

## Appendix H: Wi-Fi Time-Averaged SAR (TAS) Verification

Model Name: A3289

Date: 8/15/2024

### H. Wi-Fi Time-Averaged SAR (TAS) Verification

#### H.1. Introduction

The DUT supports time-averaged SAR (TAS) technology for the WLAN transmitters. This TAS implementation does not monitor actual output power level, instead it conservatively assumes the WLAN transmitters are operating at the maximum allowable output power for the averaging power calculation. Power levels in different bands with different operating states and power limits are not directly comparable so the TAS algorithm instead tracks the ratio of energy contribution relative to the available energy budget for each transmitter.

This resulting “utilization ratio” for a particular WLAN transmitter can then be added to the utilization ratio for all other WLAN transmitters in the device over the same time-period to derive the total WLAN system utilization ratio. The DUT supports 6GHz. Consistent with FCC guidance on compliance with time averaging exposure limits, the TAS implementation uses the total WLAN utilization ratio over a nominal 30 second time window to manage the transmitter power level and ensure that the DUT does not exceed the average power levels documented in UL FCC SAR report #14982490-S1.

To validate the proper functioning of the time-average algorithm of this device, the following test scenarios were performed. These scenarios define the operation of the algorithm in all operational states:

1. Antenna Switching – switching between different antennas on a given channel
2.  $P_{lim}$  Switching – switching between different  $P_{lims}$  for a given channel.
3. Band Switching – switching between antennas on channels in different bands and at different  $P_{lims}$ .

Predefined transmit profiles for each test scenario were created in test automation software to control the operation of the DUT while synchronized operation data was recorded from internal firmware and external power monitors. The data was plotted over time relative to the utilization limit to demonstrate that the utilization ratio never exceeds 100%. The DUT WLAN chipset applies a 1.5 dB uncertainty budget to all power control functions.

Test scenarios were agreed upon with the FCC via KDB inquiry.

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### H.2. Test Setup

The DUT supported chipset allows each antenna to have up to 200% Aggregated SAR Utilization, one radio is transmitting while the other is idle for Non-SDB mode. On the active radio, Aggregated SAR Utilization can go up to 200% by leveraging the unused SAR budget of the idle radio. Test results in §H.3 will show that average SAR Utilization ratio never exceeds 100% for all test cases.

The power optimization ( $P_{opt}$ ) setting for both antennas is a 3dB increase from  $P_{lim}$ . This applies to 2.4GHz, 5GHz and 6GHz. The measurements are performed with a fixed  $P_{lim}$ . Please see  $P_{lim}$  and  $P_{opt}$  parameters used for testing in the tables below.

Test automation is used to ensure that all WLAN 2.4GHz, 5GHz and 6GHz transmissions are operating at maximum possible duty cycle during the test.

The DUT does NOT support SDB. Therefore, Non-SDB test procedure outlined in Appendix B of inquiry was followed. Only “reported” SAR Utilization data is required at the host level. For Non-SDB measurements, switching occurs between antennas at 120 seconds during the observation window.

#### 2.4GHz Parameters used during testing

WLAN radios were configured to operate at 100% duty cycle.

Mode	Cellular Status	Power (dBm)			
		Ant 3		Ant 4	
		$P_{lim}$	$P_{opt}$	$P_{lim}$	$P_{opt}$
802.11b	Cell off (dBm)	21.5	24.5	20.5	23.5
	Cell off (mW)	141	282	112	224
	Cell on (dBm)	17.75	20.75	16.5	19.5
	Cell on (mW)	60	119	45	89

#### 5GHz Parameters used during testing

WLAN radios were configured to operate at 100% duty cycle.

Mode	Cellular Status	Power (dBm)			
		Ant 5		Ant 6	
		$P_{lim}$	$P_{opt}$	$P_{lim}$	$P_{opt}$
802.11a	Cell off (dBm)	20.5	23.5	20.5	23.5
	Cell off (mW)	112	224	112	224
	Cell on (dBm)	18.00	21.0	20.50	23.5
	Cell on (mW)	63	126	112	224

#### 6GHz Parameters used during testing

WLAN radios were configured to operate at 100% duty cycle.

Mode	Cellular Status	Power (dBm)			
		Ant 5		Ant 6	
		$P_{lim}$	$P_{opt}$	$P_{lim}$	$P_{opt}$
802.11ax	Cell off (dBm)	12.5	15.5	9.25	12.25
	Cell off (mW)	18	35	8	17
	Cell on (dBm)	11.5	14.5	8.25	11.3
	Cell on (mW)	14	28	7	13

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### H.3. WLAN TAS Verification Test Results

The TAS implementation uses the total WLAN utilization ratio over a nominal 30 second time window (since DUT supports 6GHz) to manage the transmitter power level and ensure that the DUT does not exceed the average power levels documented in UL FCC SAR report #14982490-S1.

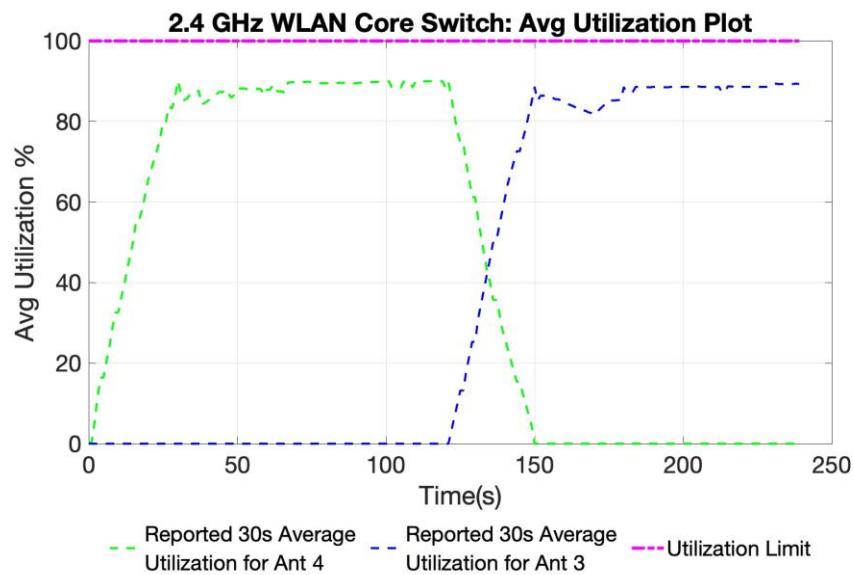
#### H.3.1. WLAN TAS Summary of Test Results

Summary of test results is illustrated below. Please refer to the proceeding sections for detailed test results for each Scenario.

Test Case	Section/ Figure	Band	Antenna / Mode		Reported/ Measured	Antenna	Limit	Time Window	Pass/ Fail	Notes
Scenario 1: Antenna Sw itching	H.3.2 Figure 1	2.4GHz	Ant 4 802.11b	Ant 3 802.11b	Reported	Ant 4 to Ant 3	100%	30 sec	Pass	Antenna sw itching at 120 seconds from Ant 4 to Ant 3 for a given channel.
	H.3.2 Figure 2	5GHz	Ant 6 802.11a	Ant 5 802.11a	Reported	Ant 6 to Ant 5	100%	30 sec	Pass	Antenna sw itching at 120 seconds from Ant 6 to Ant 5 for a given channel.
	H.3.2 Figure 3	6GHz	Ant 6 802.11a	Ant 5 802.11a	Reported	Ant 6 to Ant 5	100%	30 sec	Pass	Antenna sw itching at 120 seconds from Ant 6 to Ant 5 for a given channel.
Scenario 2: $P_{lim}$ Sw itching	H.3.3 Figure 4	2.4GHz	Ant 4 802.11b		Reported	Ant 4	100%	30 sec	Pass	$P_{lim}$ Sw itching from Cell on (Pow er state 4) to Cell off (Pow er state 1). Refer to tables in Section H.2 for $P_{lim}$ values.
	H.3.3 Figure 5	5GHz	Ant 6 802.11a		Reported	Ant 6	100%	30 sec	Pass	$P_{lim}$ Sw itching from Cell on (Pow er state 4) to Cell off (Pow er state 1). Refer to tables in Section H.2 for $P_{lim}$ values.
	H.3.3 Figure 6	6GHz	Ant 6 802.11a		Reported	Ant 6	100%	30 sec	Pass	$P_{lim}$ Sw itching from Cell on (Pow er state 4) to Cell off (Pow er state 1). Refer to tables in Section H.2 for $P_{lim}$ values.
Scenario 3: Band Sw itching	H.3.4 Figure 7	2.4GHz & 5GHz	Ant 4 802.11b	Ant 6 802.11a	Reported	Ant 4 to Ant 6	100%	30 sec	Pass	Band sw itching at 120 seconds from 2.4GHz Ant 4 to 5GHz Ant 6. Refer to tables in Section H.2 for $P_{lim}$ values.

#### H.3.2. Scenario 1: Antenna Switching Test Cases

The evaluation in Figure 1 shows switching between antennas on the 2.4GHz band at  $Time=120$  seconds. The test automation is controlling the WLAN radios to operate at 100% duty cycle. Figure 1 shows that the utilization ratio never exceeds 100%.



**Figure 1: 30 Second Aggregated SAR Utilization vs Time, 2.4GHz band**

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The evaluation in Figure 2 shows switching between antennas on the 5GHz band at *Time=120 seconds*. The test automation is controlling the WLAN radios to operate at 100% duty cycle. Figure 2 shows that the utilization ratio never exceeds 100%.

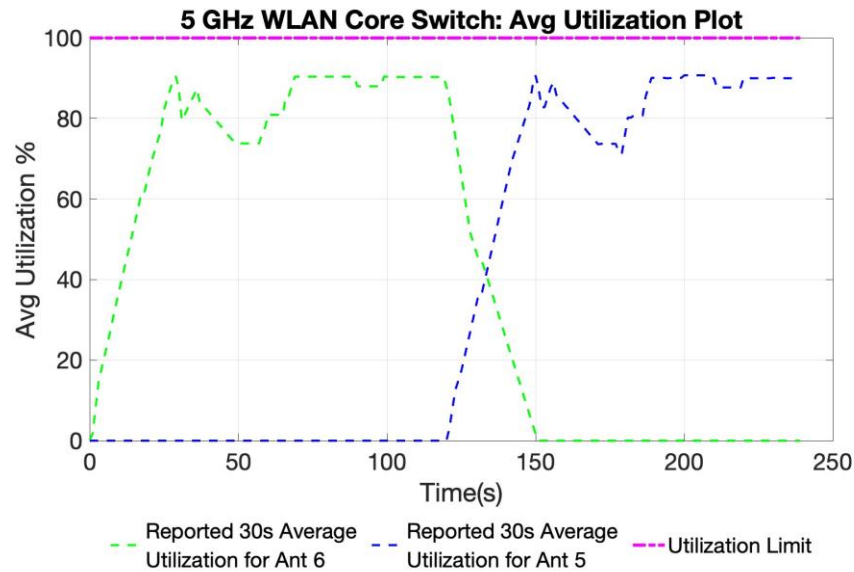


Figure 2: 30 Second Aggregated SAR Utilization vs Time, 5GHz band

The evaluation in Figure 3 shows switching between antennas on the 6GHz band at *Time=120 seconds*. The test automation is controlling the WLAN radios to operate at 100% duty cycle. Figure 3 shows that the utilization ratio never exceeds 100%.

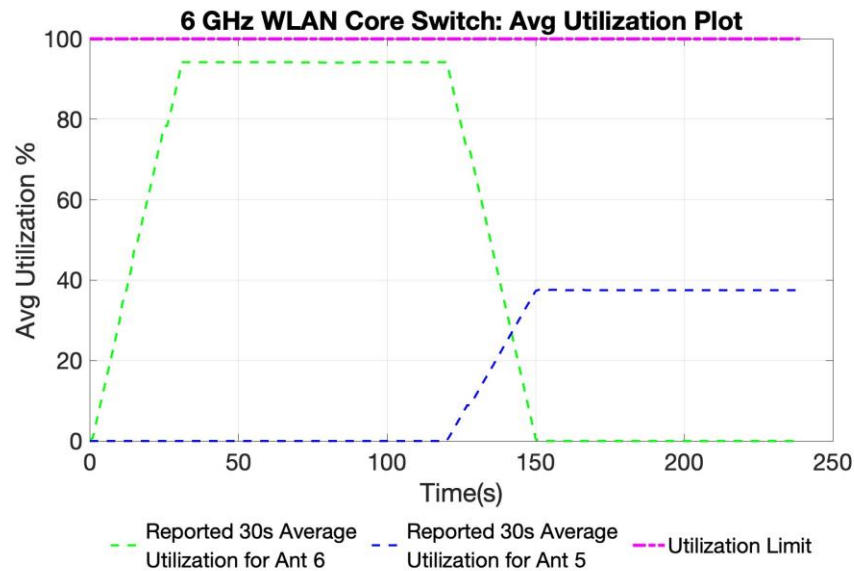


Figure 3: 30 Second Aggregated SAR Utilization vs Time, 6GHz band

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### H.3.3. Scenario 2: P<sub>lim</sub> Switching Test Cases

The evaluation in Figures 4 shows switching between Cell on (Power State 4) and Cell off (Power State 1) power states in the 2.4GHz band. The test automation is controlling the WLAN radios to operate at 100% duty cycle. Figure 4 shows that the utilization ratio never exceeds 100%.

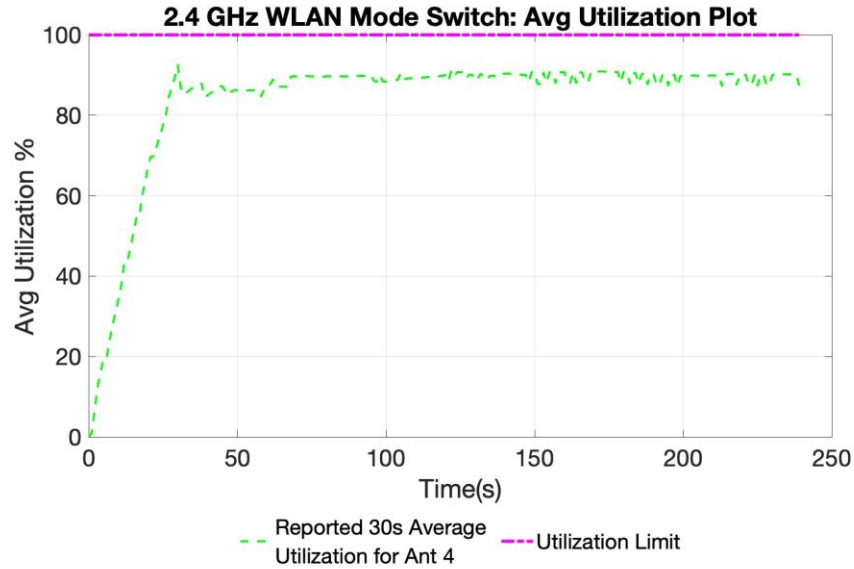


Figure 4: 30 Second Aggregated SAR Utilization vs Time during Mode Switch, 2.4GHz band

The evaluation in Figures 5 shows switching between Cell on (Power State 4) and Cell off (Power State 1) power states in the 5GHz band. The test automation is controlling the WLAN radios to operate at 100% duty cycle. Figure 5 shows that the utilization ratio never exceeds 100%.

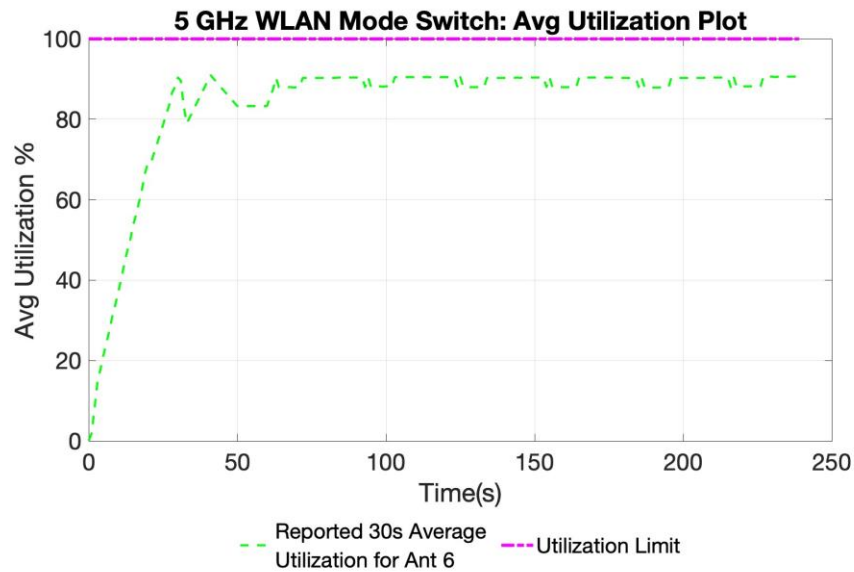


Figure 5: 30 Second Aggregated SAR Utilization vs Time during Mode Switch, 5GHz band

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The evaluation in Figures 6 shows switching between Cell on (Power State 4) and Cell off (Power State 1) power states in the 6GHz band. The test automation is controlling the WLAN radios to operate at 100% duty cycle. Figure 6 shows that the utilization ratio never exceeds 100%.

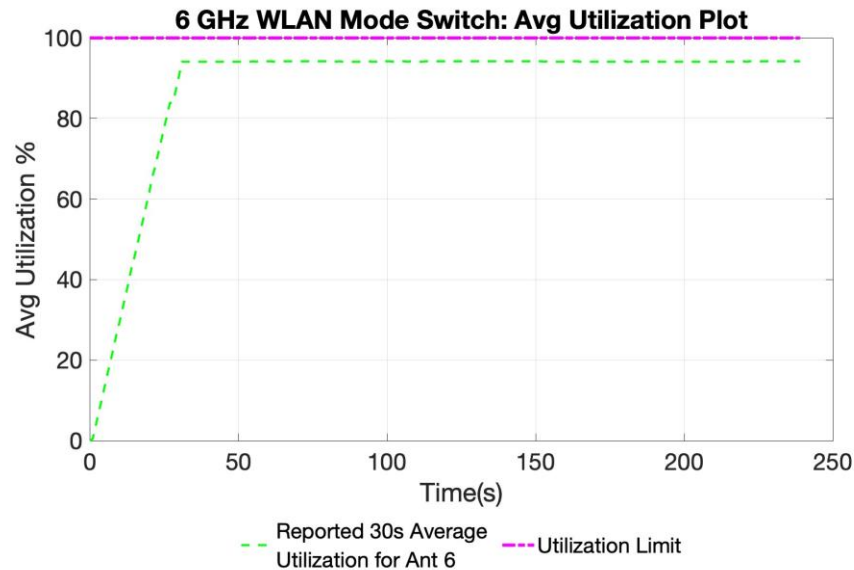


Figure 6: 30 Second Aggregated SAR Utilization vs Time during Mode Switch, 6GHz band

### H.3.4. Scenario 3: Band Switching Test Case

The evaluation in Figures 7 shows switching between 2.4GHz and 5GHz bands at  $Time=120\text{ seconds}$ . The test automation is controlling the WLAN radios to operate at 100% duty cycle. Figure 7 shows that the utilization ratio never exceeds 100%.

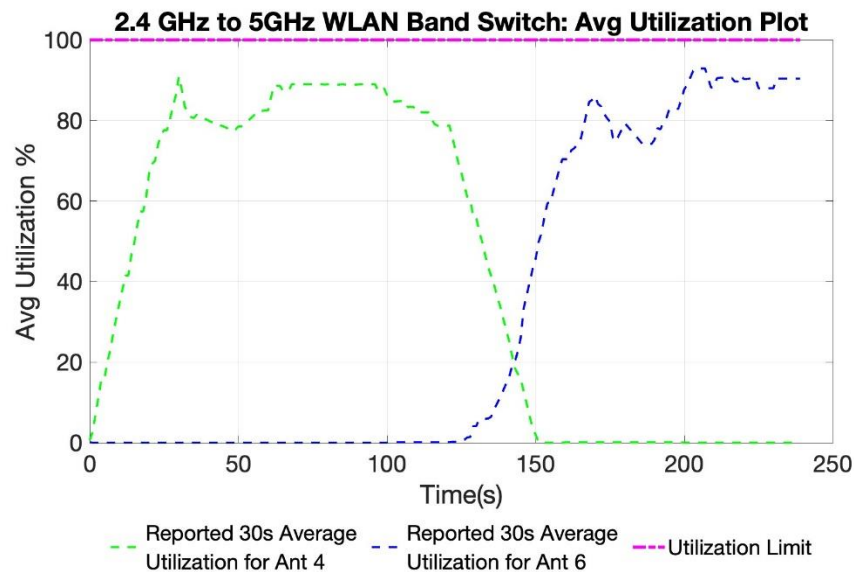


Figure 7: 30 Second Aggregated SAR Utilization vs Time during Band Switch