

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 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.

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E.3 Head Simultaneous Transmission Analysis



Table E-1
Simultaneous Transmission Scenarios of WLAN/BT (Held to Ear)

Configuration	2.4 GHz WLAN Ant 2	2.4 GHz WLAN MIMO	2.4 GHz Bluetooth	5 GHz WLAN Ant 1	5 GHz WLAN MIMO
Right Cheek	0.154*	0.488	0.231	0.477	0.515
Right Tilt	0.154	0.208	0.047	0.477*	0.515*
Left Cheek	0.154*	0.488*	0.105	0.253	0.185
Left Tilt	0.154*	0.130	0.022	0.037	0.040

Configuration	2.4 GHz WLAN MIMO	5 GHz WLAN Ant 1	5 GHz WLAN MIMO	2.4 GHz WLAN MIMO + 5 GHz WLAN MIMO	2.4 GHz Bluetooth	2.4 GHz Bluetooth + 2.4 GHz WLAN Ant 2	2.4 GHz Bluetooth + 5 GHz WLAN Ant 1	2.4 GHz Bluetooth + 5 GHz WLAN MIMO	2.4 GHz Bluetooth + 2.4 GHz WLAN Ant 2 + 5 GHz WLAN Ant 1	2.4 GHz Bluetooth + 2.4 GHz WLAN Ant 2 + 5 GHz WLAN MIMO	WLAN/BT Worst-case Combination
Right Cheek	0.488	0.477	0.515	1.003	0.231	0.385	0.708	0.746	0.862	0.900	1.003
Right Tilt	0.208	0.477	0.515	0.723	0.047	0.201	0.524	0.562	0.678	0.716	0.723
Left Cheek	0.488	0.253	0.185	0.673	0.105	0.259	0.358	0.290	0.512	0.444	0.673
Left Tilt	0.130	0.037	0.040	0.170	0.022	0.176	0.059	0.062	0.213	0.216	0.216

Table E-2
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	0.432	0.584	1.003	1.435	1.587
	Right Tilt	0.222	0.616	0.723	0.945	1.339
	Left Cheek	0.325	0.911	0.673	0.998	1.584
	Left Tilt	0.210	1.041	0.216	0.426	1.257

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E.4 Body-worn Simultaneous Transmission Analysis




Table E-3
Simultaneous Transmission Scenarios of WLAN/BT (Body-worn at 1.5 cm)

Configuration	2.4 GHz WLAN Ant 2 at 14dBm	2.4 GHz WLAN Ant 2	2.4 GHz WLAN MIMO	2.4 GHz WLAN MIMO at 17 dBm	2.4 GHz Bluetooth	5 GHz WLAN Ant 1	5 GHz WLAN MIMO	5 GHz WLAN MIMO at 15 dBm
Back	0.075	0.146	0.224	0.111	0.064	0.189	0.274	0.095

Configuration	2.4 GHz WLAN MIMO	5 GHz WLAN Ant 1	5 GHz WLAN MIMO	2.4 GHz WLAN MIMO at 17 dBm + 5 GHz WLAN MIMO at 15 dBm	2.4 GHz Bluetooth	2.4 GHz Bluetooth + 2.4 GHz WLAN Ant 2	2.4 GHz Bluetooth + 5 GHz WLAN Ant 1	2.4 GHz Bluetooth + 5 GHz WLAN MIMO	2.4 GHz Bluetooth + 2.4 GHz WLAN Ant 2 at 14dBm + 5 GHz WLAN Ant 1	2.4 GHz Bluetooth + 2.4 GHz WLAN Ant 2 at 14dBm + 5 GHz WLAN MIMO at 15 dBm	WLAN/BT Worst-case Combination
Back	0.224	0.189	0.274	0.206	0.064	0.210	0.253	0.338	0.328	0.234	0.338

Table E-4
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	0.946	0.251	0.338	1.284	0.589

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E.5 Hotspot Simultaneous Transmission Analysis



Table E-5
Simultaneous Transmission Scenarios of WLAN/BT (Hotspot at 1.0 cm)

Configuration	2.4 GHz WLAN Ant 2 at 14dBm	2.4 GHz WLAN Ant 2	2.4 GHz WLAN MIMO	2.4 GHz WLAN MIMO at 17 dBm	2.4 GHz Bluetooth	5 GHz WLAN Ant 1	5 GHz WLAN Ant 1 at 12dBm	5 GHz WLAN MIMO	5 GHz WLAN MIMO at 15 dBm
Back	0.189	0.401	0.477	0.287	0.134	0.108*	0.051	0.168	0.133
Front	0.189*	0.056	0.477*	0.287*	0.116	0.108*	0.051*	0.168*	0.133*
Top	0.189*	0.144	0.081	0.287*	0.024	-	-	0.168*	0.133*
Bottom	-	-	-	-	-	-	-	-	-
Right	-	-	-	-	-	-	-	-	-
Left	0.189*	0.016	0.374	0.287*	0.188	0.108	0.051*	0.168*	0.133*

Configuration	2.4 GHz WLAN MIMO	5 GHz WLAN Ant 1	5 GHz WLAN MIMO	2.4 GHz WLAN MIMO at 17 dBm + 5 GHz WLAN MIMO at 15 dBm	2.4 GHz Bluetooth	2.4 GHz Bluetooth + 2.4 GHz WLAN Ant 2	2.4 GHz Bluetooth + 5 GHz WLAN Ant 1	2.4 GHz Bluetooth + 5 GHz WLAN MIMO	2.4 GHz Bluetooth + 2.4 GHz WLAN Ant 2 at 14dBm + 5 GHz WLAN Ant 1 at 12dBm	2.4 GHz Bluetooth + 2.4 GHz WLAN Ant 2 at 14dBm + 5 GHz WLAN MIMO at 15 dBm	WLAN/BT Worst-case Combination
Back	0.477	0.108	0.168	0.420	0.134	0.535	0.242	0.302	0.374	0.456	0.535
Front	0.477	0.108	0.168	0.420	0.116	0.172	0.224	0.284	0.356	0.438	0.477
Top	0.081	0.000	0.168	0.420	0.024	0.168	0.024	0.192	0.213	0.346	0.420
Bottom	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-
Right	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000	-
Left	0.374	0.108	0.168	0.420	0.188	0.204	0.296	0.356	0.428	0.510	0.510

Table E-6
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	0.811	0.457	0.535	1.346	0.992
	Front	0.594	0.344	0.477	1.071	0.821
	Top	0.000	0.787	0.420	0.420	1.207
	Bottom	1.174	0.000	-	1.174	0.000
	Right	0.636	0.189	-	0.636	0.189
	Left	0.440	0.604	0.510	0.950	1.114

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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-7
Simultaneous Transmission Scenarios of WLAN/BT

Configuration	5 GHz WLAN Ant 1	5 GHz WLAN Ant 1 at 12dBm	5 GHz WLAN MIMO	5 GHz WLAN MIMO at 15 dBm
Back	0.774	0.550*	1.027	0.474
Front	1.197*	0.550*	1.331*	0.544*
Top	-	0.550*	1.331*	0.544*
Bottom	-	-	-	-
Right	-	-	-	-
Left	1.197	0.550	1.331	0.544

Configuration	5 GHz WLAN Ant 1	5 GHz WLAN Ant 1 at 12dBm	5 GHz WLAN MIMO	5 GHz WLAN MIMO at 15 dBm	WLAN/BT Worst-case Combination
back	0.774	0.550	1.027	0.474	1.027
front	1.197	0.550	1.331	0.544	1.331
top	0.000	0.550	1.331	0.544	1.331
bottom	0.000	0.000	0.000	0.000	-
right	0.000	0.000	0.000	0.000	-
left	1.197	0.550	1.331	0.544	1.331

Table E-8
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	1.141	1.230	1.027	2.168	2.257
	Front	1.338	0.000	1.331	2.669	1.331
	Top	0.000	0.000	1.331	1.331	1.331
	Bottom	1.036	0.000	-	1.036	0.000
	Right	0.466	0.000	-	0.466	0.000
	Left	1.209	3.135	1.331	2.540	See Note 1



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Table E-9
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	2.925	1.230	1.027	3.952	2.257
	Front	1.634	0.000	1.331	2.965	1.331
	Top	0.000	0.000	1.331	1.331	1.331
	Bottom	2.234	0.000	-	2.234	0.000
	Right	0.466	0.000	-	0.466	0.000
	Left	1.209	3.135	1.331	2.540	See Note 1

Notes:

- 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-10
Simultaneous Transmission Scenario with 5 GHz WLAN

Simult Tx	Configuration	NR Band n77 DoD Antenna G SAR (W/kg)	5 GHz WLAN Ant 1 at 12dBm SAR (W/kg)	Σ SAR (W/kg)
		1	2	1+2
Phablet SAR	Left	2.695	0.550	3.245
Simult Tx	Configuration	NR Band n77 Antenna G SAR (W/kg)	5 GHz WLAN Ant 1 at 12dBm SAR (W/kg)	Σ SAR (W/kg)
		1	2	1+2
Phablet SAR	Left	3.135	0.550	3.685





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Table E-11
Simultaneous Transmission Scenario with 5 GHz WLAN MIMO

Simult Tx	Configuration	NR Band n77 DoD Antenna G SAR (W/kg)	5 GHz WLAN MIMO at 15 dBm SAR (W/kg)	Σ SAR (W/kg)
		1	2	1+2
Phablet SAR	Left	2.695	0.544	3.239
Simult Tx	Configuration	NR Band n77 Antenna G SAR (W/kg)	5 GHz WLAN MIMO at 15 dBm SAR (W/kg)	Σ SAR (W/kg)
		1	2	1+2
Phablet SAR	Left	3.135	0.544	3.679

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