APPENDIX E: SIMULTANEOUS NUMERICAL CALCULATIONS

E.1 Introduction

The following procedures adopted from FCC KDB Publication 447498 D01v06 are applicable to devices with built-in unlicensed transmitters such as 802.11 and Bluetooth devices which may simultaneously transmit with the licensed transmitter.

E.2 Simultaneous Transmission Procedures

This device contains transmitters that may operate simultaneously. Therefore, simultaneous transmission analysis is required. Per FCC KDB Publication 447498 D01v06 4.3.2 and IEEE 1528-2013 Section 6.3.4.1.2, simultaneous transmission SAR test exclusion may be applied when the sum of the 1g SAR for all the simultaneous transmitting antennas in a specific a physical test configuration is ≤1.6 W/kg. The different test positions in an exposure condition may be considered collectively to determine SAR test exclusion according to the sum of 1g or 10g SAR.

Per FCC KDB Publication 941225 D06v02r01, the devices edges with antennas more than 2.5 cm from edge are not required to be evaluated for SAR ("-").

(*) For test positions that were not required to be evaluated for WLAN SAR per FCC KDB publication 248227, the worst case WLAN SAR result for the applicable exposure conditions was used for simultaneous transmission analysis.

This device is enabled with Qualcomm® Smart Transmit Gen2 with pre-defined sub6 antenna groups (AG0 and AG1). Simultaneous transmission analysis is performed per antenna groups. Appendix D contains analysis to demonstrate the AG0 and AG1 are operate mutually exclusive. Additional analysis is provided below to show compliance between AG0 and BT/WLAN and AG1 BT/WLAN.

When operating in the same antenna group, Qualcomm Smart Transmit algorithm in WWAN directly adds the time-averaged RF exposure from 4G and time-averaged RF exposure from 5G NR. Smart Transmit algorithm controls the total RF exposure from both 4G and 5G NR to not exceed FCC limit. Therefore, simultaneous transmission compliance between 4G+5G operations within an antenna group is demonstrated in the Part 2 Report during algorithm validation.

Please refer to Appendix D in the original filing in for highest reported simultaneous SAR of WLAN/BT antennas.

E.3 Head Simultaneous Transmission Analysis

Table E-1
Simultaneous Transmission Scenario with WLAN/BT (Held to Ear)

	Configuration	AG0	AG1	WLAN/BT Worst-case Combination	AG0 + WLAN/BT	AG1 + WLAN/BT
Head SAR	Right Cheek	0.174	0.899	0.691	0.865	**1.590**
	Right Tilt	0.117	0.767	0.205	0.322	0.972
	Left Cheek	0.280	0.746	0.322	0.602	1.068
	Left Tilt	0.123	0.901	0.119	0.242	1.020

E.4 Body-worn Simultaneous Transmission Analysis

Table E-2
Simultaneous Transmission Scenario with WLAN/BT (Body-worn at 1.5 cm)

	Configuration	AG0	AG1	WLAN/BT Worst-case Combination	AG0 + WLAN/BT	AG1 + WLAN/BT
Bodyworn SAR	Back	0.782	0.180	0.335	1.117	0.515

E.5 Hotspot Simultaneous Transmission Analysis

Table E-3
Simultaneous Transmission Scenarios with WLAN/BT (Hotspot at 1.0 cm)

	Configuration	AG0	AG1	WLAN/BT Worst-case Combination	AG0 + WLAN/BT	AG1 + WLAN/BT
Hotspot SAR	Back	1.065	0.230	0.467	1.532	0.697
	Front	0.628	0.161	0.261	0.889	0.422
	Top	0.000	0.476	0.095	0.095	0.571
	Bottom	1.234	0.000	-	1.234	0.000
	Right	0.302	0.079	-	0.302	0.079
	Left	0.314	0.342	0.475	0.789	0.817

E.6 Phablet Simultaneous Transmission Analysis

Per FCC KDB Publication 648474 D04 Handset SAR, Phablet SAR tests were not required if wireless router 1g SAR (scaled to the maximum output power, including tolerance) < 1.2 W/kg. Therefore, no further analysis beyond the tables included in this section was required to determine that possible simultaneous transmission scenarios would not exceed the SAR limit.

Table E-4
Simultaneous Transmission Scenarios with WLAN/BT (Phablet Max DSI= 0)

	Configuration	AG0	AG1	WLAN/BT Worst-case Combination	AG0 + WLAN/BT	AG1 + WLAN/BT
Phablet SAR	Back	1.781	0.880	1.148	2.929	2.028
	Front	1.466	0.000	1.148	2.614	1.148
	Top	0.000	2.330	1.148	1.148	3.478
	Bottom	1.397	0.000	-	1.397	0.000
	Right	1.136	0.000	-	1.136	0.000
	Left	0.348	3.111	0.879	1.227	**3.990**

Table E-5
Simultaneous Transmission Scenarios with WLAN/BT (Phablet Reduced DSI= 1)

	Configuration	AG0	AG1	WLAN/BT Worst-case Combination	AG0 + WLAN/BT	AG1 + WLAN/BT
Phablet SAR	Back	2.968	0.880	1.148	See Note 1	2.028
	Front	2.115	0.000	1.148	3.263	1.148
	Top	0.000	2.330	1.148	1.148	3.478
	Bottom	2.923	0.000	-	2.923	0.000
	Right	1.136	0.000	-	1.136	0.000
	Left	0.348	3.111	0.879	1.227	**3.990**

Notes:

1. For configurations where the sum an AG+WLAN/BT is greater than 4.0 W/kg, further breakdown evaluation of the simultaneous combinations was needed.

For SAR summation, the highest reported SAR across all test distances was used as the most conservative evaluation for simultaneous transmission analysis for each device edge.

Table E-6
Simultaneous Transmission Scenario of with 5 GHz WLAN MIMO (Phablet Reduced DSI= 1)

Configuration	Mode	2G/3G/4G/5G SAR (W/kg)	5 GHz WLAN MIMO SAR (W/kg)	Σ SAR (W/kg)
		1	2	1+2
Phablet SAR Back Side DSI = 1	GPRS 1900 Ant A	1.271	1.148	2.419
	UMTS 1750 Ant A	1.549	1.148	2.697
	UMTS 1900 Ant A	1.621	1.148	2.769
	LTE Band 66 (AWS) Ant A	1.480	1.148	2.628
	LTE Band 25 (PCS) Ant A	1.086	1.148	2.234
	LTE Band 2 (PCS) Ant A	1.507	1.148	2.655
	LTE Band 41 Ant B	2.968	1.148	See Table Below
	NR Band n66 (AWS) Antenna A	1.492	1.148	2.640
	NR Band n25 (PCS) Antenna A	2.210	1.148	3.358
	NR Band n41 Antenna B	1.144	1.148	2.292
	NR Band n41 Antenna D	1.088	1.148	2.236
	NR Band n77 DoD Antenna D	0.558	1.148	1.706

Simult Tx	Configuration	LTE Band 41 Ant B SAR (W/kg)	5 GHz WLAN MIMO SAR (W/kg)	Σ SAR (W/kg)	SPLSR
		1	2	1+2	1+2
Phablet SAR	Back	2.968	1.148	See Note 1	0.05

Notes:

1. No evaluation was performed to determine the aggregate 10g SAR for these configurations as the SPLS ratio between the antenna pairs was not greater than 0.10 per FCC KDB 447498 D01v06. See Section E.7 for detailed SPLS ratio analysis.

Table E-7
Simultaneous Transmission Scenario with 6 GHz WLAN MIMO (Phablet Reduced DSI= 1)

Configuration	Mode	2G/3G/4G/5G SAR (W/kg)	6 GHz WLAN MIMO SAR (W/kg)	Σ SAR (W/kg)
		1	2	1+2
Phablet SAR Back Side DSI = 1	GPRS 1900 Ant A	1.271	0.097	1.368
	UMTS 1750 Ant A	1.549	0.097	1.646
	UMTS 1900 Ant A	1.621	0.097	1.718
	LTE Band 66 (AWS) Ant A	1.480	0.097	1.577
	LTE Band 25 (PCS) Ant A	1.086	0.097	1.183
	LTE Band 2 (PCS) Ant A	1.507	0.097	1.604
	LTE Band 41 Ant B	2.968	0.097	3.065
	NR Band n66 (AWS) Antenna A	1.492	0.097	1.589
	NR Band n25 (PCS) Antenna A	2.210	0.097	2.307
	NR Band n41 Antenna B	1.144	0.097	1.241
	NR Band n41 Antenna D	1.088	0.344	1.432
	NR Band n77 DoD Antenna D	0.558	0.097	0.655

E.7 SPLSR Evaluation and Analysis

Per FCC KDB Publication 447498 D01v06, when the sum of the standalone transmitters is more than 1.6 W/kg for 1g and 4 W/kg for 10g, the SAR sum to peak locations can be analyzed to determine SAR distribution overlaps. When the SAR peak to location ratio (shown below) for each pair of antennas is ≤ 0.04 for 1g and ≤ 0.10 for 10g, simultaneous SAR evaluation is not required. The distance between the transmitters was calculated using the following formula.

$$\text{Distance}_{Tx1-Tx2} = R_i = \sqrt{(x_1 - x_2)^2 + (y_1 - y_2)^2} \text{ (Phablet)}$$

$$\text{SPLS Ratio} = \frac{(SAR_1 + SAR_2)^{1.5}}{R_i}$$

E.7.1 Phablet Back Side SPLSR Evaluation and Analysis

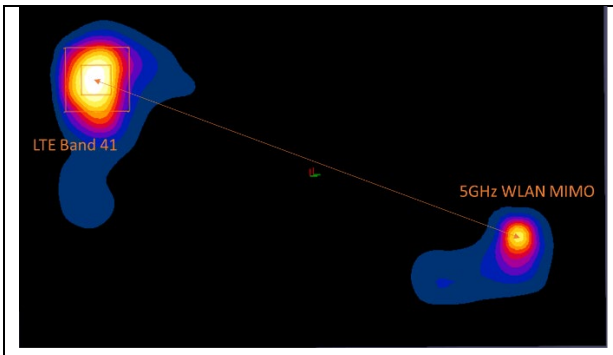
Table E-8
Peak SAR Locations for Phablet Back Side

Mode/Band	x (mm)	y (mm)
5 GHz WLAN MIMO	0.80	71.10
LTE Band 41 Ant B	-57.70	-72.80

Table E-9
Phablet Back Side SAR to Peak Location Separation Ratio Calculations

Antenna Pair		Standalone SAR (W/kg)		Standalone SAR Sum (W/kg)	Peak SAR Separation Distance (mm)	SPLS Ratio	Plot Number
Ant "a"	Ant "b"	a	b	a+b	D_{a-b}	$(a+b)^{1.5}/D_{a-b}$	
5 GHz WLAN MIMO	LTE Band 41 Ant B	1.148	2.968	4.116	155.34	0.05	1

Table E-10
Phablet Back Side SAR to Peak Location Separation Ratio Plots



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E.8 Simultaneous Transmission Conclusion

The above numerical summed SAR results and SPLSR are sufficient to determine that simultaneous transmission cases will not exceed the SAR limit and therefore no measured volumetric simultaneous SAR summation is required per FCC KDB Publication 447498 D01v06 and IEEE 1528- 2013 Section 6.3.4.1.