

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.

The standalone reported SAR and antenna group separation distances in the original filing were used to determine simultaneous transmission compliance as they are more conservative. Please see the original filing for complete evaluation of simultaneous transmission analysis and standalone reported SAR for modes and bands not evaluated for this permissive change.



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 (“-“).

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.

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E.3 Head Simultaneous Transmission Analysis

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

Head SAR	Configuration	AG0 SAR (W/kg)	AG1 SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	AG0 + WLAN/BT SAR (W/kg)	AG1 + WLAN/BT SAR (W/kg)
	Right Cheek	0.326	0.398	0.868	1.194	1.266
	Right Tilt	0.162	0.527	0.454	0.616	0.981
	Left Cheek	0.335	0.642	0.450	0.785	1.092
	Left Tilt	0.203	0.960	0.408	0.611	1.368

E.4 Body-worn Simultaneous Transmission Analysis



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

Bodyworn SAR	Configuration	AG0 SAR (W/kg)	AG1 SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	AG0 + WLAN/BT SAR (W/kg)	AG1 + WLAN/BT SAR (W/kg)
	Back	0.936	0.254	0.306	1.242	0.560

E.5 Hotspot Simultaneous Transmission Analysis

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

Hotspot SAR	Configuration	AG0 SAR (W/kg)	AG1 SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	AG0 + WLAN/BT SAR (W/kg)	AG1 + WLAN/BT SAR (W/kg)
	Back	0.748	0.491	0.466	1.214	0.957
	Front	0.480	0.434	0.363	0.843	0.797
	Top	-	0.809	0.363	0.363	1.172
	Bottom	1.133	-	-	1.133	-
	Right	0.486	0.147	-	0.486	0.147
	Left	0.410	0.563	0.403	0.813	0.966

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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)

Phablet SAR	Configuration	AG0 SAR	AG1 SAR	WLAN/BT	AG0 +	AG1 +
		(W/kg)	(W/kg)	Worst-case Combination SAR (W/kg)	WLAN/BT SAR (W/kg)	WLAN/BT SAR (W/kg)
	Back	1.942	1.317	1.192	3.134	2.509
	Front	1.310	-	0.752	2.062	0.752
	Top	-	1.824	0.133	0.133	1.957
	Bottom	1.600	-	-	1.600	-
	Right	0.500	-	-	0.500	-
	Left	1.159	3.130	0.549	1.708	3.679

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

Phablet SAR	Configuration	AG0 SAR	AG1 SAR	WLAN/BT	AG0 +	AG1 +
		(W/kg)	(W/kg)	Worst-case Combination SAR (W/kg)	WLAN/BT SAR (W/kg)	WLAN/BT SAR (W/kg)
	Back	3.105	1.317	1.192	See Note 1	2.509
	Front	2.230	-	0.752	2.982	0.752
	Top	-	1.824	0.133	0.133	1.957
	Bottom	2.958	-	-	2.958	-
	Right	0.500	-	-	0.500	-
	Left	1.159	3.130	0.549	1.708	3.679

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.



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

Configuration	Mode	2G/3G/4G/5G SAR (W/kg)	5 GHz WLAN MIMO SAR (W/kg)	6 GHz WLAN MIMO SAR (W/kg)	Σ SAR (W/kg)		SPLSR
		1	2	3	1+2	1+3	1+2
Phablet SAR Back Side DSI = 1	LTE Band 41	3.105	1.192	0.258	See Note 1	3.363	0.06
	NR Band n25 (PCS)	2.253	1.192	0.258	3.445	2.511	N/A
	NR Band n77 DoD Antenna D	1.942	1.192	0.258	3.134	2.200	N/A

Note: 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.

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.

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

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



E.7.1 Phablet Back Side (Phablet Reduced DSI = 1) SPLSR Evaluation and Analysis

Table E-7
Peak SAR Locations for Phablet Back Side (Phablet Reduced DSI = 1)

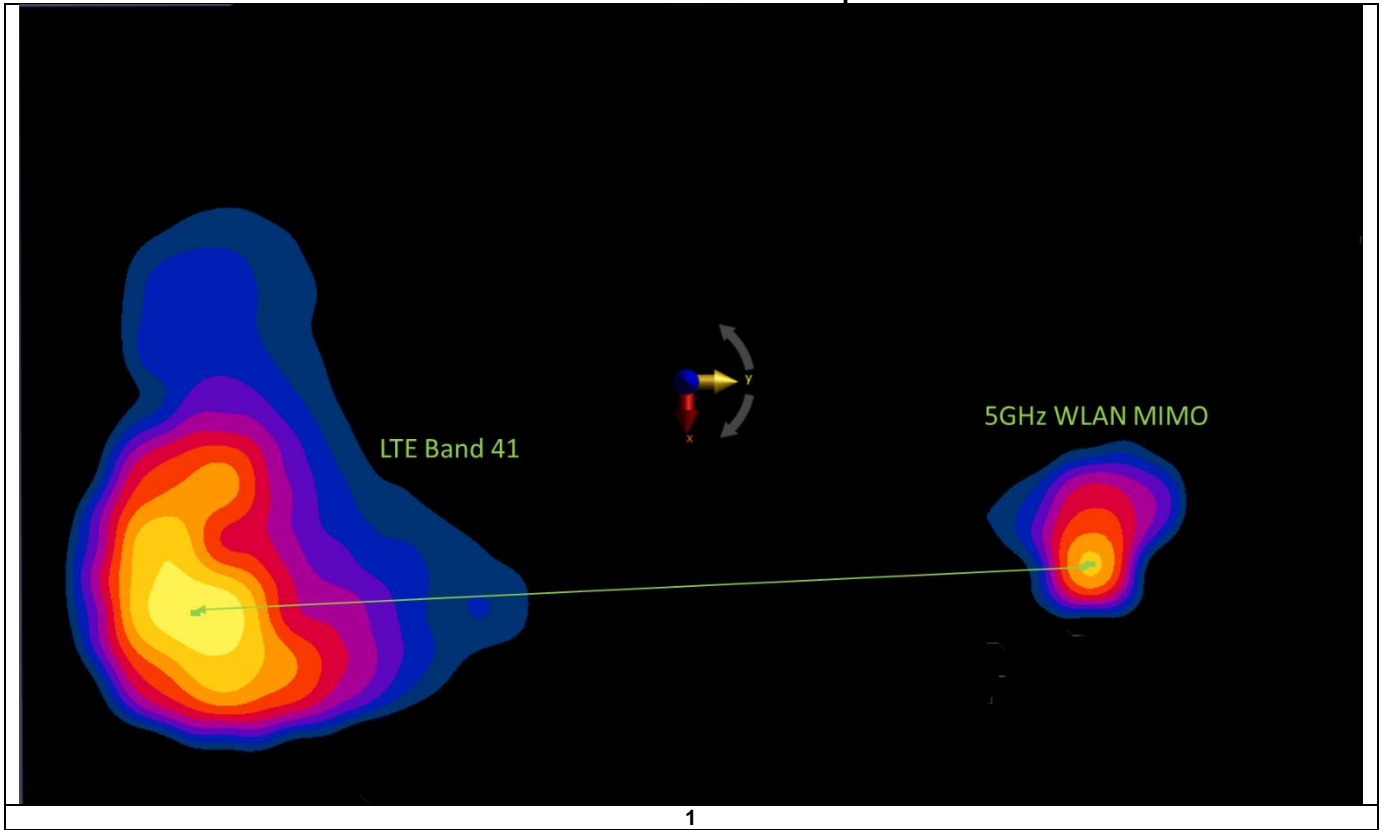
Mode/Band	x (mm)	y (mm)
5 GHz WLAN MIMO	0.60	61.90
LTE Band 41	2.60	-75.50

Table E-8
Phablet Back Side SAR to Peak Location Separation Ratio Calculations (Phablet Reduced DSI = 1)

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}	
LTE Band 41	5 GHz WLAN MIMO	3.105	1.192	4.297	137.41	0.06	1



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



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.

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