I. Wi-Fi Time-Averaged SAR (TAS) Verification

I.1. Introduction

The DUT supports time-averaged SAR (TAS) technology for the WLAN transmitters. This TAS implementation does not monitor actual outpower 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. Consistent with FCC guidance on compliance with time averaging exposure limits, the TAS implementation uses the total WLAN utilization ratio over a nominal 60 second time window to manage the transmitter power level and ensure that the DUT does not exceed the average power levels documented in the SAR report.

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. Change in Antenna
2. Change in Band/Channel
3. Change in Device State

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 maximum time-averaged power was never exceeded. Internally reported power values were captured via DUT firmware while conducted power was measured directly from the DUT antenna ports. These are referred to as Reported and Measured, respectively, in the test plots. 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.

2.4GHz Parameters used during testing

Channel/ Mode	Cellular Status	Power (dBm)			
		Ant 3		Ant 4	
		P_{lim}	P_{opt}	P_{lim}	P_{opt}
Ch 6 802.11b	Cell off (dBm)	21.5	24.5	20.25	23.25
	Cell off (mW)	141	282	106	211
	Cell on (dBm)	21.5	24.5	17.25	20.25
	Cell on (mW)	141	282	53	106

5GHz Parameters used during testing

Channel/ Mode	Cellular Status	Power (dBm)			
		Ant 5		Ant 6	
		P_{lim}	P_{opt}	P_{lim}	P_{opt}
Ch 149 802.11a	Cell off (dBm)	19.25	22.25	16.25	19.25
	Cell off (mW)	84	168	42	84
	Cell on (dBm)	15.25	18.25	12.25	15.25
	Cell on (mW)	33	67	17	33

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

I.2. WLAN TAS Verification Test Results

I.2.1. Scenario 1: Change in Antenna Test Case

The evaluation in Figures 1, 2 and 3 shows switching between antennas on the 2.4GHz band at *Time*=120s. The test automation is controlling the WLAN radios to operate at 100% duty cycle. Figure 1 shows that the utilization ratio never exceeds 100% and Figure 2 shows that the average transmit power never exceeds the average P_{lim}. Figure 3 shows the measured instantaneous power during the test.

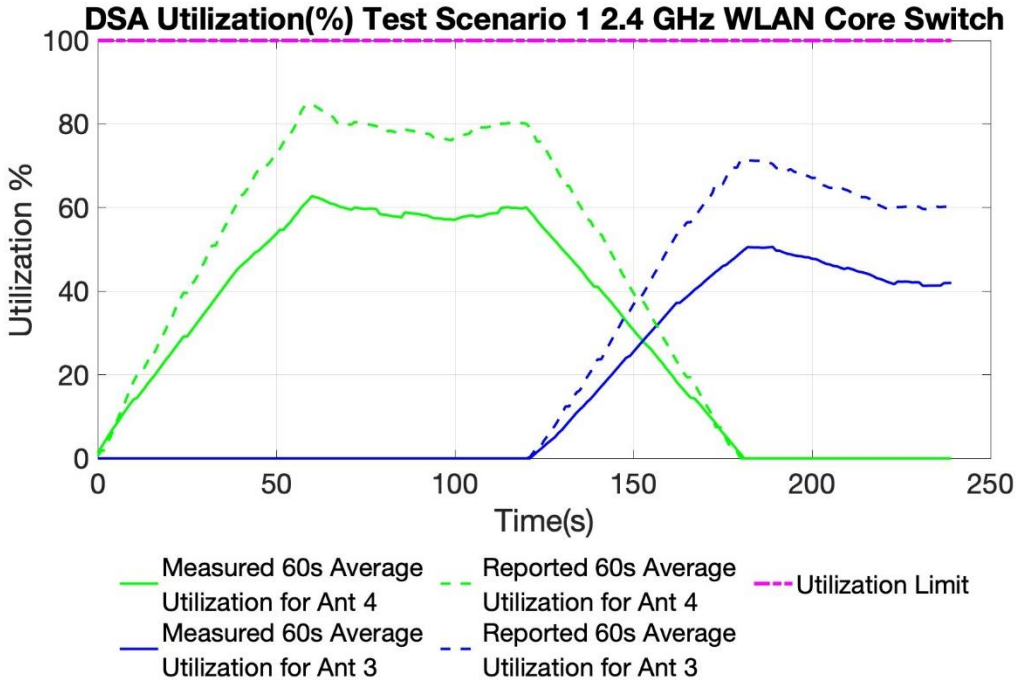

Figure 1: 60 Second Aggregated SAR Utilization vs Time, 2.4GHz

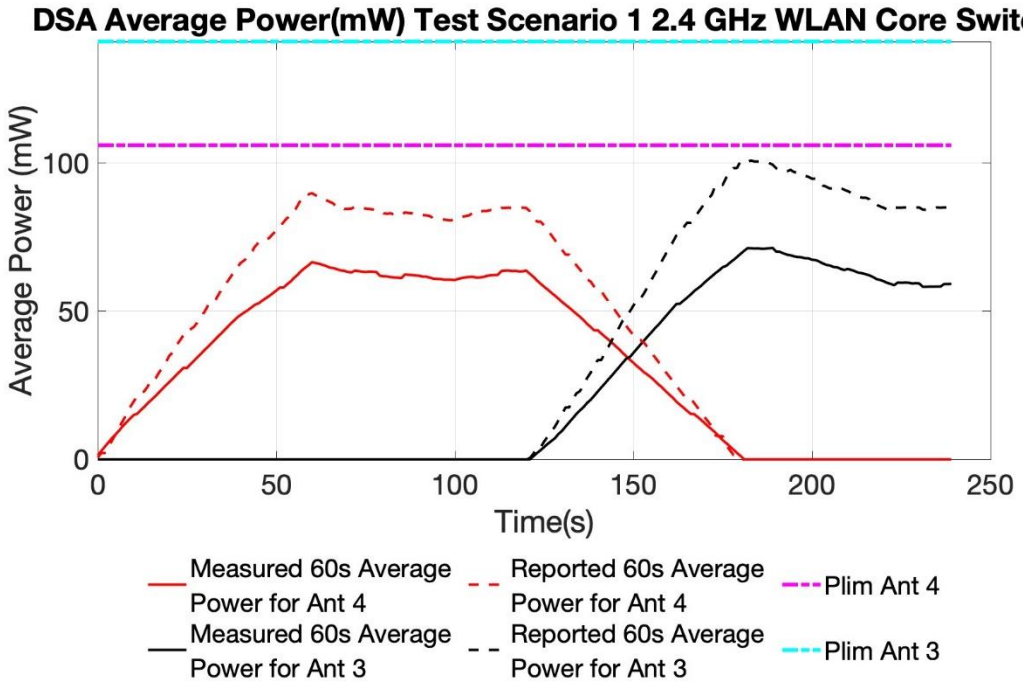

Figure 2: 60 Second Average Power vs Time, 2.4GHz

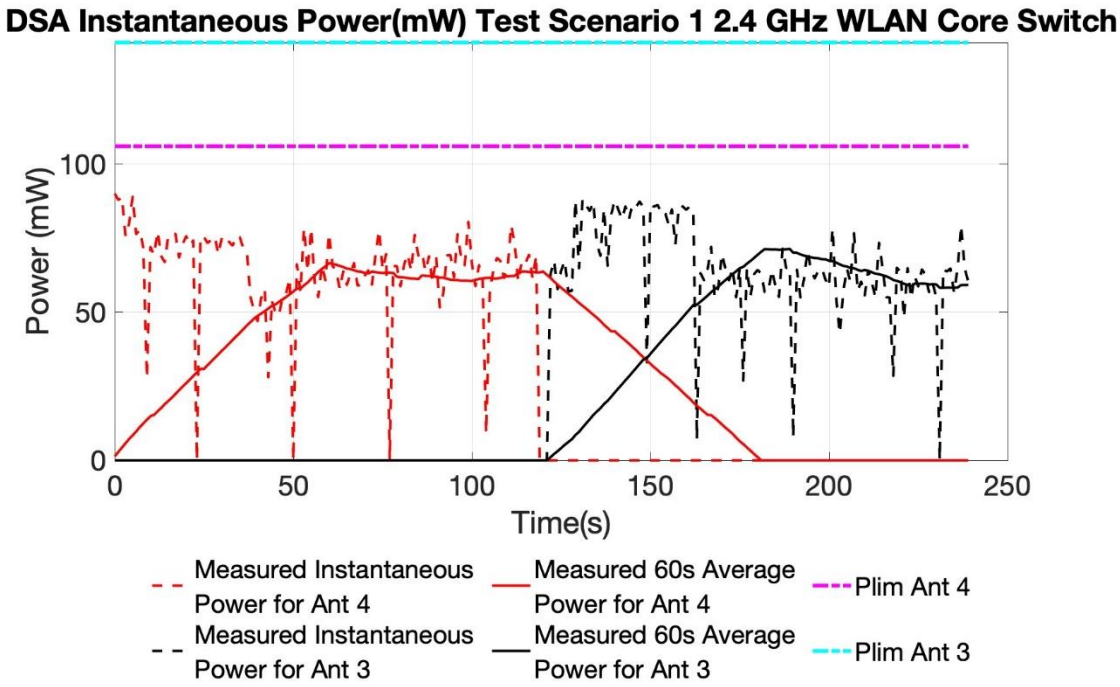

Figure 3: 60 Second Average Power vs Time and Instantaneous Power, 2.4GHz

The evaluation in Figures 4, 5 and 6 shows switching between antennas on the 5GHz band at *Time*=120s. The test automation is controlling the WLAN radios to operate at 100% duty cycle. Figure 4 shows that the utilization ratio never exceeds 100% and Figure 5 shows that the average transmit power never exceeds the average P_{lim}. Figure 6 shows the measured instantaneous power during the test.

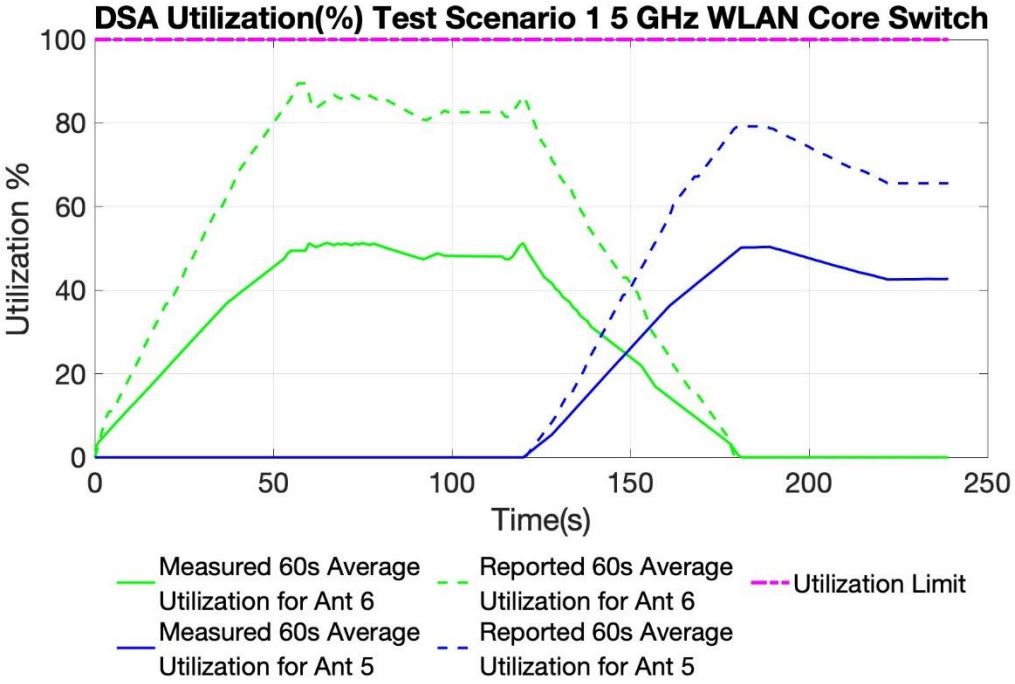

Figure 4: 60 Second Aggregated SAR Utilization vs Time, 5GHz

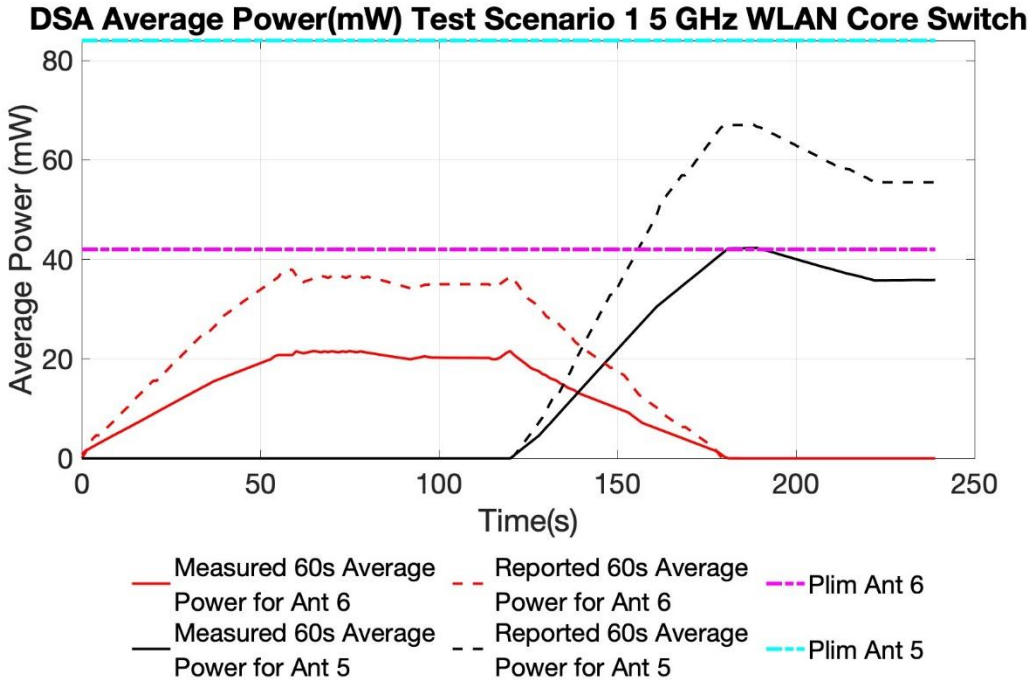

Figure 5: 60 Second Average Power vs Time, 5GHz

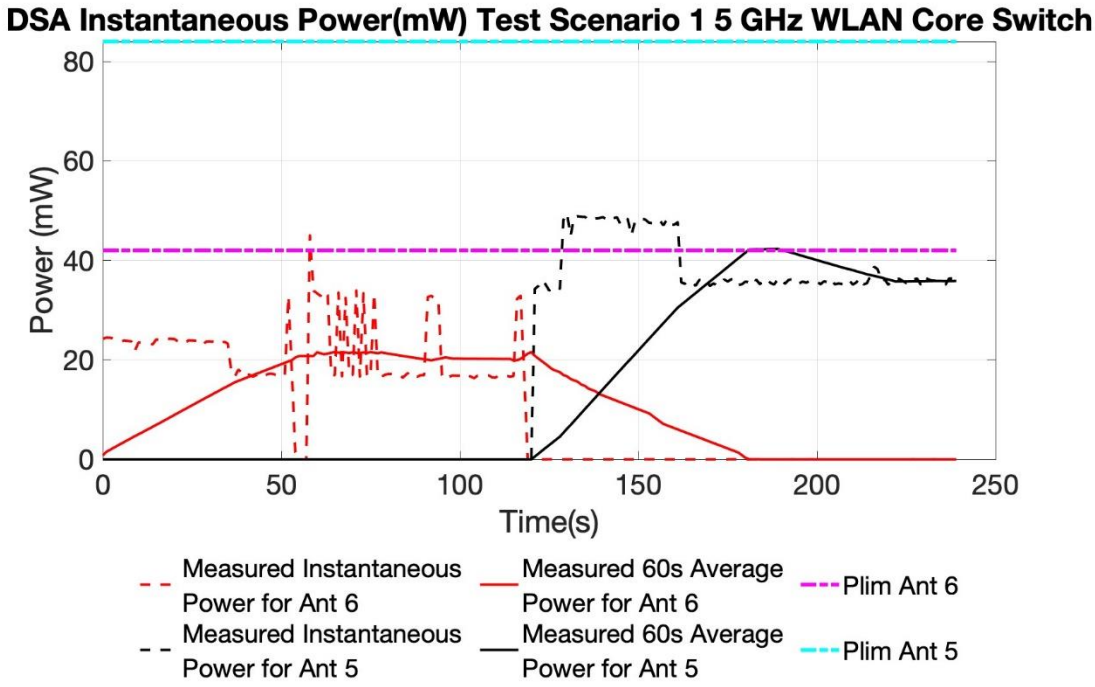

Figure 6: 60 Second Average Power vs Time and Instantaneous Power, 5GHz

I.2.2. Scenario 2: Change in Channel/Band Test Case

The evaluation in Figures 7, 8 and 9 shows switching between 2.4GHz and 5GHz bands at *Time*=120s. The test automation is controlling the WLAN radios to operate at 100% duty cycle. Figure 7 shows that the utilization ratio never exceeds 100% and Figure 8 shows that the average transmit power never exceeds the average P_{lim}. Figure 9 shows the measured instantaneous power during the test.

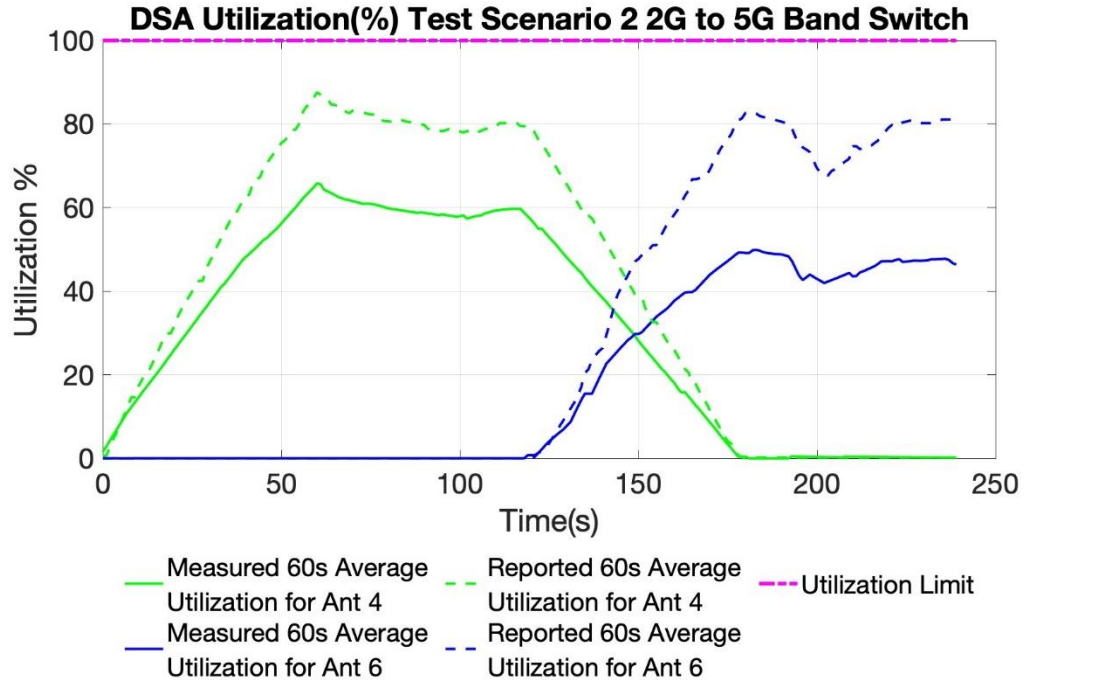

Figure 7: 60 Second Aggregated SAR Utilization vs Time during Band Switch

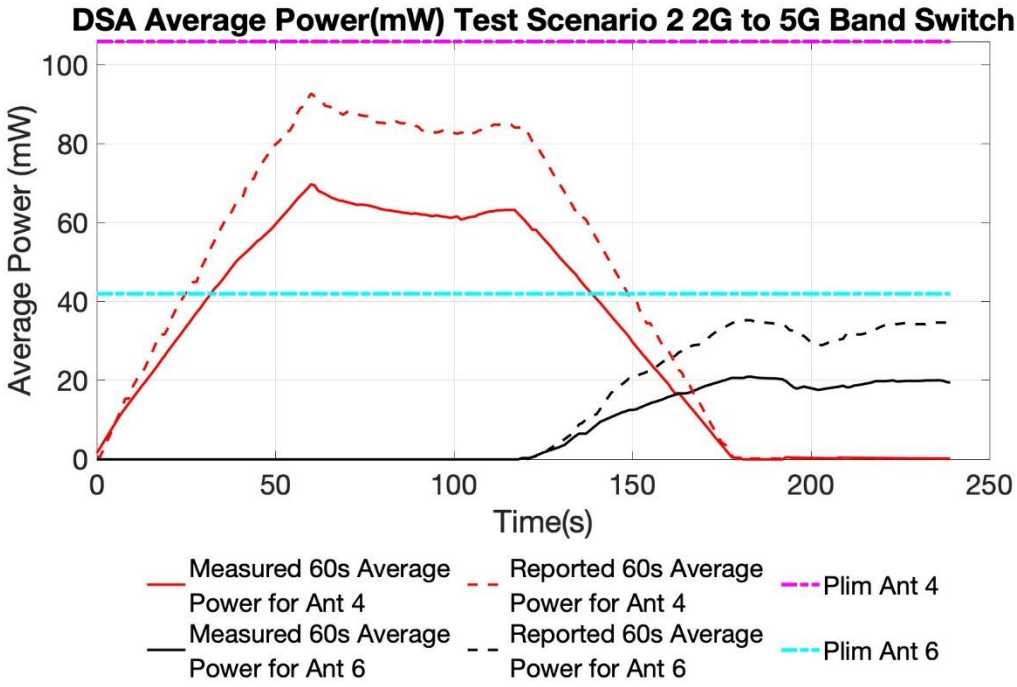

Figure 8: 60 Second Average Power vs Time during Band Switch

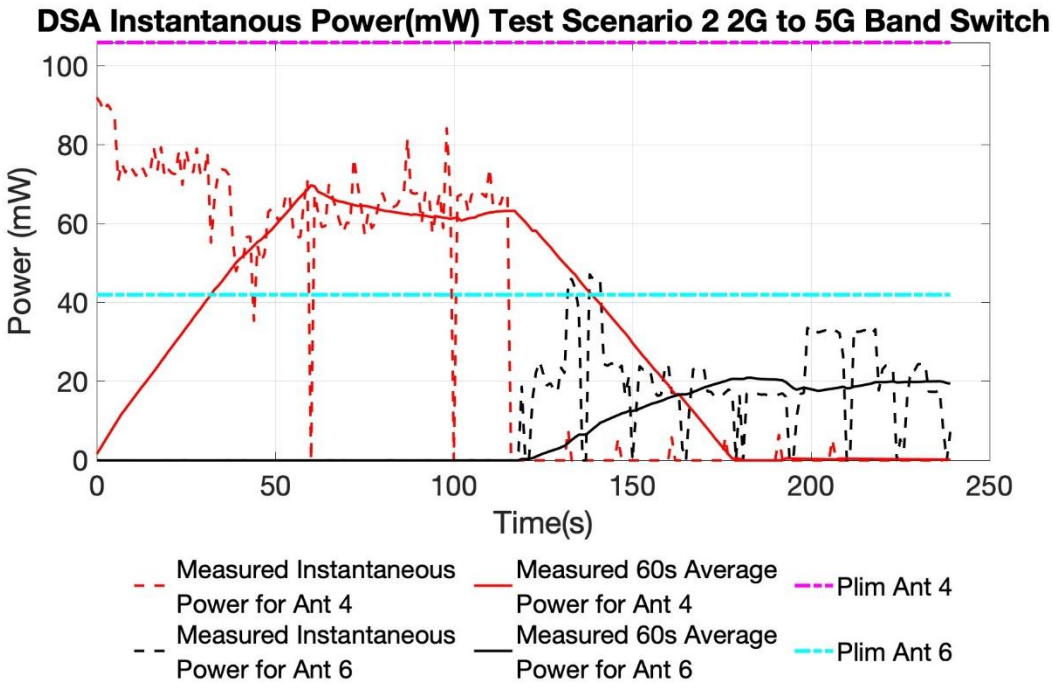

Figure 9: 60 Second Average Power vs Time during Band Switch and Instantaneous Power

I.2.3. Scenario 3: Change in Device State Test Case

The evaluation in Figures 10, 11 and 12 shows switching between Cell on and Cell off in the 2.4GHz band at *Time*=120s. The test automation is controlling the WLAN radios to operate at 100% duty cycle. Figure 10 shows that the utilization ratio never exceeds 100% and Figure 11 shows that the average transmit power never exceeds the average P_{lim}. Figure 12 shows the measured instantaneous power during the test.

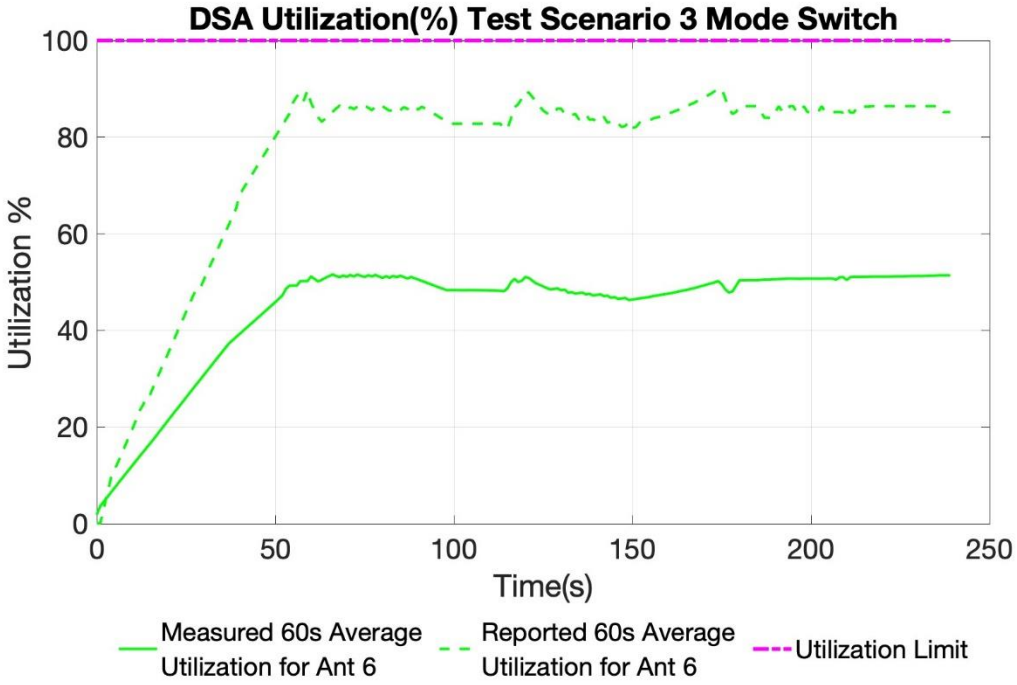

Figure 10: 60 Second Aggregated SAR Utilization vs Time during Mode Switch

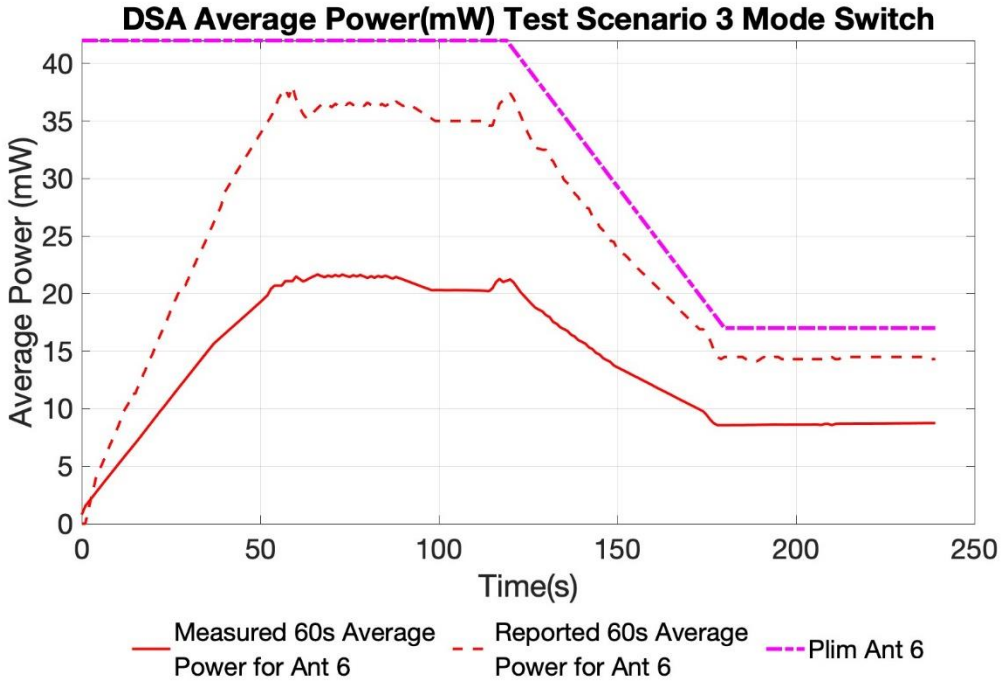

Figure 11: 60 Second Average Power vs Time during Mode Switch

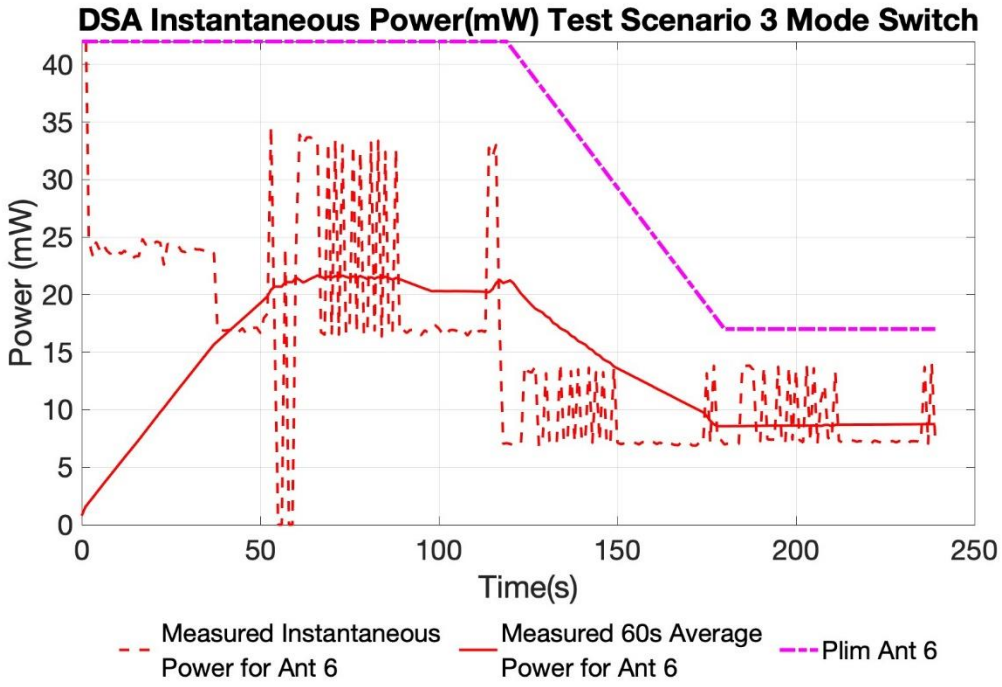

Figure 12: 60 Second Average Power vs Time during Mode Switch and Instantaneous Power