

APPENDIX E: MULTI-TX AND ANTENNA SAR CONSIDERATIONS

E.1 Introduction

The following procedures adopted from FCC KDB Publication 447498 D04v06 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 D04v06 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 (“-“).

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 is demonstrated in the Part 2 Report during algorithm validation.

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E.3 Head (DSI = 2) Simultaneous Transmission Analysis

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

Configuration	2.4 GHz WLAN Ant 2 at 13 dBm SAR (W/kg)	2.4 GHz WLAN MIMO at 16 dBm SAR (W/kg)	5 GHz WLAN MIMO at 15 dBm SAR (W/kg)	6 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 11.5 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 2 at 11.5 dBm SAR (W/kg)	2.4 GHz Bluetooth MIMO at 11 dBm SAR (W/kg)
	1	2	3	4	5	6	7
Right Cheek	0.102	0.365	0.505	0.092	0.136	0.063	0.073
Right Tilt	0.018	0.170	0.435	0.091	0.042	0.007	0.012
Left Cheek	0.150	0.241	0.600	0.354	0.033	0.089	0.148
Left Tilt	0.017	0.074	0.584	0.195	0.015	0.008	0.009

Configuration	2.4 GHz Bluetooth Ant 1 at 11.5 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 2 at 11.5 dBm SAR (W/kg)	2.4 GHz WLAN MIMO at 16 dBm SAR (W/kg)	5 GHz WLAN MIMO at 15 dBm SAR (W/kg)	6 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN MIMO at 16 dBm + 5 GHz WLAN MIMO at 15 dBm SAR (W/kg)	2.4 GHz WLAN MIMO at 16 dBm + 6 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 11.5 dBm + 2.4 GHz WLAN Ant 2 at 13 dBm SAR (W/kg)	2.4 GHz Bluetooth MIMO at 11 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 11.5 dBm + 5 GHz WLAN MIMO at 15 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 2 at 11.5 dBm + 5 GHz WLAN MIMO at 15 dBm SAR (W/kg)	2.4 GHz Bluetooth MIMO at 11 dBm + 5 GHz WLAN MIMO at 15 dBm SAR (W/kg)	2.4 GHz Bluetooth MIMO at 11 dBm + 6 GHz WLAN MIMO at 15 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 11.5 dBm + 2.4 GHz WLAN Ant 2 at 13 dBm + 5 GHz WLAN MIMO at 15 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 11.5 dBm + 2.4 GHz WLAN Ant 2 at 13 dBm + 6 GHz WLAN MIMO at 15 dBm SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)		
	5	6	2	3	4	2+3	2+4	5+1	7	5+3	5+4	6+3	6+4	7+3	7+4	5+1+3	5+1+4	
Right Cheek	0.136	0.063	0.365	0.505	0.092	0.870	0.457	0.238	0.073	0.641	0.228	0.568	0.155	0.578	0.165	0.743	0.330	0.870
Right Tilt	0.042	0.007	0.170	0.435	0.091	0.605	0.261	0.060	0.012	0.477	0.133	0.442	0.098	0.447	0.103	0.495	0.151	0.605
Left Cheek	0.033	0.089	0.241	0.600	0.354	0.841	0.595	0.183	0.148	0.633	0.387	0.689	0.443	0.748	0.502	0.783	0.537	0.841
Left Tilt	0.015	0.008	0.074	0.584	0.195	0.658	0.269	0.032	0.009	0.599	0.210	0.592	0.203	0.593	0.204	0.616	0.227	0.658

Table E-2
Simultaneous Transmission Scenario with WLAN/BT (Held to Ear)

Head SAR	Configuration	Licensed SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	Licensed + WLAN/BT SAR (W/kg)
	Right Cheek		0.478	0.870
Right Tilt		0.782	0.605	1.387
Left Cheek		0.277	0.841	1.118
Left Tilt		0.417	0.658	1.075

*Note: For all combinations where the sum of Licensed SAR + WLAN/BT is less than 1.6 W/kg, there's no further analysis required for compliance demonstration.

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E.4 Body-worn (DSI = 0) Simultaneous Transmission Analysis

**Table E-3
Simultaneous Transmission Scenarios of WLAN/BT (Body-worn)**

Configuration	2.4 GHz WLAN Ant 2 SAR (W/kg)	2.4 GHz WLAN Ant 2 at 13 dBm SAR (W/kg)	2.4 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN MIMO at 16 dBm SAR (W/kg)	5 GHz WLAN MIMO SAR (W/kg)	5 GHz WLAN MIMO at 15 dBm SAR (W/kg)	6 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 1 SAR (W/kg)	2.4 GHz Bluetooth Ant 2 SAR (W/kg)	2.4 GHz Bluetooth MIMO SAR (W/kg)
	1	2	3	4	5	6	7	8	9	10
Back	0.116	0.018	0.181	0.037	0.169	0.067	0.039	0.036	0.025	0.025

Configuration	2.4 GHz Bluetooth Ant 1 SAR (W/kg)	2.4 GHz Bluetooth Ant 2 SAR (W/kg)	2.4 GHz WLAN MIMO SAR (W/kg)	5 GHz WLAN MIMO SAR (W/kg)	6 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN MIMO at 16 dBm + 5 GHz WLAN MIMO at 15 dBm SAR (W/kg)	2.4 GHz WLAN MIMO at 16 dBm + 6 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 1 + 2.4 GHz WLAN Ant 2 SAR (W/kg)	2.4 GHz Bluetooth MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 1 + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 2 + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 2 + 6 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth MIMO + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth MIMO + 6 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 1 + 2.4 GHz WLAN Ant 2 at 13 dBm + 5 GHz WLAN MIMO at 15 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 + 2.4 GHz WLAN Ant 2 at 13 dBm + 6 GHz WLAN MIMO SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	
	8	9	3	5	7	4+6	4+7	8+1	10	8+5	8+7	9+5	9+7	10+5	10+7	8+2+6	8+2+7	0.205
Back	0.036	0.025	0.181	0.169	0.039	0.104	0.076	0.152	0.025	0.205	0.075	0.194	0.064	0.194	0.064	0.121	0.093	0.205

**Table E-4
Simultaneous Transmission Scenario with WLAN/BT (Body-worn at 1.5 cm)**

Bodyworn SAR	Configuration	Licensed SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	Licensed + WLAN/BT SAR (W/kg)
	Back		0.454	0.205

*Note: For all combinations where the sum of Licensed SAR + WLAN/BT is less than 1.6 W/kg, there's no further analysis required for compliance demonstration.

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E.5 Hotspot (DSI = 3) Simultaneous Transmission Analysis

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

Configuration	2.4 GHz WLAN Ant 2 SAR (W/kg)	2.4 GHz WLAN Ant 2 at 13 dBm SAR (W/kg)	2.4 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN MIMO at 16 dBm SAR (W/kg)	5 GHz WLAN MIMO SAR (W/kg)	5 GHz WLAN MIMO at 15 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 SAR (W/kg)	2.4 GHz Bluetooth Ant 2 SAR (W/kg)	2.4 GHz Bluetooth MIMO SAR (W/kg)
	1	2	3	4	5	6	7	8	9
Back	0.200	0.036	0.291	0.067	0.280	0.083	0.068	0.048	0.078
Front	0.158	0.032	0.246	0.053	0.089	0.023	0.059	0.052	0.055
Top	0.007	0.000	0.168	0.024	0.161	0.068	0.033	0.003	0.021
Right	0.094	0.017	0.127	0.021	0.075	0.034	-	0.028	0.021
Left	-	-	0.769	0.166	0.149	0.049	0.193	-	0.119

Configuration	2.4 GHz Bluetooth Ant 1 SAR (W/kg)	2.4 GHz Bluetooth Ant 2 SAR (W/kg)	2.4 GHz WLAN MIMO SAR (W/kg)	5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN MIMO at 16 dBm + 5 GHz WLAN MIMO at 15 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 + 2.4 GHz WLAN Ant 2 SAR (W/kg)	2.4 GHz Bluetooth Ant 1 + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 2 + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth MIMO + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 1 + 2.4 GHz WLAN Ant 2 at 13 dBm + 5 GHz WLAN MIMO at 15 dBm SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)
	7	8	3	5	4+6	7+1	7+5	8+5	9+5	7+2+6	
Back	0.068	0.048	0.291	0.280	0.150	0.268	0.348	0.328	0.358	0.187	0.358
Front	0.059	0.052	0.246	0.089	0.076	0.217	0.148	0.141	0.144	0.114	0.246
Top	0.033	0.003	0.168	0.161	0.092	0.040	0.194	0.164	0.182	0.101	0.194
Right	-	0.028	0.127	0.075	0.055	0.094	0.075	0.103	0.096	0.051	0.127
Left	0.193	-	0.769	0.149	0.215	0.193	0.342	0.149	0.268	0.242	0.769

Table E-6
Simultaneous Transmission Scenarios with WLAN/BT (Hotspot at 1.0 cm)

Hotspot SAR	Configuration	Licensed SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	Ant Licensed + WLAN/BT SAR (W/kg)
		Back	1.136	0.348
	Front	0.643	0.246	0.889
	Top	0.505	0.194	0.699
	Bottom	1.033	-	1.033
	Right	0.352	0.127	0.479
	Left	0.491	0.769	1.260

*Note: For all combinations where the sum of Licensed SAR + WLAN/BT is less than 1.6 W/kg, there's no further analysis required for compliance demonstration.

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E.6 Phablet (DSI = 0 & 1) SAR 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 (Phablet)

Configuration	5 GHz WLAN MIMO SAR (W/kg)	6 GHz WLAN MIMO SAR (W/kg)
	1	2
Back	0.614	0.170
Front	0.598	0.169
Top	0.333	0.102
Right	0.639	0.081
Left	1.373	0.256

Table E-8
Simultaneous Transmission Scenarios of NFC/UWB (Phablet)

	Configuration	NFC SAR (W/kg)	UWB (1) SAR (W/kg)	UWB (2) SAR (W/kg)	UWB Worst-case SAR (W/kg)	NFC + UWB Worst-case SAR (W/kg)
Phablet SAR	Back	0.024	0.000	0.001	0.001	0.025
	Front	0.000	0.000	0.001	0.001	0.001
	Top	-	-	0.000	0.000	0.000
	Right	0.000	-	-	-	0.000
	Left	0.000	0.002	0.001	0.002	0.002

Table E-9
Simultaneous Transmission Scenarios with WLAN/BT (Phablet at 0.0 cm)

	Configuration	Licensed SAR (W/kg)	NFC + UWB Worst-case SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	Licensed + NFC + UWB Worst-case + WLAN/BT SAR (W/kg)
Phablet SAR	Back	1.568	0.025	0.614	2.207
	Front	-	0.001	0.598	0.599
	Top	2.006	0.000	0.333	2.339
	Bottom	1.903	0.000	-	1.903
	Right	-	0.000	0.639	0.639
	Left	-	0.002	1.373	1.375

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*Note: For all combinations where the sum of Licensed SAR + WLAN/BT is less than 4.0 W/kg, there's no further analysis required for compliance demonstration.

E.7 Conclusion

The above numerical summed SAR results is 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.

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