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PART 2 : RF Exposure Compliance Test Report

Applicant Name: **SAMSUNG Electronics Co., Ltd.** 129, Samsung-ro, Yeongtong-gu, Suwon-Si, Gyeonggi-do, 16677 Rep. of Korea	**Date of Issue:** Nov. 02, 2023 **Test Report No.:** HCT-SR-2310-FC010-R1 **Test Site: HCT CO., LTD.**

FCC ID: A3LSMS926B

Equipment Type:	**Mobile Phone**
Application Type:	**Certification**
FCC Rule Part(s):	**CFR §2.1093**
Model Name:	**SM-S926B/DS**
Additional Model Name:	**SM-S926B**
Date of Test:	**Oct.11, 2023 ~ Oct.17, 2023**
Results:	**Pass**

I attest to the accuracy of data. All measurements reported herein were performed by me or were made under my supervision and are correct to the best of my knowledge and belief. I assume full responsibility for the completeness of these measurements and vouch for the qualifications of all persons taking them.

Tested By	Reviewed By
Jung-Hun, Park Test Engineer SAR Team Certification Division	Yun-jeang, Heo Technical Manager SAR Team Certification Division

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REVISION HISTORY

The revision history for this test report is shown in table.

Revision No.	Date of Issue	Description
0	Oct 18, 2023	Initial Release
1	Nov. 02, 2023	Revised Typo Sec. 3.1

This test results were applied only to the test methods required by the standard.

The above Test Report is not related to the accredited test result by (KS Q) ISO/IEC 17025 and KOLAS(Korea Laboratory Accreditation Scheme), which signed the ILAC-MRA.

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1. RF Exposure Limits

1.1RF Exposure Limits for Frequencies < 6 GHz

HUMAN EXPOSURE	UNCONTROLLED ENVIRONMENT General Population (W/kg) or (mW/g)	CONTROLLED ENVIRONMENT Occupational (W/kg) or (mW/g)
SPATIAL PEAK SAR * (Partial Body)	1.6	8.0
SPATIAL AVERAGE SAR ** (Whole Body)	0.08	0.4
SPATIAL PEAK SAR *** (Hands / Feet / Ankle / Wrist)	4.0	20.0

NOTES:

* The Spatial Peak value of the SAR averaged over any 1 g of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

** The Spatial Average value of the SAR averaged over the whole-body.

******* The Spatial Peak value of the SAR averaged over any 10 g of tissue (defined as a tissue volume in the shape of a cube) and over the appropriate averaging time.

Uncontrolled Environments are defined as locations where there is the exposure of individuals who have no knowledge or control of their exposure. The general population/uncontrolled exposure limits are applicable to situations in which the general public may be exposed or in which persons who are exposed as a consequence of their employment may not be mad fully aware of the potential for exposure or cannot exercise control over their exposure. Members of the general public would come under this category when exposure is not employment-related; for example, in the case of a wireless transmitter that exposes persons in its vicinity.

Controlled Environments are defined as locations where there is exposure that may be incurred by persons who are aware of the potential for exposure, (i.e.as a result of employment or occupation). In general, occupational/controlled exposure limits are applicable to situations in which persons are exposed as a consequence of their employment, who have been made fully aware of the potential for exposure and can exercise control over their exposure. This exposure category is also applicable when the exposure is of a transient nature due to incidental passage through a location where the exposure levels may be higher than the general population/uncontrolled limits, but the exposed person is fully aware of the potential for exposure and can exercise control over his or her exposure by leaving the area or by some other appropriate means.

1.2 Interim Guidance for Time Averaging

Per October 2018 TCB Workshop Notes, the below time-averaging windows can be used for assessing time-averaged exposures for devices that are capable of actively monitoring and adjusting power output over time to comply with exposure limits.

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

2. Test Location

2.1 Test Laboratory

Company Name	HCT Co., Ltd.
Address	74, Seoicheon-ro 578beon-gil, Majang-myeon, Icheon-si,Gyeonggi-do, 17383 KOREA
Telephone	031-645-6300
Fax.	031-645-6401

2.2 Test Facilities

Our laboratories are accredited and approved by the following approval agencies according to ISO/IEC 17025.

Korea	National Radio Research Agency (Designation No. KR0032)
	KOLAS (Testing No. KT197)

3. Information of the DUT

3.1 DUT Specification overview

Model Name	SM-S926B/DS
Additional Model Name	SM-S926B
Equipment Type	Mobile Phone
FCC ID	A3LSMS926B
Application Type	Certification
Applicant	SAMSUNG Electronics Co., Ltd.

Device Wireless specification overview		
Band & Mode	**Operating Mode**	**Tx Frequency**
GSM850	Voice / Data	824.2 ㎒ ~ 848.8 ㎒
GSM1900	Voice / Data	1 850.2 ㎒ ~ 1 909.8 ㎒
UMTS Band 2	Voice / Data	1 852.4 ㎒ ~ 1 907.6 ㎒
UMTS Band 4	Voice / Data	1 712.4 ㎒ ~ 1 752.6 ㎒
UMTS Band 5	Voice / Data	826.4 ㎒ ~ 846.6 ㎒
LTE FDD Band 2 (PCS)	Voice / Data	1 850.7 ㎒ ~ 1 909.3 ㎒
LTE FDD Band 4 (AWS)	Voice / Data	1 710.7 ㎒ ~ 1 754.3 ㎒
LTE FDD Band 5 (Cell)	Voice / Data	824.7 ㎒ ~ 848.3 ㎒
LTE FDD Band 12	Voice / Data	699.7 ㎒ ~ 715.3 ㎒
LTE FDD Band 13	Voice / Data	779.5 ㎒ ~ 784.5 ㎒
LTE FDD Band 17	Voice / Data	706.5 ㎒ ~ 713.5 ㎒
LTE FDD Band 25	Voice / Data	1 850.7 ㎒ ~ 1 914.3 ㎒
LTE FDD Band 26	Voice / Data	814.7 ㎒ ~ 848.3 ㎒
LTE TDD Band 41	Voice / Data	2 498.5 ㎒ ~ 2 687.5 ㎒
LTE TDD Band 66 (AWS)	Voice / Data	1 710.7 ㎒ ~ 1 779.3 ㎒
NR FDD Band n2 (PCSFDD)	Voice / Data	1 852.5 ㎒ ~ 1 907.5 ㎒
NR FDD Band n5	Voice / Data	826.5 ㎒ ~ 846.5 ㎒
NR FDD Band n25 (PCS)	Voice / Data	1 852.5 ㎒ ~ 1 912.5 ㎒
NR TDD Band n41	Voice / Data	2 506.02 ㎒ ~ 2 679.99 ㎒
NR FDD Band n66	Voice / Data	1 712.5 ㎒ ~ 1 777.5 ㎒
NR TDD Band n77	Voice / Data	3 705 ㎒ ~ 3 975 ㎒
NR TDD Band n77 DoD	Voice / Data	3 455.04 ㎒ ~ 3 544.98 ㎒
U-NII-1	Voice / Data	5 180 ㎒ ~ 5 240 ㎒
U-NII-2A	Voice / Data	5 260 ㎒ ~ 5 320 ㎒
U-NII-2C	Voice / Data	5 500 ㎒ ~ 5 720 ㎒
U-NII-3	Voice / Data	5 745 ㎒ ~ 5 825 ㎒
U-NII-4	Voice / Data	5 845 ㎒ ~ 5 885 ㎒
U-NII-5	Voice / Data	5 955 ㎒ – 6 425 ㎒
U-NII-6	Voice / Data	6 425 ㎒ – 6 525 ㎒
U-NII-7	Voice / Data	6 525 ㎒ – 6 875 ㎒
U-NII-8	Voice / Data	6 875 ㎒ – 7 115 ㎒
2.4 ㎓ WLAN	Voice / Data	2 412 ㎒ ~ 2 472 ㎒
Bluetooth / LE 5.3	Data	2 402 ㎒ ~ 2 480 ㎒
UWB	Data	6 489.6 ㎒ ~ 7 987.2 ㎒
NFC	Data	13.56 ㎒
WPC	Data	110 ㎑ ~ 148 ㎑

Device Serial Numbers	**Mode**	**Serial Number**
	WLAN	WI40584M
	The manufacturer has confirmed that the devices tested have the same physical, mechanical and thermal characteristics are within operational tolerances expected for production units.	

Measurement Plot Summary Table

Test Case#	Test Scenario	Tech	Band	Antenna	DSI	Channel	Frequency	Conducted Plot No.	SAR Plot No.
1	Time-varying Tx power transmission	WLAN	2.4G	SUB6	1	11	2462	1	
2			5G	SUB4	1	155	5775	2	
3	Change in Call	WLAN	2.4G	SUB6	1	11	2462	3	
4	Change in DSI	WLAN	2.4G	SUB6	1	11	2462	4	
		WLAN	2.4G	SUB6	0	11	2462		
5	WLAN SAR1 vs SAR2 (Dual Band Simultaneous mode) / Antenna Switch	WLAN	2.4G	SUB6	1	11	2462	5	
			5G	SUB4	1	155	5775		

3.2 Test Under Dynamic Transmission Condition for RF Exposure Compliance

This feature performs time averaging algorithm in real time to control and manage transmitting power and ensure the time-averaged RF exposure is in compliance with FCC requirements all the time.
The Smart Transmit algorithm maintains the time-averaged transmit power, in turn, time-averaged RF exposure of SAR_design_target for sub 6 radio, below the predefined time averaged power limit for each characterized technology and band.
Smart Transmit allows the device to transmit at higher power instantaneously, as high as Pmax, when needed, but enforces power limiting to maintain time-averaged transmit power to Plimit for frequencies < 6 GHz and input.power.limit for frequencies > 6 GHz.

Note that the device uncertainty for sub 6GHz WLAN is 1.0dB for this DUT and the reserve power margin is 1 dB

For a given exposure category (head vs. non-head) and antenna group, OEM can configure:
o TOTAL_MIN_RES_RATIO
This entry corresponds to the minimum reserve margin for WLAN radio when operating in standalone mode per antenna group. Here, TOTAL_MIN_RES_RATIO is 1.

This purpose of the Part 2 report is to demonstrate the DUT complies with FCC RF exposure requirement under Tx varying transmission scenarios, thereby validity of Qualcomm® Smart Transmit feature implementation in this device. It serves to compliment the Part 0 and Part 1 Test Reports to justify compliance per FCC

All Part 2 tests of this device were conducted according to the guidelines of the Qualcomm document 80-W2112-5 Rev. YD

■<u>Test case reduction for multiple filings</u>
Per the Guidance of the FCC and Qualcomm (Document No: 80-W2112-5 Rev. YD, Sec.4.2,)

For multiple filings with same chipset, the test case reduction proposal for Part 2 testing is:

1. Full set of tests in the first filing, i.e., both power measurement and RF exposure measurement, are required.

2. For all subsequent filings with the same chipset, only power measurement (scenarios (a) – (h)) is required. In the case of scenario (a) time-varying Tx transmission test, only one band (instead of two bands) per technology is sufficient

■ **Regulatory body configuration:**

Based on regulatory requirement for each countries/regions, FCC time window/limits and/or ICNIRP 1998 time window/limits can be selected and/or combined. Additionally, Time-Averaged Exposure mode or Peak Exposure mode can be selected based on MCC for Smart Transmit to operate. In Time-Averaged Exposure mode, the wireless device can instantaneously transmit at high transmit powers and exceed the Plimit for a short duration before limiting the power to maintain the time-averaged transmit power under the Plimit; while in Peak Exposure mode, the maximum instantaneous transmit power is limited to Plimit. Depending on BDF file, regulatory body configuration is different.

■ ***force peak*** **for Tx transmitting frequency**

The Smart Transmit feature applies time-averaging windows when the device detects an MCC that matches Time-Averaged Exposure MCCs list. For each of the MCCs under Time-Averaged Exposure MCCs list, the Smart Transmit feature can limit either maximum peak power or maximum time-average power to Plimit per tech/band/antenna/DSI. If force peak is set to '1' for a given tech/band/antenna/DSI in the BDF File, then the Smart Transmit feature limits the maximum Tx power to Plimit for the selected tech/band/antenna/DSI. In other words, with force peak set to '1', under static condition (i.e., fixed tech/band/antenna/DSI) and in single active Tx scenario, Smart Transmit can guarantee Tx power level of Plimit at all times.

This device was tested in part 2 of Tx Varying transmission(Time-Averaged Exposure mode) testing using US MCC (310).and MCC ,'1' was used to test the peak exposure mode.

4. Tx Varying Transmission Test Cases and Test Proposal

To validate time averaging feature and demonstrate the compliance in Tx varying transmission conditions, the following transmission scenarios are covered in Part 2 test:

1. During a time-varying Tx power transmission: To prove that the Smart Transmit feature accounts for Tx power variations in time accurately.

2. During a call disconnect and re-establish scenario: To prove that the Smart Transmit feature accounts for history of past Tx power transmissions accurately.

3. During DSI (Device State Index) change: To prove that the Smart Transmit feature functions correctly during transition from one device state (DSI) to another.

4. During antenna (or beam) switch: To prove that the Smart Transmit feature functions correctly during transitions in antenna (such as AsDiv scenario) or beams (different antenna array configurations).

5. SAR exposure switching between two active radios (radio1 and radio2): To prove that the Smart Transmit feature functions correctly and ensures total RF exposure compliance when exposure varies among SAR _radio1 only, SAR _radio1 + SAR _radio2, and SAR _radio2 only scenarios.

As described in Part 0 report, the RF exposure is proportional to the Tx power for a SAR- and PD-characterized wireless device. Thus, feature validation in Part 2 can be effectively performed through conducted (for f < 6GHz) and radiated (for f ≥ 6GHz) power measurement. Therefore, the compliance demonstration under dynamic transmission conditions and feature validation are done in conducted/radiated power measurement setup for transmission scenario 1 through 5.

■Test case reduction for multiple filings

Per Qualcomm Document (80-W2112-5 Rev. YD ,Sec 4.2 , For Multiple variants which uses the same chipset. -the same chipset and Smart Transmit algorithm are used in the new model- the number of test cases in Part 2 can be reduced in the case of multiple filings using same chipset (post full part 2 test on the first filing), i.e., the essential test cases in power measurement are required to ensure the Smart Transmit performs as expected in the new design, but the RF exposure measurement can be excluded.

Furthermore, as described in Section 5.2.1of 80-W2112-5 Rev. YD, for scenario (a), two bands per technology are selected for time-varying Tx transmission test to provide high confidence. In this case, one band per technology can be considered as well to reduce test cases further.

The strategy for testing in Tx varying transmission condition is outlined as follows:

Demonstrate the total RF exposure averaged over FCC defined time windows does not exceed FCC's SAR limits, through time-averaged power measurements

Measure conducted Tx power (for *f* < 6GHz) versus time.
Convert it into RF exposure and divide by respective FCC limits to get normalized exposure versus time.
Perform running time-averaging over FCC defined time windows.
Demonstrate that the total normalized time-averaged RF exposure is less than 1 for all transmission scenarios (i.e., transmission scenarios 1, 2, 3, 4, 5) at all times.

Mathematical expression:

– For sub-6 transmissions only:

$$1g\_or\_10gSAR(t) = \frac{conducted\_Tx\_power(t)}{conducted\_Tx\_power\_P_{limit}} * 1g\_or\_10gSAR\_P_{limit} \quad (1a)$$

$$\frac{\frac{1}{T_{SAR}}\int_{t-T_{SAR}}^{t} 1g\_or\_10gSAR(t)dt}{FCC\ SAR\ limit} \leq 1 \quad (1b)$$

where, $conducted\_Tx\_power(t)$, $conducted\_Tx\_power\_P_{limit}$, and $1g\_or\_10gSAR\_P_{limit}$ correspond to the measured instantaneous conducted Tx power, measured conducted Tx power at Plimit, and measured 1gSAR or 10gSAR values at Plimit corresponding to sub-6 transmission.

Demonstrate the total RF exposure averaged over FCC defined time windows does not exceed FCC's SAR limits, through time-averaged SAR measurements. Note as mentioned earlier, this measurement is performed for transmission scenario 1 only.

Mathematical expression:

- For sub-6 transmission only:

$$1g\_or\_10gSAR(t) = \frac{pointSAR(t)}{pointSAR\_P_{limit}} * 1g\_or\_10gSAR(t)\_P_{limit} \qquad (3a)$$

$$\frac{\frac{1}{T_{SAR}}\int_{t-T_{SAR}}^{t} 1g\_or\_10gSAR(t)dt}{FCC\ SAR\ limit} \leq 1 \qquad (3b)$$

$$1g\_or\_10gSAR(t) = \frac{pointSAR(t)}{pointSAR\_P_{limit}} * 1g\_or\_10gSAR(t)\_P_{limit} \qquad (3a)$$

$$\frac{\frac{1}{T_{SAR}}\int_{t-T_{SAR}}^{t} 1g\_or\_10gSAR(t)dt}{FCC\ SAR\ limit} \leq 1 \qquad (3b)$$

where, pointSAR(t),PointSAR_Plimit and 1g_or_10gSAR_ Plimit correspond to the measured instantaneous point SAR, measured.
point SAR at *Plimit*, and measured *1gSAR* or 10gSAR values at *Plimit* corresponding to sub-6 transmission.
Similarly, *pointE(t)*|, *pointE*_input.power.limitand $4cm^2$ *PD_input. power. limit* correspond to the measured

5. SAR Time Averageing Validation Test Procedures

This chapter provides the test plan and test procedure for validating Qualcomm Smart Transmit feature for sub-6 transmission. The 100 seconds time window for operating f < 3GHz is used as an example to detail the test procedures in this chapter. The same test plan and test procedures described in this chapter apply to 60 seconds time window for operating $f \geq$ 3GHz.

5.1 Test sequence determination for validation

Following the FCC recommendation, two test sequences having time-variation in Tx power are predefined for sub-6 (f < 6 GHz) validation:

Test sequence 1: request EUT's Tx power to be at maximum power, measured *Pmax*†, for 80s, then requesting for half of the maximum power, i.e., measured *Pmax*/2, for the rest of the time.

NOTE: For test sequence generation, "measured *Plimit*" and "measured *Pmax*" are used instead of the "*Plimit*" specified in BDF entry and "*Pmax*" specified for the device, because Smart Transmit feature operates against the actual power level of the "*Plimit*" that was calibrated for the EUT. The "measured *Plimit*" accurately reflects what the feature is referencing to, therefore, it should be used during feature validation testing. The RF tune up and device- to-device variation are already considered in Part 0 report prior to determining *Plimit*.

5.2 Test configuration selection criteria for validating Smart Transmit feature

For validating Smart Transmit feature, this section provides a general guidance to select test cases. In practice, an adjustment can be made in test case selection. The justification/clarification may be provided.

5.2.1 Test configuration selection for time-varying Tx power transmission

The Smart Transmit time averaging feature operation is independent of bands, modes, and channels for a given technology. Hence, validation of Smart Transmit in one band/mode/channel
per technology is sufficient. Two bands per technology are proposed and selected for this testing to provide high confidence in this validation.
The criteria for the selection are based on the *Plimit* values determined in Part 0 report. Select two bands* in each supported technology that correspond to least** and highest*** *Plimit* values that are less than *Pmax* for validating Smart Transmit.

*If one *Plimit* level applies to all the bands within a technology, then only one band needs to be tested. In this case, within the bands having the same *Plimit*, the radio configuration (e.g., # of RBs, channel#) and device position that correspond to the highest *measured* 1gSAR at *Plimit* shown in Part 1 report is selected.

** In case of multiple bands having the same least *Plimit* within the technology, The “least Plimit” term also implies that the technology/band with the largest difference between Pmax and Plimit (Plimit<Pmax) should be considered in the selection.
*** The band having a higher *Plimit* needs to be properly selected so that the power limiting enforced by Smart Transmit can be validated using the pre-defined test sequences. If the highest *Plimit* in a technology is too high where the power limiting enforcement is not needed when testing with the pre-defined test sequences, then the next highest level is checked. This process is continued within the technology until the second band for validation testing is determined.

5.2.2 Test configuration selection for change in call

The criteria to select a test configuration for call-drop measurement is:

Select technology/band with least *Plimit* among all supported technologies/bands, and select the radio configuration (e.g., # of RBs, channel#) in this technology/band that corresponds to the highest *measured* 1gSAR at *Plimit* listed in Part 1report.

In case of multiple bands having same least *Plimit*, then select the band having the highest *measured* 1gSAR at *Plimit* in Part 1 report.

This test is performed with the EUT’s Tx power requested to be at maximum power, the above band selection will result in Tx power enforcement (i.e., EUT forced to have Tx power at *Preserve*) for longest duration in one FCC defined time window. The call change (call drop/reestablish) is performed during the Tx power enforcement duration (i.e., during the time when EUT is forced to have Tx power at *Preserve*). One test is sufficient as the feature operation is independent of technology and band.

5.2.3 Test configuration selection for change in antenna

The criteria to select a test configuration for antenna switch measurement is:

Whenever possible and supported by the EUT, first select antenna switch configuration within the same technology/band (i.e., same technology and band combination) and having different Plimit, and having both Plimit < Pmax where possible. Otherwise, select at least one antenna having Plimit < Pmax.

In case of multiple bands having same difference in *Plimit* among supported antennas, then select the band having the highest *measured* 1gSAR at *Plimit* in Part 1report.

This test is performed with the EUT's Tx power requested to be at maximum power in selected technology/band, and antenna change is conducted during Tx power enforcement duration (i.e., during the time when EUT is forced to have Tx power at *Preserve*).

5.2.4 Test configuration selection for change in DSI

The criteria to select a test configuration for DSI change test is
Select a technology/band having the *Plimit* <*Pmax* within any technology and DSI group, and for the same technology/band having a different *Plimit* in any other DSI group. Note that the selected DSI transition need to be supported by the device.

NOTE: The antennas corresponding to the selected DSIs should be in the same antenna group if EUT is configured with GEN2_SUB6 or GEN2_SUB6_MMW, and selected DSIs should be under the same exposure category (i.e., both selected DSIs are either under head exposure category or under non-head exposure category) if EUT is enabled with Smart Transmit version 18 or higher.

This test is performed with the EUT's Tx power requested to be at maximum power in selected technology/band, and DSI change is conducted during Tx power enforcement duration (i.e., during the time when EUT is forced to have Tx power at *Preserve*).

5.2.5 Test configuration selection for SAR exposure switching

If supported, the test configuration for SAR exposure switching should cover

1. SAR exposure switch when two active radios are in the same time window
(a. LTE+sub6 NR, b. Inter-band ULCA, c.WLAN DBS)
2. SAR exposure switch when two active radios are in different time windows. One test with two active radios in any two different time windows is sufficient as Smart Transmit operation is the same for RF exposure switch in any combination of two different time windows. For device supporting LTE + mmW NR, this test is covered in SAR vs PD exposure switch validation.

The Smart Transmit time averaging operation is independent of the source of SAR exposure (for example, LTE vs. Sub6 NR) and ensures total time-averaged RF exposure compliance. Hence, validation of Smart Transmit in any one simultaneous SAR transmission scenario (i.e., one combination for LTE + Sub6 NR transmission and one band combination for interband ULCA) is sufficient, where the SAR exposure varies among SAR_{radio1} only, SAR_{radio1} + SAR_{radio2}, and SAR_{radio2} only scenarios.

The criteria to select a test configuration for validating Smart Transmit feature during SAR exposure switching scenarios is
-Select any two < 6GHz technologies/bands that the EUT supports simultaneous transmission
(for example, LTE+Sub6NR).
- Among all supported simultaneous transmission configurations, the selection order is select one configuration where both P_{limit} of radio1 and radio2 is less than their corresponding P_{max}, preferably, with different P_{limits}. If this configuration is not available, then, select one configuration that has P_{limit} less than its P_{max} for at least one radio. If this cannot be found, then,select one configuration that has P_{limit} of radio1 and radio2 greater than P_{max} but with least (P_{limit} – P_{max})delta.

Test for one simultaneous transmission scenario is sufficient as the feature operation is the same.

5.3 Test procedures for conducted power measurements

This section provides general conducted power measurement procedures to perform compliance test under dynamic transmission scenarios described in Section 4. In practice, an adjustment can be made in these procedures. The justification/clarification may be provided.

5.3.1 Time-varying Tx power transmission scenario

This test is performed with the two pre-defined test sequences described in Section 5.1 for all the technologies and bands selected in Section 5.2.1. The purpose of the test is to demonstrate the effectiveness of power limiting enforcement and that the time-averaged SAR (corresponding time-averaged Tx power) does not exceed the FCC limit at all times (see Eq. (1a) and (1b)).

Test procedure

1. Measure Pmax, measure Plimit and calculate Preserve (= measured Plimit in dBm – Reserve_power_margin in dB) and follow Section 5.1 to generate the test sequences for all the technologies and bands selected in Section 5.2.1. Both test sequence 1 and test sequence 2 are created based on measured Pmax and measured Plimit of the EUT. Test condition to measure Pmax and Plimit is:

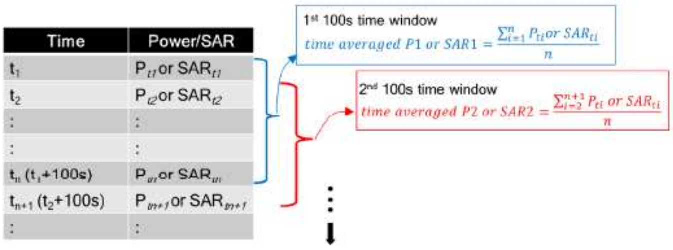
▣Measure*Pmax* with Smart Transmit <u>disabled</u> and callbox set to request maximum power.
▣ Measure*Plimit* with Smart Transmit <u>enabled</u> and *Reserve_power_margin*set to 0 dB, callbox set to request maximumpower.

2. Set *Reserve_power_margin*to actual (intended) value (3dB for this EUT based on Part 1 report) and reset power on EUT to enable Smart Transmit, establish radio link in desired radio configuration, with callbox requesting the EUT's Tx power to be at pre-defined test sequence 1, measure and record Tx power versus time, and then convert the conducted Tx power into 1gSAR or 10gSAR value (see Eq. (1a)) using measured *Plimit* from above Step 1. Perform running time average to determine time-averaged power and 1gSAR or 10gSAR versus time as illustrated in Figure 5-1 where using 100-seconds time window as an example.

NOTE: In Eq.(1a), instantaneous Tx power is converted into instantaneous 1gSAR or 10gSAR value by applying the measured worst-case 1gSAR or 10gSAR value at *Plimit* for the corresponding technology/band/antenna/DSI reported in Part 1 report.

NOTE: For an easier computation of the running time average, 0 dBm can be added at the beginning of the test sequences the length of the responding time window, for example, add 0dBm for 100-seconds so the running time average can be directly performed starting with the first 100-seconds data using excel spreadsheet. This technique applies to all tests performed in this Part 2 report for easier time-averaged computation using excel spreadsheet.

Figure 5-1 100s running average illustration



3.Make one plot containing:

a. Instantaneous Tx power versus time measured in Step2,
b. Requested Tx power used in Step 2 (test sequence1),
c. Computed time-averaged power versus time determined in Step2,
d. Time-averaged power limit (corresponding to FCC SAR limit of 1.6 W/kg for 1gSAR or 4.0W/kg for 10gSAR) givenby

$$Time\ avearged\ power\ limit = meas.P_{limit} + 10 \times \log\left(\frac{FCC\ SAR\ limit}{meas.SAR\_Plimit}\right) \qquad (5a)$$

where $meas.\ Plimit$ and $meas.\ SAR\_Plimit$ correspond to measured power at P_{limit} and measured SAR at P_{limit}.

4. Make another plot containing:

a.Computed time-averaged 1gSAR or 10gSAR versus time determined in Step2
b.FCC *1gSARlimit* of 1.6W/kg or FCC *10gSARlimit* of4.0W/kg.

5. Repeat Steps 2 ~ 4 for pre-defined test sequence 2 and replace the requested Tx power (test sequence 1) in Step 2 with test sequence2.

6. Repeat Steps 2 ~ 5 for all the selected technologies and bands.

The validation criteria are, at all times, the time-averaged power versus time shown in Step 3 plot shall not exceed the time-averaged power limit (defined in Eq. (5a)), in turn, the time-averaged 1gSAR or 10gSAR versus time shown in Step 4 plot shall not exceed the FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR (i.e., Eq. (1b)).

5.3.2 Change in call scenario

This test is to demonstrate that Smart Transmit feature accurately accounts for the past Tx powers during time-averaging when a new call is established.

The call disconnects and re-establishment needs to be performed during power limit enforcement, i.e., when the EUT's Tx power is at *Preserve* level, to demonstrate the continuity of RF exposure management and limiting in call change scenario. In other words, the RF exposure averaged over any FCC defined time window (including the time windows containing the call change) doesn't exceed FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR.

$$1g\_or\_10gSAR_1(t) = \frac{conducted\_Tx\_power\_1(t)}{conducted\_Tx\_power\_P_{limit\_1}} * 1g\_or\_10gSAR\_P_{limit\_1} \quad (6a)$$

$$1g\_or\_10gSAR_2(t) = \frac{conducted\_Tx\_power\_2(t)}{conducted\_Tx\_power\_P_{limit\_2}} * 1g\_or\_10gSAR\_P_{limit\_2} \quad (6b)$$

$$\frac{1}{T_{SAR}}\left[\int_{t-T_{SAR}}^{t_1} \frac{1g\_or\_10gSAR_1(t)}{FCC\ SAR\ limit} dt + \int_{t-T_{SAR}}^{t} \frac{1g\_or\_10gSAR_2(t)}{FCC\ SAR\ limit} dt\right] \le 1 \quad (6c)$$

where, *conducted_Tx_power_1(t)*, *conducted_Tx_power_Plimit_1*, and *1g_or_10gSAR_Plimit_1* correspond to the measured instantaneous conducted Tx power, measured conducted Tx power at *Plimit*, and measured *1gSAR* or *10gSAR* value at *Plimit* of technology1/band1; *conducted_Tx_power_2(t)*, *conducted_Tx_power_Plimit_2(t)*, and *1g_or_10gSAR_Plimit_2* correspond to the measured instantaneous conducted Tx power, measured conducted Tx power at *Plimit*, and measured *1gSAR* or *10gSAR* value at *Plimit* of technology2/band2. Transition from technology1/band1 to the technology2/band2 happens at time-instant '*t1*'.

Test procedure

1. Measure *Plimit* for the technology/band selected in Section 5.2.2. Measure *Plimit* with Smart Transmit enabled and *Reserve_power_margin*set to 0 dB, callbox set to request maximum power.
2. Set *Reserve_power_margin*to actual (intended) value and reset power on EUT to enable Smart Transmit.
3. Establish radio link with callbox in the selected technology/band.
4. Request EUT's Tx power at 0 dBm for at least one time window specified for the selected technology/band, followed by requesting EUT's Tx power to be at maximum power for about ~60 seconds, and then drop the call for ~10 seconds. Afterwards, re-establish another call in the same radio configuration (i.e., same technology/band/channel) and continue callbox requesting EUT's Tx power to be at maximum power for the remaining time of at least another full duration of the specified time window. Measure and record Tx power versus time. Once the measurement is done, extract instantaneous Tx power versus time, convert the measured conducted Tx power into 1gSAR or 10gSAR value using Eq. (1a), and then perform the running time average to determine time-averaged power and 1gSAR or 10gSAR versus time.

   NOTE: In Eq.(1a), instantaneous Tx power is converted into instantaneous 1gSAR or 10gSAR value by applying the measured worst-case 1gSAR or 10gSAR value at *Plimit* for the corresponding technology/band/antenna/DSI reported in Part 1 report.

5. Make one plot containing: (a) instantaneous Tx power versus time, (b) requested power, (c) computed time-averaged power, (d) time-averaged power limit calculated using Eq.(5a).
6. Make another plot containing: (a) computed time-averaged 1gSAR or 10gSAR versus time, and (b) FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for10gSAR.

The validation criteria are, at all times, the time-averaged power versus time shall not exceed the time-averaged power limit (defined in Eq.(5a)), in turn, the time-averaged 1gSAR or 10gSAR versus time shall not exceed the FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR (i.e., Eq. (1b)).

5.3.3 Change in antenna

This test is to demonstrate the correct power control by Smart Transmit during antenna switches from one antenna to another. The test procedure is identical to Section 5.2.4, by replacing technology/band switch operation with antenna switch. The validation criteria are, at all times, the time-averaged 1gSAR or 10gSAR versus time shall not exceed FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR.

$$1gSAR_1(t) = \frac{conducted\_Tx\_power\_1(t)}{conducted\_Tx\_power\_P_{limit\_1}} * 1g\_or\ 10g\_SAR\_P_{limit\_1} \qquad (7a)$$

$$1gSAR_2(t) = \frac{conducted\_Tx\_power\_2(t)}{conducted\_Tx\_power\_P_{limit\_2}} * 1g\_or\ 10g\_SAR\_P_{limit\_2} \qquad (7b)$$

$$\frac{1}{T1_{SAR}}\left[\int_{t-T1_{SAR}}^{t_1} \frac{1g\_or\ 10g\_SAR_1(t)}{FCC\ SAR\ limit} dt\right] + \frac{1}{T2_{SAR}}\left[\int_{t-T2_{SAR}}^{t} \frac{1g_{or}10g\_SAR_2(t)}{FCC\ SAR\ limit} dt\right] \le 1 \qquad (7c)$$

where, *conducted_Tx_power_1(t)*, *conducted_Tx_power_Plimit_1*, and *1g_ or 10g_SAR_Plimit_1* correspond to the instantaneous Tx power, conducted Tx power at *Plimit*, and compliance *1g_ or 10g_SAR* values at *Plimit_1* of band1 with time-averaging window '*T1SAR*'; *conducted_Tx_power_2(t)*, *conducted_Tx_power_Plimit_2*, and *1g_ or 10g_SAR_Plimit_2* correspond to the instantaneous Tx power, conducted Tx power at *Plimit*, and compliance *1g_ or 10g_SAR* values at *Plimit_2* of band2 with time-averaging window '*T2SAR*'. One of the two bands is less than 3GHz, another is greater than 3GHz. Transition from first band with time-averaging window '*T1SAR*' to the second band with time-averaging window '*T2SAR*' happens at time-instant '*t1*'

5.3.4 Change in DSI

This test is to demonstrate the correct power control by Smart Transmit during DSI switches from one DSI to another. The test procedure is identical to Section 5.2.5, by replacing technology/band switch operation with DSI switch. The validation criteria are, at all times, the time-averaged 1gSAR or 10gSAR versus time shall not exceed FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR.

5.3.5 Switch in SAR exposure between WLAN transmitters

This test is to demonstrate that Smart Transmit feature accurately accounts for switching in exposures among SAR for single WLAN radio, simultaneous WLAN radio & back to single WLAN radio, and ensures total time-averaged RF exposure compliance with FCC limit. This test is similar to SAR exposure switch tests for WWAN radios.
In test setup, the isolation between WLAN radio1 and WLAN radio2 should be 20dB or higher for this test.
Test configuration selection criteria: Among all supported simultaneous transmission configurations, the selection order is
1. Select SISO configurations where both Plimit of radio1 and radio2 is less than their corresponding Pmax. If this configuration is not available, then,
2. Select one SISO configuration that has Plimit less than its Pmax for at least one radio. If this cannot be found, then,
3. Select MIMO configurations where both MIMO Plimit of radio1 and MIMO Plimit of radio2 is less than their corresponding Pmax. If this configuration is not available, then,
4. Select one MIMO configuration that has MIMO Plimit less than its Pmax for at least one radio. If this cannot be found, then,
5. Select MIMO configurations with least MIMO Plimit for both radio1 and radio2. The test for SAR exposure switch for WLAN radios is not required if MIMO Plimit > Pmax + 3dB for both radio configurations.

Test procedure:
1. Measure Plimit for WLAN radio1 and WLAN radio2 in selected band. Test condition to measure conducted Plimit is:

Establish a WLAN call in desired radio1 configuration. Measure conducted Tx power corresponding to WLAN radio1 Plimit with Smart Transmit Peak exposure mode enabled and callbox set to request maximum duty cycle.
Repeat above step to measure Plimit corresponding to WLAN radio2 configuration.

2. Set EUT to the intended Smart Transmit exposure mode. First, establish WLAN connection with the callbox in radio2 configuration at low duty cycle for one time window. After one time window, request radio2 configuration to transmit at maximum duty cycle for more than one time-window duration to test predominantly radio2 SAR exposure scenario. After at least one time-window, add radio1 configuration to the existing radio2 configuration call, and request both radio1 and radio2 to transmit at maximum duty cycle to test radio1 and radio2 SAR exposure scenario. After at least one more time-window, drop (or request low duty cycle) radio2 configuration to test predominantly radio1 SAR exposure scenario. Continue the test for at least one more time-window. Record the conducted Tx powers for both radio1 and radio2 configurations for the entire duration of this test.

3. Once the measurement is done, extract instantaneous Tx power versus time for both radio1 and radio2 configurations. Similar to technology/band switch test in Section 5.3.3, convert the conducted Tx power for both these radios into 1g_or_10gSAR value (see Eq. (7a) and (7b)) using corresponding technology/band Plimit measured in Step 1, and then perform 30s running average to determine time-averaged 1g_or_10gSAR versus time as illustrated in Figure 5-1. Note that here all WLAN bands are averaged over the same time window (i.e., 30s for FCC, 360s for ICNIRP) inside Smart Transmit.

4. Make one plot containing: (a) computed normalized time-averaged 1g_or_10gSAR for radio1 configuration versus time determined in Step 3, (b) computed normalized timeaveraged 1g_or_10gSAR for radio2 configuration versus time determined in Step 3, (c) computed total normalized time-averaged 1g_or_10gSAR versus time (sum of Steps (4.a) and (4.b)) determined in Step 3, and (d) corresponding normalized regulatory 1g_or_10gSARlimit limit of 1.0.

The validation criteria is, at all times, the time-averaged 1g_or_10gSAR versus time shall not exceed the regulatory 1g_or_10gSARlimit limit.

5.4 Test procedure for time-varying SAR measurements

This section provides general time-varying SAR measurement procedures to perform compliance test under dynamic transmission scenarios described in Section 4. In practice, an adjustment can be made in these procedures. The justification/clarification may be provided.
To perform the validation through SAR measurement for transmission scenario 1 described in Section 4, the "path loss" between callbox antenna and EUT needs to be calibrated to ensure that the EUT Tx power reacts to the requested power from callbox in a radiated call. It should be noted that when signaling in closed loop mode, protocol-level power control is in play, resulting in EUT not solely following callbox TPC (Tx power control) commands. In other words, EUT response has many dependencies (RSSI, quality of signal, path loss variation, fading, etc.,) other than just TPC commands. These dependencies have less impact in conducted setup (as it is a controlled environment and the path loss can be very well calibrated) but have significant impact on radiated testing in an uncontrolled environment, such as SAR test setup. Therefore, the deviation in EUT Tx power from callbox requested power is expected, however the time- averaged SAR should not exceed FCC SAR requirement at all times as Smart Transmit controls Tx power at EUT.

The following steps are for time averaging feature validation through SAR measurement:

1. "Path Loss" calibration: Place the EUT against the phantom in the worst-case position determined based on Section 5.2.1. For each band selected, prior to SAR measurement, perform "path loss" calibration between callbox antenna and EUT. Since the SAR test environment is not controlled and well calibrated for OTA (Over the Air) test, extreme care needs to be taken to avoid the influence from reflections. The test setup is described in Section7.1.

2. Time averaging feature validation:

i. For a given radio configuration (technology/band) selected in Section 5.2.1, enable Smart Transmit and set *Reserve_power_margin*to 0 dB, with callbox to request maximum power, perform area scan, conduct pointSAR measurement at peak location of the area scan. This point SAR value, *pointSAR_Plimit*, corresponds to point SAR at the measured *Plimit* (i.e., measured *Plimit* from the EUT in Step 1 of Section5.3.1).

ii. Set*Reserve_power_margin*to actual (intended) value and reset power on EUT to enable Smart Transmit. Note, if *Reserve_power_margin*cannot be set wirelessly, care must be taken to re-position the EUT in the exact same position relative to the SAM phantom as in above Step 2.i. Establish radio link in desired radio configuration, with callbox requesting the EUT's Tx power at power levels described by test sequence 1 generated in Step 1 of Section 5.3.1, conduct point SAR measurement versus time at peak location of the area scan determined in Step 2.i of this section. Once the measurement is done, extract instantaneous point SAR vs time data, *point SAR(t)*, and convert it into instantaneous 1gSAR or 10gSAR vs. time using Eq. (3a), re-written below:

$$1g\_or\_10gSAR(t) = \frac{pointSAR(t)}{pointSAR\_P_{limit}} * 1g\_or\_10gSAR\_P_{limit}$$

where, *pointSAR_Plimit* is the value determined in Step 2.i, and *pointSAR(t)* is theinstantaneous point SAR measured in Step 2.ii,1g-or10gSAR_P*limit*isthe measured1gSAR or 10gSAR value listed in Part 1 repo rt.

iii. Perform 100s running average to determine time-averaged 1gSAR or 10gSAR versus time.

iv. Make one plot containing: (a) time-averaged 1gSAR or 10gSAR versus time determined in Step 2.iii of this section, (b) FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR.

v Repeat 2.ii ~ 2.iv for test sequence 2 generated in Step 1 of Section 5.3.1.

vi. Repeat 2.i ~ 2.v for all the technologies and bands selected in Section5.2.1.

The time-averaging validation criteria for SAR measurement is that, at all times, the time- averaged 1gSAR or 10gSAR versus time shall not exceed FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR (i.e., Eq. (3b)).

6. Test Configurations

6.1 WLAN (sub-6)transmission

The *Plimit* values, corresponding to 1.0 W/kg (1gSAR) and 2.5 W/kg (10gSAR) of *SAR_design_target*, for technologies and bands supported by EUT are derived in Part 0 report and summarized in Table 6-1. Note all *Plimit* power levels entered in Table 6-1 correspond to average power levels after accounting for duty cycle in the case of TDD modulation schemes (for e.g., GSM, LTE TDD).

Table 6-1: *Plimit* for supported technologies and bands (*Plimit* in BDF file)

Plim values in green indicate Plimit < Pmax			Plim values in green indicate Plimit > Pmax				
Plimit corresponding to 1 W/kg (1g) 2.5W/kg(10g) SAR_Design_target						Pmax	Pmax
SAR Exposure Position			Head (RCV ON)	Hotspot (Hotspot on)	Phablet /Earjack	Maximum Tune-up Output Power (Burst Average Power) [dBm]	Maximum Tune-up Output Power (Frame Averaged Power) [dBm]
Averaging volume			1g	1g	10g		
seperation Distance			0 mm	10 mm	0 mm		
Mode	Band	Antenna	DSI=1	DSI=0	DSI=0		
WLAN	2.4	Sub 4	13.0	21.2		17.0	17.0
WLAN	2.4	Sub 6	13.0	23.2		17.0	17.0
WLAN	5	Sub 4	12.0	15.5		15.0	15.0
WLAN	5	Sub 1	12.0	21.4		15.0	15.0
WLAN	6	Sub 4	8.0	17.8		9.0	9.0
WLAN	6	Sub 1	8.0	19.4		9.0	9.0
BT	2.4	Sub 4	12.5	21.9		16.0	16.0
BT	2.4	Sub 6	12.5	21.6		16.0	16.0

* Maximum tune up target power, *Pmax*, is configured in NV settings in EUT to limit maximum transmitting power. This power is converted into peak power in NV settings for TDD schemes. The EUT maximum allowed output power is equal to *Pmax* + 1dB device uncertainty.

Based on selection criteria described in Section 5.2.1, the selected technologies/bands for testing time-varying test sequences are highlighted in yellow in Table 6-1. As per Part 1 report, the *Reserve_power_margin*(dB) for Samsung Mobile Phone (FCC ID: A3LSMS926B) is set to 1dB in BDF file, and is used in Part 2 test.

The radio configurations used in Part 2 test for selected technologies, bands, DSIs and antennas are listed in Table 6-2. The corresponding worst-case radio configuration 1gSAR or 10gSAR values for selected technology/band/DSI are extracted from Part 1 report and are listed in the last column of Table 6-2.

Based on equations (1a)and (3a), it is clear that Part 2 testing outcome is normalized quantity, which implies that it can be applied to any radio configuration within a selected technology/band/DSI. Thus, as long as applying the worst-case SAR obtained from the worst radio configuration in Part 1 testing to calculate time-varying SAR exposure in equations (1a) and (3a), the accuracy in compliance demonstration remains the same.

Table 6-2: Radio configurations selected for Tx varying transmission test

Test Case #	Test Scenario	Tech	Band	Antenna	DSI	Channel	Frequency [MHz]	RB/RB Offset/Bandwidth (MHz)	Mode	SAR Exposure Scenario	Part 1 Worst Case Measured SAR at Plimit (W/kg)
1	Time-varying Tx power transmission	WLAN	2.4G	SUB6	1	11	2462	-	802.11b 1Mbps	Head, Left Touch 0mm	0.500
2			5G	SUB4	1	155	5775	-	802.11ac80 MCS0	Head, Right Touch 0mm	0.306
3	Change in Call	WLAN	2.4G	SUB6	1	11	2462	-	802.11b 1Mbps	Head, Left Touch 0mm	0.500
4	Change in DSI	WLAN	2.4G	SUB6	1	11	2462	-	802.11b 1Mbps	Head, Left Touch 0mm	0.500
		WLAN	2.4G	SUB6	0	11	2462	-	802.11b 1Mbps	Body, Left 10mm	0.322
5	WLAN SAR1 vs SAR2 (Dual Band Simultaneous mode) / Antenna Switch	WLAN	2.4G	SUB6	1	11	2462	-	802.11b 1Mbps	Head, Left Touch 0mm	0.500
		WLAN	5G	SUB4	1	155	5775	-	802.11ac80 MCS0	Head, Right Touch 0mm	0.306

This device uses different Device State Index (DSI) to configure different time averaged power levels based on certain exposure scenarios.

Scenario	Description	SAR Test Cases
Head (DSI = 1)	Device positioned next to head	Head SAR per KDB Publication 648474 D04
Body (DSI = 0)	Device transmits in hotspot mode near body	Hotspot SAR per KDB Publication 941225 D06

Based on the selection criteria described in Section 6.2, the radio configurations for the Tx varying transmission test cases listed in Section 6 are:

1. Technologies and bands for time-varying Tx power transmission: The test case 1~2 listed in Table 6-2 are selected to test with the test sequences defined in Section 5.2.1 in both time- varying conducted power measurement and time-varying SAR.

2. Technology and band for change in call test: Following the guidelines in Section 5.2.2 WLAN 2.4GHz (test case 3 in Table 6-2) is selected for performing the call drop test in conducted power setup.

3. Technologies and bands for change in DSI: Based on selection criteria in Section 5.2.4, for a given technology and band, test case4 in Table 6-2 is selected for DSI Switch.

4. Technologies and bands for change in antenna: Based on selection criteria in Section 5.2.3, for a given DSI=1 (Head Exposure), test case 5 in Table 6-2 is selected for antenna switch WLAN 2.4GHz, Ant Sub 6 to WLAN 5GHz, Ant Sub4 in conducted power setup.

5. Technologies and bands for switch in SAR exposure: Based on selection criteria in Section 5.2.5 Scenario 1, test case 5 in Table 6-2 is selected for SAR exposure switching test in one of the supported simultaneous WLAN transmission scenario, i.e., LTE + Sub6 NR or PCC + SCC active in the same 100s time window or WLAN radio1 and WLAN radio2 active in the same 30s time window, in conducted power setup.

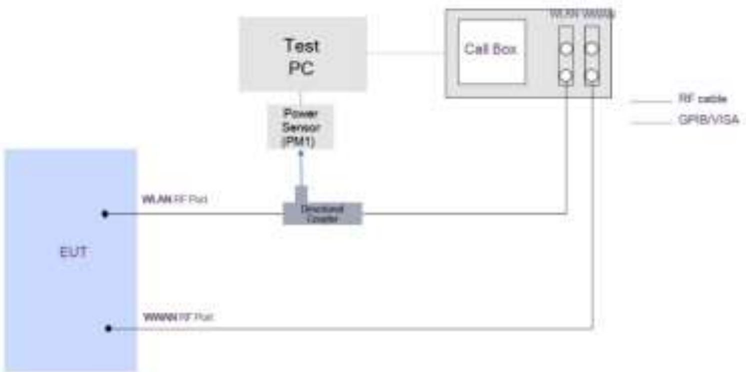
7. Time-varying Tx power measurement for below 6GHz frequency

7.1 Conducted Measurement Test setup

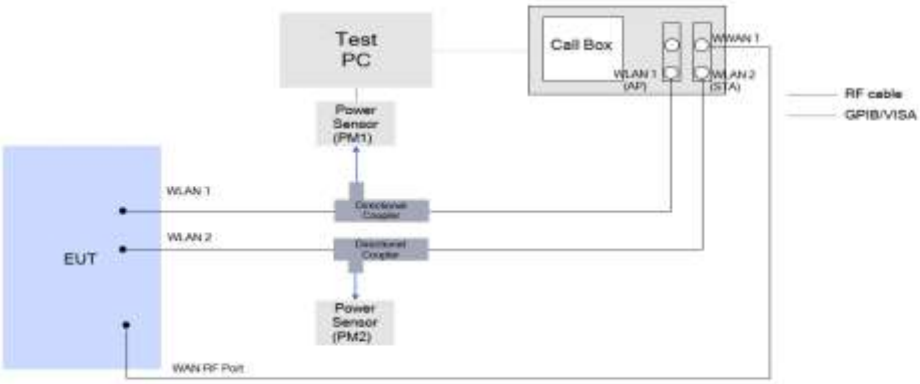
WLAN Test Setup

The Rohde & Schwarz CMW500 callbox is used in this test. The test setup picture and schematic are shown in Figures 7-1(a) for measurements with a single antenna of EUT (see Appendix B–The test Setup Photo 1).
For single antenna measurement, one port (RF3 COM) of the callbox is connected to the RF port of the EUT using a directional coupler. For antenna & technology switch measurement, two ports (RF3 COM and RF4 COM) of the callbox used for signaling two different technologies are connected to a combiner, which is in turn connected to a directional coupler. The other end of the directional coupler is connected to a splitter to connect to two RF ports of the EUT corresponding to the two antennas of interest. In both the setups, power meter is used to tap the directional coupler for measuring the conducted output power of the EUT. For time averaging validation test (Section 5.3.1), call drop test (Section 5.3.2), and DSI switch test (Section 5.3.4), only RF3 COM port of the callbox is used to communicate with the EUT. For Change in antenna test (Section. 5.3.3), and Switch in SAR exposure between WLAN transmitters(Section. 5.3.5), both RF3 COM and RF4 COM port of callbox are used to switch from one technology communicating on RF3 COM port to another technology communicating on RF4 COM port. All the path losses from RF port of EUT to the callbox RF COM port and to the power meter are calibrated and automatically entered as offsets in the callbox and the power meter via test scripts on the PC used to control callbox and power meter.

If WLAN 2.4GHz conducted port and WLAN 5GHz conducted port are same on this EUT (i.e., they share the same antenna), then low-/high-pass filter is used to separate WLAN 2.4GHz and WLAN 5GHz signals for power meter measurement via directional couplers, as shown in below Figures 7-1(b) (see Appendix B- Test setup photo-3)



7-1(a) WLAN Time-varying Tx Power Transmission, Change in Call, Change in DSI



7-1(b) WLAN SAR1 vs SAR2 (DBS)/ WLAN Ant Switch

Figure 7-1 Conducted power measurement setup

Both the callbox and power meter are connected to the PC using GPIB cables. Two test scripts are custom made for automation, and the test duration set in the test scripts is 460 seconds.
For time-varying Tx power measurement, the PC runs the 1st test script to send GPIB commands to control the callbox's requested power versus time, while at the same time to record the conducted power measured at EUT RF port using the power meter. The commands sent to the callbox to request power are:

-0dBm for 100 seconds
- test sequence 1 (defined in Section 5.1 and generated in Section 5.3.1), for 360 seconds
- stay at the last power level of test sequence 1 for the remaining time.

Power meter readings are periodically recorded every 100ms. A running average of this measured Tx power over 100 seconds is performed in the post-data processing to determine the 100s-time averaged power.
For call drop, antenna switch, and DSI switch tests, after the call is established, the callbox is set to request the EUT's Tx power at 0dBm for 100 seconds while simultaneously starting the 2nd test script runs at the same time to start recording the Tx power measured at EUT RF port using the power meter. After the initial 100 seconds since starting the Tx power recording, the callbox is set to request maximum power from the EUT for the rest of the test.
Note that the call drop/re-establish, or technology/band/antenna switch or DSI switch is manually performed when the Tx power of EUT is at *Preserve* level. See Section 5.3 for detailed test procedure of call drop test, technology/band/antenna switch test and DSI switch test.

7.2 P*limit* and P*max* measurement Results

The measured *Plimit* for all the selected radio configurations given in Table 6-2 are listed in below Table 7-1. *Pmax* was also measured for radio configurations selected for testing time-varying Tx power transmission scenarios in order to generate test sequences following the test procedures in Section 5.1.

Table 7-1: Measured Plimit and Pmax of selected radio configuration

Test Case #	Test Scenario	Tech	Band	Antenna	DSI	Channel	Frequency [MHz]	RB/RB Offset /Bandwidth (MHz)	Mode	SAR Exposure Scenario	Plimit BDF Setting [dBm]	Tune Up Target Power Pmax [dBm]	Measured P*limit* [dBm]	Measured P*max* [dBm]	Part 1 Worst Case Measured SAR at Plimit (W/kg)
1	Time-varying Tx power transmission	WLAN	2.4G	SUB6	1	11	2462	-	802.11b 1Mbps	Head, Left Touch 0mm	13.00	17.00	13.10	17.20	0.500
2			5G	SUB4	1	155	5775	-	802.11ac80 MCS0	Head, Right Touch 0mm	12.00	14.00	12.74	10.68	0.306
3	Change in Call	WLAN	2.4G	SUB6	1	11	2462	-	802.11b 1Mbps	Head, Left Touch 0mm	13.00	17.00	13.10	17.20	0.500
4	Change in DSI	WLAN	2.4G	SUB6	1	11	2462	-	802.11b 1Mbps	Head, Left Touch 0mm	13.00	17.00	13.10	17.20	0.500
		WLAN	2.4G	SUB6	0	11	2462	-	802.11b 1Mbps	Body, Left 10mm	17.00	17.00	17.20	17.20	0.322
5	WLAN SAR1 vs SAR2 (Dual Band Simultaneous mode) / Antenna Switch	WLAN	2.4G	SUB6	1	11	2462	-	802.11b 1Mbps	Head, Left Touch 0mm	13.00	17.00	13.10	17.20	0.500
		WLAN	5G	SUB4	1	155	5775	-	802.11ac80 MCS0	Head, Right Touch 0mm	12.00	14.00	12.74	10.68	0.306

Note:

1. The device uncertainty of *Pmax* is +1dB/-1.5dB as provided by manufacturer.

7.3 Time-varying Tx power measurement results

The measurement setup is shown in Figures 7-1(a), 7-1(b)and 7-1(c). The purpose of the time-varying Tx power measurement is to demonstrate the effectiveness of power limiting enforcement and that the time-averaged Tx power when represented in time-averaged 1gSAR or 10gSAR values does not exceed FCC limit as shown in Eq. (1a) and (1b), rewritten below:

$$1g\_or\_10gSAR(t) = \frac{conducted\_Tx\_power(t)}{conducted\_Tx\_power\_P_{limit}} * 1g\_or\_10gSAR\_P_{limit} \qquad (1a)$$

$$\frac{\frac{1}{T_{SAR}}\int_{t-T_{SAR}}^{t} 1g\_or\_10gSAR(t)dt}{FCC\ SAR\ limit} \leq 1 \qquad (1b)$$

where, *conducted_Tx_Power(t)*, *conducted_Tx_Plimit*, and 1g_or_10g SAR_P*limit* $1g\_or\_10gSAR\_P_{limit}$ correspond to the measured instantaneous conducted Tx power, measured conducted Tx power at *Plimit*, and measured *1gSAR* and *10gSAR* values at *Plimit* reported in Part 1 test (listed in Table7-2 of this report as well).

Following the test procedure in Section 5.3, the conducted Tx power measurement for all selected configurations are reported in this section. In all the conducted Tx power plots, the dotted line represents the requested power by callbox (test sequence 1 or test sequence 2), the blue curve represents the instantaneous conducted Tx power measured using power meter, the green curve represents time-averaged power and red line represents the conducted power limit that corresponds to FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR.

Similarly, in all the 1g or 10gSAR plots (when converted using Eq. (1a)), the green curve represents the 100s time averaged 1gSAR or 10gSAR value calculated based on instantaneous 1gSAR or 10gSAR; and the red line limit represents the FCC limit of 1.6 W/kg for 1gSAR or 4.0 W/kg for 10gSAR.

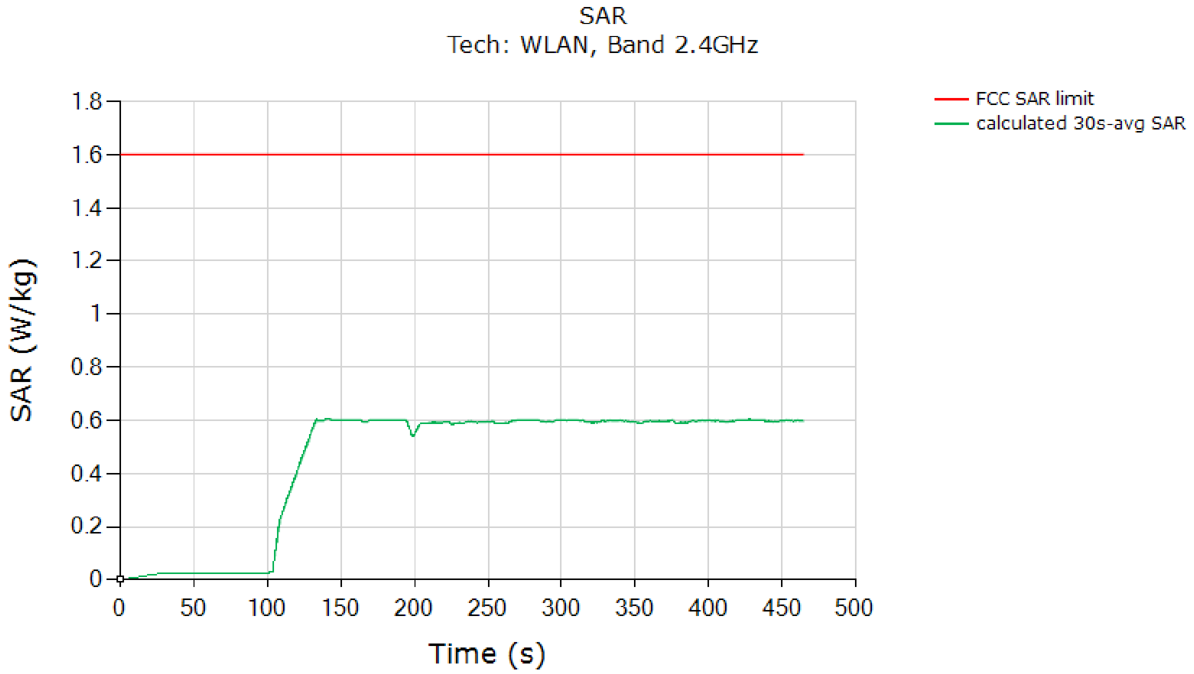
Time-varying Tx power measurements were conducted on test cases #1 ~ #5 in Table 7-1, by generating test sequence 1 and test sequence 2 given in Appendix A using measured *Plimit* and measured *Pmax* for each of these test cases. Measurement results for test cases #1 ~ #5 are given in Sections 7.3. - 7.5.

7.3.1 WLAN 2.4 GHz (test case 1 in Table 6-2)

Conducted Plot No. 1

Test result for test sequence 1

Above time-averaged conducted Tx power is converted/calculated into time-averaged 1gSAR using Equation (1a) and plotted below to demonstrate that the time-averaged 1gSAR versus time does not exceed the FCC limit of 1.6 W/kg for 1gSAR:



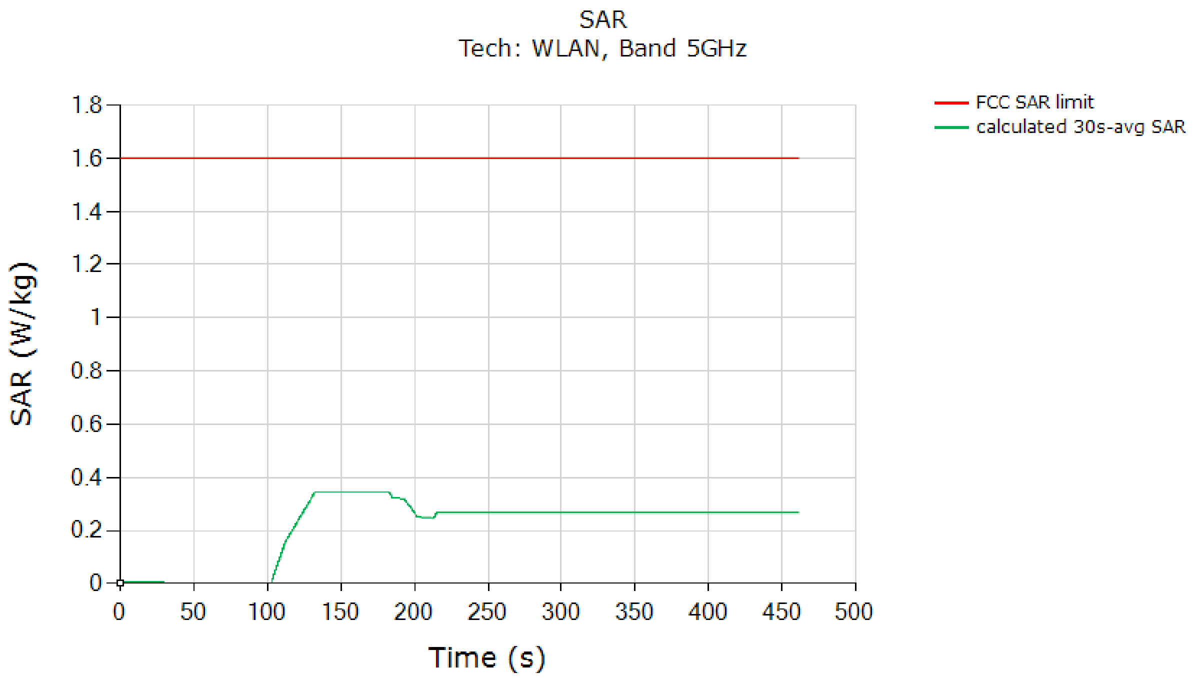
FCC 1g SAR Limit [W/kg]	1.6 W/kg
Max 30s-time averaged 1gSAR (green curve)	0.604 W/kg
Validated: Max time averaged SAR (green curve) is within 1dB device uncertainty of measured SAR at *Plimit* (last column in Table 7-1).	

7.3.2 WLAN 5GHz (test case 2 in Table 6-2)

Conducted Plot No. 2

Test result for test sequence 1

Above time-averaged conducted Tx power is converted/calculated into time-averaged 1gSAR using Equation (1a) and plotted below to demonstrate that the time-averaged 1gSAR versus time does not exceed the FCC limit of 1.6 W/kg for 1gSAR:



FCC 1g SAR Limit [W/kg]	1.6 W/kg
Max 30s-time averaged 1gSAR (green curve)	0.344 W/kg
Validated: Max time averaged SAR (green curve) is within 1dB device uncertainty of measured SAR at *Plimit* (last column in Table 7-1).	

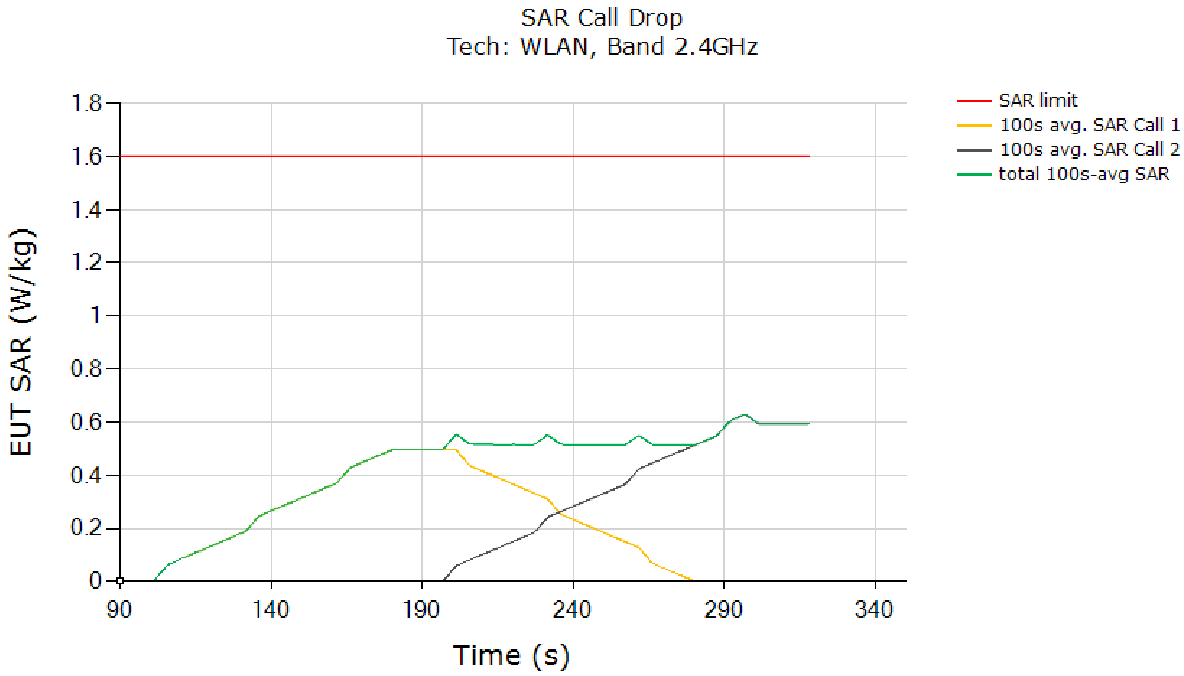
7.4 Change in Call Test results (test case 3 in Table 6-2)

This test was measured with WLAN 2.4GHz, DSI=1 (Head Exposure), and with callbox requesting maximum power. The call drop was manually performed when the EUT is transmitting at *Preserve* level as shown in the plot below. The measurement setup is shown in Figure 7-1(a). The detailed test procedure is described in Section 5.3.2.

Conducted Plot No. 3

Call drop test result:

Above time-averaged conducted Tx power is converted/calculated into time-averaged 1gSAR using Equation (1a) and plotted below to demonstrate that the time-averaged 1gSAR versus time does not exceed the FCC limit of 1.6 W/kg for 1gSAR:



FCC 1g SAR Limit [W/kg]	1.6 W/kg
Max 100s-time averaged 11gSAR (green curve)	0.628 W/kg
Validated: Max time averaged SAR (green curve) is within 1dB device uncertainty of measured SAR at *Plimit* (last column in Table 7-1).	

7.5 Change in DSI test results (test case 4 in Table 6-2)

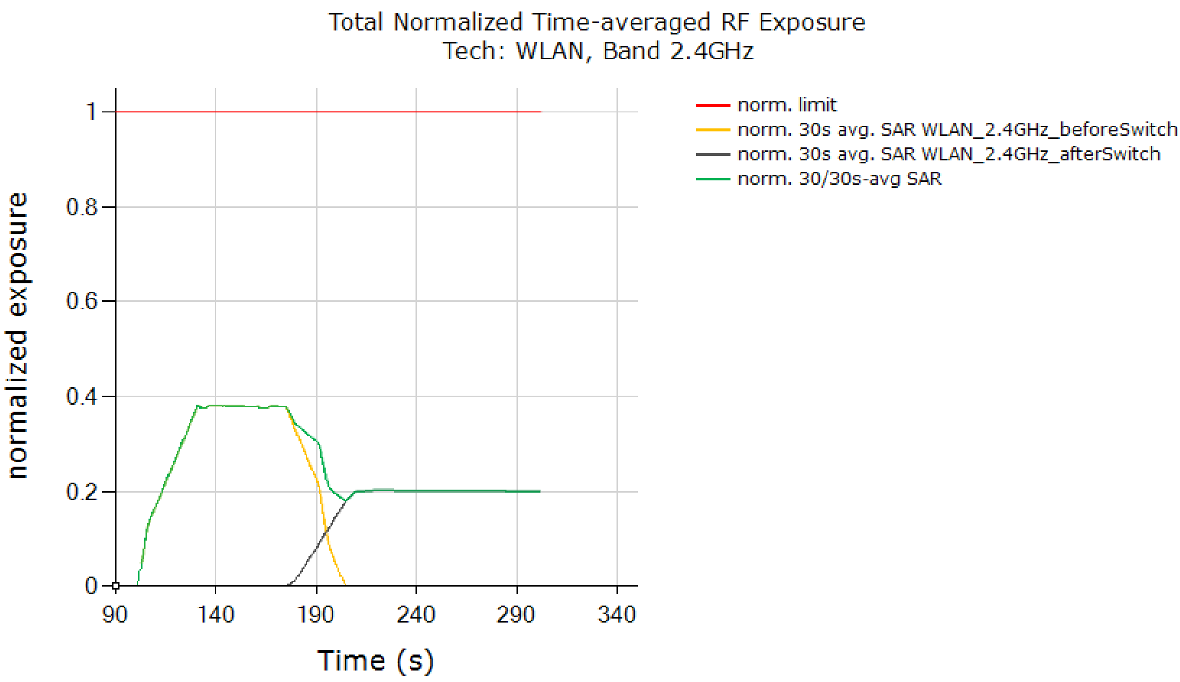
This test was conducted with callbox requesting maximum power, and with DSI switch from NR n77 DSI = 1 (Head Exposure) to DSI = 0 (Body Exposure). Following procedure detailed in Section 5.3.4 using the measurement setup shown in Figure 7-1(a).

Conducted Plot No.4

Test result for change in DSI:

As per the manufacturer, *Reserve_power_margin* = 1dB.
Based on Table 7-1, *Plimit* = 13.0 dBm for WLAN 2.4GHz, Head exposure DSI = 1, and *Plimit* = 17.0 dBm for Body exposure DSI = 0 .
The difference in *Preserve* (= *Plimit* – *Reserve_power_margin*) level corresponds to the expected different in *Plimit* levels(within 1dB of sub6 radio design related uncertainty).

All the time-averaged conducted Tx power measurement results were converted into time-averaged normalized SAR values using Equation (6a), (6b) and (6c), and plotted below to demonstrate that the time-averaged normalized SAR versus time does not exceed the FCC limit of 1 unit.



FCC normalized SAR limit	1.0
Max 100s-time averaged normalized SAR (green curve)	0.382
Validated:	

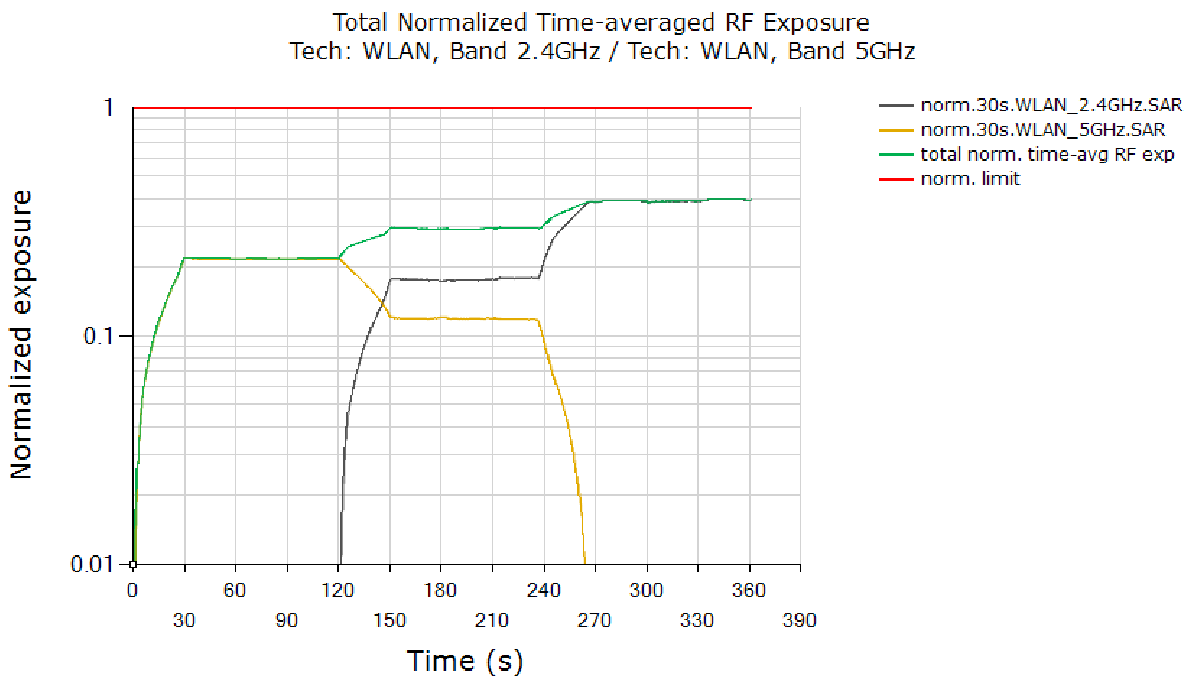
In this test, the total time-averaged normalized RF exposure (green curve) did not exceed Normalized limit of 1.0 at all times, the above test result validated the continuity of power limiting in SAR exposure switch scenario.

7.6 Switch in SAR exposure test results (test case 5 in Table 6-2)

This test was conducted with callbox set to request maximum duty cycle, and with the EUT in WLAN 2.4GHz + WLAN 5GHz. Here, WLAN 2.4GHz Ant Sub6, DSI = 1(Head Exposure) (30s window, Plimit = 13.0 dBm, Pmax = 17.0 dBm, measured Plimit = 13.10 dBm), and WLAN 5GHz Ant Sub4, DSI = 1(Head Exposure) (30s window, *Plimit* = 12.0 dBm, *Pmax* = 14.0 dBm, measured *Plimit* = 10.68 dBm). Following procedure detailed in Section 5.3.5, and using the measurement setup shown in Figure 7-1(b) The WLAN DBS SAR exposure switch measurement is performed with the EUT in various SAR exposure scenarios.

Conducted Plot No.5

All the conducted Tx power measurement results were converted into time-averaged normalized SAR values using Equation (7a), (7b) and (7c), and plotted below to demonstrate that the time-averaged normalized SAR versus time does not exceed the FCC limit of 1 unit. Equation (7a) is used to convert the WLAN Tx power of device to obtain 30s-averaged normalized SAR in WLAN 2.4GHz, Ant Sub6 as shown in black curve. Similarly, equation (7b) is used to obtain 30s-averaged normalized SAR in WLAN 5GHz, Ant Sub4 as shown in orange curve. Equation (7c) is used to obtain total time-averaged normalized SAR as shown in green curve (i.e., sum of black and orange curves).



FCC normalized total exposure limit	1.0
Max Norm. Total time-avg. SAR (green curve) (green curve)	0.399
Validated:	

In this test, the total time-averaged normalized RF exposure (green curve) did not exceed normalized limit of 1.0 at all times, the above test result validated the continuity of power limiting in SAR exposure switch scenario.

8. Equipment List

Manufacturer	Type / Model	S/N	Calib. Date	Calib.Interval	Calib.Due
R&S	Wireless Communication Test Set/ CMW500	167918	03/23/2023	Annual	03/23/2024
R&S	Power Sensor/NRP8S	109996	11/29/2022	Annual	11/29/2023
R&S	Power Sensor/NRP8S	104636	07/03/2023	Annual	07/03/2024
Narda	Directional Coupler/4216-10	01653	07/03/2023	Annual	07/03/2024
Narda	Directional Coupler/4216-10	01652	07/03/2023	Annual	07/03/2024
WEINWRIGHT INSTRUMENTS	High Pass Filter/WHKX12-2805	61	02/23/2023	Annual	02/23/2024

9. Conclusion

Qualcomm Smart Transmit feature employed in Samsung Mobile Phone (FCC A3LSMS926B) has been validated through the conducted/radiated power measurement.

As demonstrated in this report, the power limiting enforcement is effective and the totalnormalized time-averaged RF exposure does not exceed 1.0 for all the transmission scenarios described in Section 4.

Therefore, the EUT complies with FCC RF exposure requirement.

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Appendix A: Test Sequences

1. Test sequence is generated based on below parameters of the EUT:

a. Measured maximum power (P_{max})

b. Measured Tx_power_at_SAR_design_target (P_{limit})

c. Reserve_power_margin (dB)

$P_{reserve}$ (dBm) = measured P_{limit}(dBm) – Reserve_power_margin (dB)

If only WLAN technology is managed under Smart Transmit: Reserve_power_margin (dB) = –10*log10(TOTAL_MIN_RES_RATIO) ⎫

d. FCC SAR_time_window (100s for f < 3GHz, 60s for 3GHz < f ≤ 6GHz and 30s for 6GHz < f ≤ 10GHs)

2. Test Sequence 1 Waveform:
Based on the parameters above, the Test Sequence 1 is generated with one transition between high and low Tx powers. Here, high power = Pmax; low power = Pmax/2, and the transition occurs after 80 seconds at high power Pmax. As long as the power enforcement is taking into effective during one 100s/60s time window, the validation test with this defined test sequence 1 is valid, otherwise, select other radio configuration (band/DSI within the same technology group) having lower Plimit for this test. The Test sequence 1 waveform is shown below:

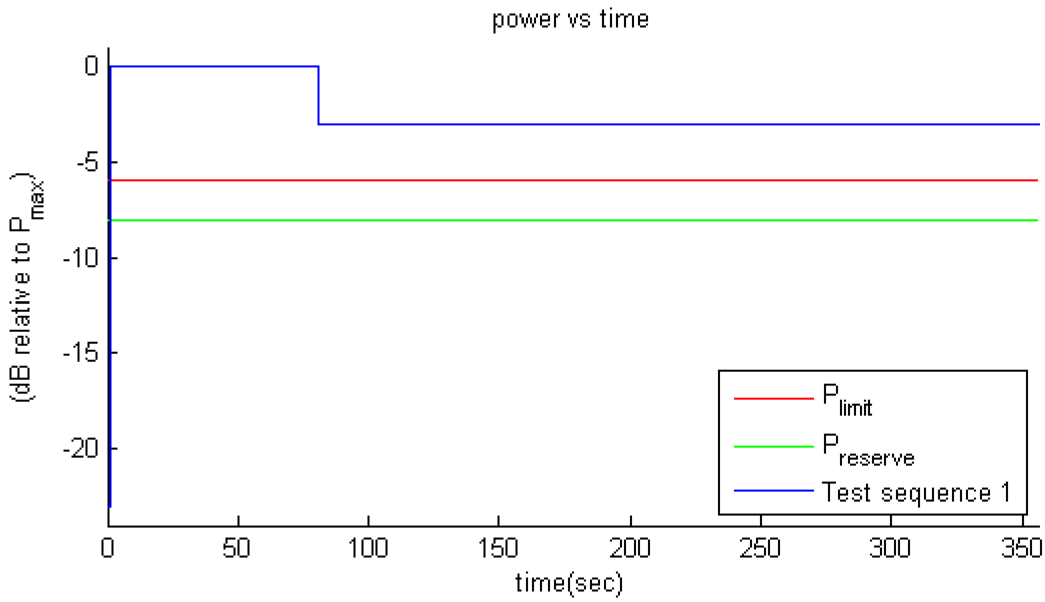

Figure 1 Test sequence 1 waveform