-averaged RF exposure

limit of total RF exposure (normalized)	1.0
Max total normalized time-averaged RF exposure	0.589
Validation result: pass	

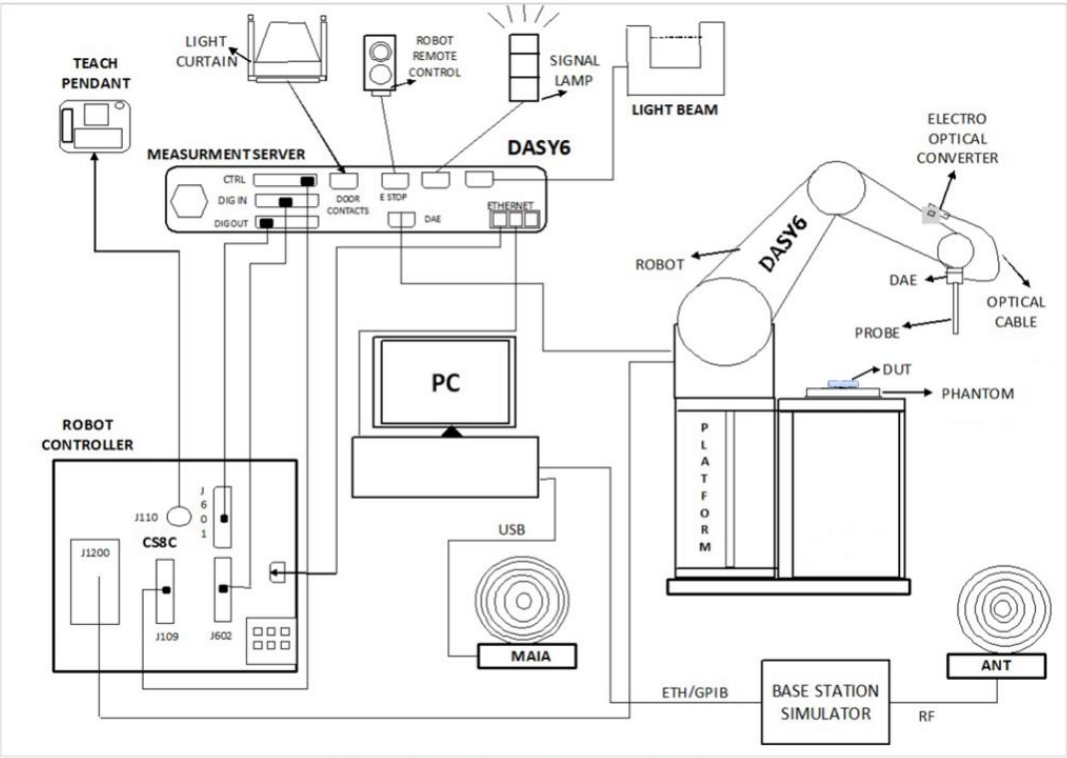
8. Conclusions

This document proposes TA-SAR and TA-PD test scenarios and procedures, and further proves Mediatek's TA-SAR and TA-PD algorithms can meet the FCC SAR and PD regulations with the proposed test scenarios and procedures. As shown in section4 and section 6, Mediatek's TA-SAR and TA-PD algorithms are able to maintain SAR and PD over time below the FCC regulatory limits (based on the agreed TX-power-to-SAR/PD translation). Furthermore, the near-field measurements results shown in section 5 and section 7 demonstrate that Mediatek's TA-SAR and TA-PD algorithms really can maintain SAR and PD over time below the FCC regulatory limits under the proposed test procedures. Based on the provided measurement evidences, it is concluded that Mediatek's TA-SAR and TA-PD algorithms can be tested by using the proposed test methodology for compliance.

9. cDASY6 System Verification

9.1 The system to be used for the near field power density measurement

- SPEAG DASY6 system
- SPEAG cDASY6 5G module software
- EUmmWVx probe
- 5G Phantom cover



9.2 Test Side Location

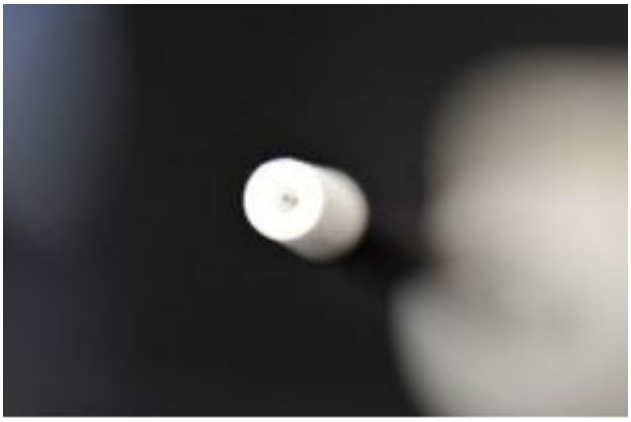
Sporton Lab and below test site location are accredited to ISO 17025 by Taiwan Accreditation Foundation (TAF code: 3786). The ISED Assigned Code is 4086H

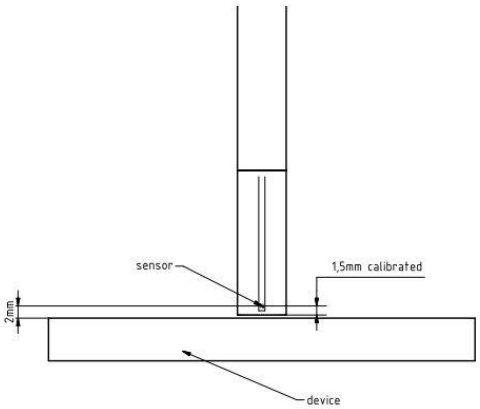
Test Site	SPORTON INTERNATIONAL INC. Wensan Laboratory	
Test Site Location	4086H No.58, Aly. 75, Ln. 564, Wenhua 3rd, Rd., Guishan Dist., Taoyuan City 333010, Taiwan	
Test Site No.	SAR-5GNR01-HY	SAR-5GNR02-HY

9.3 EUmmWave Probe

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

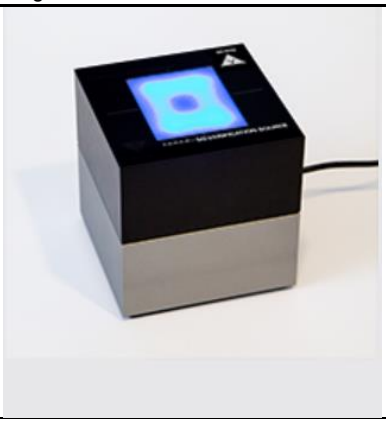
Frequency	750 MHz – 110 GHz
Probe Overall Length	320 mm
Probe Body Diameter	8.0 mm
Tip Length	23.0 mm
Tip Diameter	8.0 mm
Probe's two dipoles length	0.9 mm – Diode loaded
Dynamic Range	< 20 V/m - 10000 V/m with PRE-10 (min < 50 V/m - 3000 V/m)
Position Precision	< 0.2 mm
Distance between diode sensors and probe's tip	1.5 mm
Minimum Mechanical separation between probe tip and a Surface	0.5 mm
Applications	E-field measurements of 5G devices and other mm-wave transmitters operating above 10GHz in < 2 mm distance from device (free-space) Power density, H-field and far-field analysis using total field reconstruction.
Compatibility	cDASY6 + 5G-Module SW1.0 and higher





9.4 EUmmWave Verification source

Model	Ka-band horn antenna
Calibrated frequency:	30 GHz at 10mm from the case surface
Frequency accuracy	± 100 MHz
E-field polarization	linear
Harmonics	-20 dBc
Total radiated power	14 dBm
Power stability	0.05 dB
Power consumption	5 W
Size	100 x 100 x 100 mm
Weight	1 kg

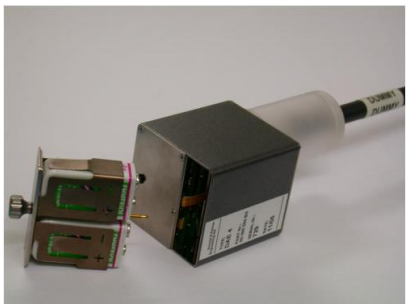


9.5 SAR E-Field Probe

Construction	Symmetric design with triangular core Built-in shielding against static charges PEEK enclosure material (resistant to organic solvents, e.g., DGBE)
Frequency	10 MHz – >6 GHz Linearity: ±0.2 dB (30 MHz – 6 GHz)
Directivity	±0.3 dB in TSL (rotation around probe axis) ±0.5 dB in TSL (rotation normal to probe axis)
Dynamic Range	10 µW/g – >100 mW/g Linearity: ±0.2 dB (noise: typically <1 µW/g)
Dimensions	Overall length: 337 mm (tip: 20 mm) Tip diameter: 2.5 mm (body: 12 mm) Typical distance from probe tip to dipole centers: 1 mm

9.6 Data Acquisition Electronics (DAE)

The data acquisition electronics (DAE) consists of a highly sensitive electrometer-grade preamplifier with auto-zeroing, a channel and gain-switching multiplexer, a fast 16 bit AD-converter and a command decoder and control logic unit. Transmission to the measurement server is accomplished through an optical downlink for data and status information as well as an optical uplink for commands and the clock.
The input impedance of the DAE is 200 MOhm; the inputs are symmetrical and floating. Common mode rejection is above 80 dB.



10. Test Equipment List

Manufacturer	Name of Equipment	Type/Model	Serial Number	Calibration	
				Last Cal.	Due Date
SPEAG	835MHz System Validation Kit(2)	D835V2	4d060	Feb. 17, 2025	Feb. 15, 2027
SPEAG	1900MHz System Validation Kit	D1900V2	5d185	Jun. 11, 2025	Jun. 10, 2026
SPEAG	3500MHz System Validation Kit(2)	D3500V2	1014	Jan. 15, 2025	Jan. 13, 2027
SPEAG	5G Verification Source	30GHz	1009	May. 14, 2025	May. 13, 2026
SPEAG	Data Acquisition Electronics	DAE4	1707	Nov. 20, 2025	Nov. 19, 2026
SPEAG	Data Acquisition Electronics	DAE4	1776	Feb. 13, 2026	Feb. 12, 2027
SPEAG	Data Acquisition Electronics	DAE4	699	Feb. 13, 2026	Feb. 12, 2027
SPEAG	Dosimetric E-Field Probe	EX3DV4	3728	Mar. 26, 2026	Mar. 25, 2027
SPEAG	Dosimetric E-Field Probe	EX3DV4	7785	Nov. 26, 2025	Nov. 25, 2026
SPEAG	Dosimetric E-Field Probe	EX3DV4	7814	Jun. 19, 2025	Jun. 18, 2026
SPEAG	EUmmWV Probe Tip Protection	EUmmWV4	9461	Oct. 15, 2025	Oct. 14, 2026
Testo	Hygro meter	608-H1	45196600	Nov. 04, 2025	Nov. 03, 2026
Keysight	5G Wireless Test Platform	E7515B	MY58300712	Sep. 09, 2025	Sep. 08, 2026
R&S	Wideband Radio Communication Tester	CMW500	115793	Nov. 26, 2025	Nov. 25, 2026
SPEAG	Device Holder	N/A	N/A	N/A	N/A
Anritsu	Signal Generator	MG3710A	6201502524	Sep. 24, 2025	Sep. 23, 2026
Keysight	ENA Network Analyzer	E5071C	MY46104758	Oct. 14, 2025	Oct. 13, 2026
SPEAG	Dielectric Probe Kit	DAK-3.5	1126	Sep. 16, 2025	Sep. 15, 2026
LINE SEIKI	Digital Thermometer	DTM3000-spezial	3690	Aug. 14, 2025	Aug. 13, 2026
R&S	Power Sensor	NRP8S	109688	Sep. 15, 2025	Sep. 14, 2026
R&S	Power Sensor	NRP8S	103999	Jan. 06, 2025	Jan. 05, 2027
Anritsu	Power Meter	ML2496A	2119003	Jul. 14, 2025	Jul. 13, 2026
Anritsu	Power Sensor	MA2411B	1726150	Aug. 18, 2025	Aug. 17, 2026
Anritsu	Spectrum Analyzer	MS2830A	6201396378	Jul. 09, 2025	Jul. 08, 2026
Mini-Circuits	Power Amplifier	ZVE-3W-83+	1651	Dec. 24, 2025	Dec. 23, 2026
Bojay	mmwave measurement horn antenna	AQRH-15	23	Note 1	
Warison	10-50 GHz Directional Coupler	WCOU-10-50S-10	WR889BMC481	Note 1	
ATM	500M-18GHz Dual Directional Coupler	C122H-10	P610410z-02	Note 1	
Woken	Attenuator 1	WK0602-XX	N/A	Note 1	
Woken	Attenuator 2	PE7005-10	N/A	Note 1	
Woken	Attenuator 3	PE7005- 3	N/A	Note 1	

General Note:

1. Prior to system verification and validation, the path loss from the signal generator to the system check source and the power meter, which includes the amplifier, cable, attenuator and directional coupler, was measured by the network analyzer. The reading of the power meter was offset by the path loss difference between the path to the power meter and the path to the system check source to monitor the actual power level fed to the system check source.
2. The dipole calibration interval can be extended to 3 years with justification. The dipoles are also not physically damaged, or repaired during the interval. The justification data in appendix B can be found which the return loss is < -20dB, within 20% of prior calibration, the impedance is within 5 ohm of prior calibration for each dipole.

11. System verification and validation

11.1 Tissue Verification

The tissue dielectric parameters of tissue-equivalent media used for SAR measurements must be characterized within a temperature range of 18℃ to 25℃, measured with calibrated instruments and apparatuses, such as network analyzers and temperature probes. The temperature of the tissue-equivalent medium during SAR measurement must also be within 18℃ to 25℃ and within ± 2℃ of the temperature when the tissue parameters are characterized. The tissue dielectric measurement system must be calibrated before use. The dielectric parameters must be measured before the tissue-equivalent medium is used in a series of SAR measurements.

The liquid tissue depth was at least 15cm in the phantom for all SAR testing

The SPEAG Dasy Measurement system implement a SAR error compensation algorithm as documented in IEEE Std 1528-2013 to automatically compensate the measured SAR results for deviations between the measured and required tissue dielectric parameters, according to IEC/IEEE 62209-1528, the tolerance for “Delta (σ)” and “Delta (εr)” can be relaxed to ± 10%

<Tissue Check Results>

Frequency (MHz)	Liquid Temp. (℃)	Conductivity (σ)	Permittivity (ε_r)	Conductivity Target (σ)	Permittivity Target (ε_r)	Delta (σ) (%)	Delta (ε_r) (%)	Limit (%)	Date
835	22.5	0.901	44.900	0.90	41.50	0.11	8.19	±10	2026/4/5
1900	22.5	1.470	39.900	1.40	40.00	5.00	-0.25	±10	2026/3/28
3500	22.7	2.72	37.9	2.91	37.90	-6.53	0.00	±10	2026/4/17

11.2 System Verification

Comparing to the original SAR value provided by SPEAG, the verification data should be within its specification of 10 %. Below table shows the target SAR and measured SAR after normalized to 1W input power. The table below indicates the system performance check can meet the variation criterion and the plots can be referred to Appendix A.

<System Verification Results>

Date	Frequency (MHz)	Input Power (mW)	Dipole S/N	Probe S/N	DAE S/N	Measured 1g SAR (W/kg)	Targeted 1g SAR (W/kg)	Normalized 1g SAR (W/kg)	Deviation (%)
2026/4/5	835	250	D835V2-4d060	EX3DV4 - SN3728	DAE4 Sn1707	2.390	9.280	9.56	3.02
2026/3/28	1900	50	D1900V2-5d185	EX3DV4 - SN7785	DAE4 Sn1707	2.070	39.600	41.4	4.55
2026/4/17	3500	50	D3500V2-1014	EX3DV4 - SN7814	DAE4 Sn1776	3.380	65.700	67.6	2.89

11.3 Power Density system verification and validation

The system performance check verifies that the system operates within its specifications.
The EUT is replaced by a calibrated source, the same spatial resolution, measurement region and the test separation used in the calibration was applied to system check. Through visual inspection into the measured power density distribution, both spatially (shape) and numerically (level) have no noticeable difference. The measured results should be within 0.6dB of the calibrated targets.

Frequency [GHz]	Grid step	Grid extent X/Y [mm]	Measurement points
10	0.25 ($\frac{\lambda}{4}$)	120/120	16 × 16
30	0.25 ($\frac{\lambda}{4}$)	60/60	24 × 24
60	0.25 ($\frac{\lambda}{4}$)	32.5/32.5	26 × 26
90	0.25 ($\frac{\lambda}{4}$)	30/30	36 × 36

Settings for measurement of verification sources

<PD System Verification Results>

Frequency (GHz)	5G Verification Source	Probe S/N	DAE S/N	Distance (mm)	Measured results Savg tot 4 cm^2 (W/m^2)	Targeted Savg tot 4 cm^2 (W/m^2)	Deviation (dB)	Date
30G	30GHz_1009	EUmmWV4 - SN9461	DAE4 Sn699	5.55mm	30.6	31.8	-0.17	2026/4/14

12. Uncertainty Assessment

Declaration of Conformity:
The test results with all measurement uncertainty excluded is presented in accordance with the regulation limits or requirements declared by manufacturers.
Comments and Explanations:
The declared of product specification for EUT presented in the report are provided by the manufacturer, and the ufacturer takes all the responsibilities for the accuracy of product specification.
The component of uncertainly may generally be categorized according to the methods used to evaluate them. The evaluation of uncertainly by the statistical analysis of a series of observations is termed a Type An evaluation of uncertainty. The evaluation of uncertainty by means other than the statistical analysis of a series of observation is termed a Type B evaluation of uncertainty. Each component of uncertainty, however evaluated, is represented by an estimated standard deviation, termed standard uncertainty, which is determined by the positive square root of the estimated variance.
A Type A evaluation of standard uncertainty may be based on any valid statistical method for treating data. This includes calculating the standard deviation of the mean of a series of independent observations; using the method of least squares to fit a curve to the data in order to estimate the parameter of the curve and their standard deviations; or carrying out an analysis of variance in order to identify and quantify random effects in certain kinds of measurement.
A type B evaluation of standard uncertainty is typically based on scientific judgment using all of the relevant information available. These may include previous measurement data, experience, and knowledge of the behavior and properties of relevant materials and instruments, manufacture's specification, data provided in calibration reports and uncertainties assigned to reference data taken from handbooks. Broadly speaking, the uncertainty is either obtained from an outdoor source or obtained from an assumed distribution, such as the normal distribution, rectangular or triangular distributions indicated in table below.

Uncertainty Distributions	Normal	Rectangular	Triangular	U-Shape
Multi-plying Factor[(a)]	1/k[(b)]	$1/\sqrt{3}$	$1/\sqrt{6}$	$1/\sqrt{2}$

(a) standard uncertainty is determined as the product of the multiplying factor and the estimated range of variations in the measured quantity
(b) κ is the coverage factor

Standard Uncertainty for Assumed Distribution

The combined standard uncertainty of the measurement result represents the estimated standard deviation of the result. It is obtained by combining the individual standard uncertainties of both Type A and Type B evaluation using the usual "root-sum-squares" (RSS) methods of combining standard deviations by taking the positive square root of the estimated variances.

Expanded uncertainty is a measure of uncertainty that defines an interval about the measurement result within which the measured value is confidently believed to lie. It is obtained by multiplying the combined standard uncertainty by a coverage factor. Typically, the coverage factor ranges from 2 to 3. Using a coverage factor allows the true value of a measured quantity to be specified with a defined probability within the specified uncertainty range. For purpose of this document, a coverage factor two is used, which corresponds to confidence interval of about 95 %. The DASY uncertainty Budget is shown in the following tables.
The judgment of conformity in the report is based on the measurement results excluding the measurement uncertainty.

Applicable for SAR Measurements:

Uncertainty Budget (4 MHz - 10 GHz range)							
Error Description	Uncertainty Value (±%)	Probability	Divisor	(Ci) 1g	(Ci) 10g	Standard Uncertainty (1g) (±%)	Standard Uncertainty (10g) (±%)
Measurement System							
Probe Calibration	18.60	N	2	1	1	9.3	9.3
Axial Isotropy	4.70	R	1.732	0.7	0.7	1.9	1.9
Hemispherical Isotropy	9.60	R	1.732	0.7	0.7	3.9	3.9
Linearity	4.70	R	1.732	1	1	2.7	2.7
Modulation Response	4.68	R	1.732	1	1	2.7	2.7
System Detection Limits	1.00	R	1.732	1	1	0.6	0.6
Boundary Effects	2.00	R	1.732	1	1	1.2	1.2
Readout Electronics	0.30	N	1	1	1	0.3	0.3
Response Time	0.00	R	1.732	1	1	0.0	0.0
Integration Time	2.60	R	1.732	1	1	1.5	1.5
RF Ambient Noise	3.00	R	1.732	1	1	1.7	1.7
RF Ambient Reflections	3.00	R	1.732	1	1	1.7	1.7
Probe Positioner	0.40	R	1.732	1	1	0.2	0.2
Probe Positioning	6.70	R	1.732	1	1	3.9	3.9
Post-processing	4.00	R	1.732	1	1	2.3	2.3
Test Sample Related							
Device Holder	3.60	N	1	1	1	3.6	3.6
Test sample Positioning	3.03	N	1	1	1	3.0	3.0
Power Scaling	0.00	R	1.732	1	1	0.0	0.0
Power Drift	5.00	R	1.732	1	1	2.9	2.9
Phantom and Setup							
Phantom Uncertainty	7.60	R	1.732	1	1	4.4	4.4
SAR correction	0.00	R	1.732	1	0.84	0.0	0.0
Liquid Conductivity Repeatability	0.03	N	1	0.78	0.77	0.0	0.0
Liquid Conductivity (target)	5.00	R	1.732	0.78	0.77	2.3	2.2
Liquid Conductivity (mea.)	2.50	R	1.732	0.78	0.77	1.1	1.1
Temp. unc. - Conductivity	3.68	R	1.732	0.78	0.77	1.7	1.6
Liquid Permittivity Repeatability	0.02	N	1	0.23	0.26	0.0	0.0
Liquid Permittivity (target)	5.00	R	1.732	0.23	0.26	0.7	0.8
Liquid Permittivity (mea.)	2.50	R	1.732	0.23	0.26	0.3	0.4
Temp. unc. - Permittivity	0.84	R	1.732	0.23	0.26	0.1	0.1
Combined Std. Uncertainty						14.5%	14.2%
Coverage Factor for 95 %						K=2	K=2
Expanded STD Uncertainty						29.0%	28.4%

The budget is valid for evaluation distances > λ/2π. For specific tests and configurations, the Uncertainty could be considerably smaller.

Applicable for PD Measurements:

mmWave Uncertainty Budget Evaluation Distances to the Antennas > λ/2π					
Error Description	Uncertainty Value (±dB)	Probability	Divisor	(Ci)	Standard Uncertainty (±dB)
Uncertainty terms dependent on the measurement system					
Probe Calibration	0.49	N	1	1	0.49
Probe correction	0.00	R	1.732	1	0.00
Frequency response (BW ≤ 1 GHz)	0.20	R	1.732	1	0.12
Sensor cross coupling	0.00	R	1.732	1	0.00
Isotropy	0.50	R	1.732	1	0.29
Linearity	0.20	R	1.732	1	0.12
Probe scattering	0.00	R	1.732	1	0.00
Probe positioning offset	0.30	R	1.732	1	0.17
Probe positioning repeatability	0.04	R	1.732	1	0.02
Sensor mechanical offset	0.00	R	1.732	1	0.00
Probe spatial resolution	0.00	R	1.732	1	0.00
Field impedance dependence	0.00	R	1.732	1	0.00
Amplitude and phase drift	0.00	R	1.732	1	0.00
Amplitude and phase noise	0.04	R	1.732	1	0.02
Measurement area truncation	0.00	R	1.732	1	0.00
Data acquisition	0.03	N	1	1	0.03
Sampling	0.00	R	1.732	1	0.00
Field reconstruction	0.60	R	1.732	1	0.35
Forward transformation	0.00	R	1.732	1	0.00
Power density scaling	0.00	R	1.732	1	0.00
Spatial averaging	0.10	R	1.732	1	0.06
System detection limit	0.04	R	1.732	1	0.02
Uncertainty terms dependent on the DUT and environmental factors					
Probe coupling with DUT	0.00	R	1.732	1	0.0
Modulation response	0.40	R	1.732	1	0.2
Integration time	0.00	R	1.732	1	0.0
Response time	0.00	R	1.732	1	0.0
Device holder influence	0.10	R	1.732	1	0.1
DUT alignment	0.00	R	1.732	1	0.0
RF ambient conditions	0.04	R	1.732	1	0.0
Ambient reflections	0.04	R	1.732	1	0.0
Immunity / secondary reception	0.00	R	1.732	1	0.0
Drift of the DUT		R	1.732	1	
Combined Std. Uncertainty					0.76 dB
Expanded STD Uncertainty (95%)					1.52 dB