

APPENDIX E: MULTI-TX AND ANTENNA SAR CONSIDERATIONS

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.

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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 1 SAR (W/kg)	2.4 GHz WLAN Ant 2 SAR (W/kg)	2.4 GHz WLAN MIMO SAR (W/kg)	5 GHz WLAN Ant 1 SAR (W/kg)	5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 1 SAR (W/kg)	2.4 GHz Bluetooth Ant 2 SAR (W/kg)
	1	2	3	4	5	6	7
Right Cheek	0.226	0.255*	0.280*	0.136	0.288	0.104	0.113
Right Tilt	0.226*	0.255*	0.280*	0.117	0.155	0.092	0.093
Left Cheek	0.226*	0.255	0.280	0.035	0.191	0.026	0.148
Left Tilt	0.226*	0.255*	0.280*	0.074	0.152	0.024	0.162

Configuration	2.4 GHz WLAN Ant 1 SAR (W/kg)	2.4 GHz WLAN Ant 2 SAR (W/kg)	2.4 GHz WLAN MIMO SAR (W/kg)	5 GHz WLAN Ant 1 SAR (W/kg)	5 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 WLAN Ant 1 + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN Ant 2 + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN MIMO + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN Ant 1 + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	5 GHz WLAN Ant 1 + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	5 GHz WLAN MIMO + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	5 GHz WLAN Ant 1 + 2.4 GHz Bluetooth Ant 2 SAR (W/kg)	5 GHz WLAN MIMO + 2.4 GHz Bluetooth Ant 2 SAR (W/kg)	2.4 GHz WLAN Ant 2 + 5 GHz WLAN Ant 1 + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	2.4 GHz WLAN Ant 2 + 5 GHz WLAN MIMO + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)
	1	2	3	4	5	6	7	1+5	2+5	3+5	2+6	4+6	5+6	4+7	5+7	2+4+6	2+5+6	
Right Cheek	0.226	0.255	0.280	0.136	0.288	0.104	0.113	0.514	0.543	0.568	0.359	0.240	0.392	0.249	0.401	0.495	0.647	0.647
Right Tilt	0.226	0.255	0.280	0.117	0.155	0.092	0.093	0.381	0.410	0.435	0.347	0.209	0.247	0.210	0.248	0.464	0.502	0.502
Left Cheek	0.226	0.255	0.280	0.035	0.191	0.026	0.148	0.417	0.446	0.471	0.281	0.061	0.217	0.183	0.339	0.316	0.472	0.472
Left Tilt	0.226	0.255	0.280	0.074	0.152	0.024	0.162	0.378	0.407	0.432	0.279	0.098	0.176	0.236	0.314	0.353	0.431	0.432

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	0.243	0.647	0.890
	Right Tilt	0.127	0.502	0.629
	Left Cheek	0.228	0.472	0.700
	Left Tilt	0.122	0.432	0.554

E.4 Open 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 1 SAR (W/kg)		2.4 GHz WLAN Ant 2 SAR (W/kg)		2.4 GHz WLAN MIMO SAR (W/kg)		5 GHz WLAN Ant 1 SAR (W/kg)		5 GHz WLAN MIMO SAR (W/kg)		2.4 GHz Bluetooth Ant 1 SAR (W/kg)		2.4 GHz Bluetooth Ant 2 SAR (W/kg)	
	1		2		3		4		5		6		7	
Back	0.061		0.089		0.079		0.093		0.120		0.026		0.090	

Configuration	2.4 GHz WLAN Ant 1 SAR (W/kg)	2.4 GHz WLAN Ant 2 SAR (W/kg)	2.4 GHz WLAN MIMO SAR (W/kg)	5 GHz WLAN Ant 1 SAR (W/kg)	5 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 WLAN Ant 1 + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN Ant 2 + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN MIMO + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN Ant 2 + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	5 GHz WLAN Ant 1 + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	5 GHz WLAN MIMO + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	5 GHz WLAN Ant 1 + 2.4 GHz Bluetooth Ant 2 SAR (W/kg)	5 GHz WLAN MIMO + 2.4 GHz Bluetooth Ant 2 SAR (W/kg)	2.4 GHz WLAN Ant 2 + 5 GHz WLAN MIMO + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	2.4 GHz WLAN Ant 2 + 5 GHz WLAN MIMO + 2.4 GHz Bluetooth Ant 2 SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)
Back	0.061	0.089	0.079	0.093	0.120	0.026	0.090	0.181	0.209	0.199	0.115	0.119	0.146	0.183	0.210	0.208	0.235	0.235

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	0.699	0.235	0.934

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E.5 Open Hotspot Simultaneous Transmission Analysis

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

Configuration	Configuration		2.4 GHz WLAN Ant 1 SAR (W/kg)	2.4 GHz WLAN Ant 2 SAR (W/kg)	2.4 GHz WLAN MIMO SAR (W/kg)	5 GHz WLAN Ant 1 SAR (W/kg)	5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 1 SAR (W/kg)	2.4 GHz Bluetooth Ant 2 SAR (W/kg)
			1	2	3	4	5	6	7
	Back	0.116	0.225	0.170	0.200	0.111	0.077	0.168	0.502
	Front	0.136	0.172	0.170	0.073	0.084	0.072	0.119	0.328
	Top	0.055	0.129	0.136	0.058	0.122	0.049	0.112	0.300
	Bottom	-	-	-	-	-	-	-	-
	Right	-	0.009	0.038	-	0.075	-	0.034	0.113
	Left	0.224	-	0.160	0.166	0.147	0.119	0.285	0.371

Configuration	2.4 GHz WLAN Ant 1 SAR (W/kg)	2.4 GHz WLAN Ant 2 SAR (W/kg)	2.4 GHz WLAN MIMO SAR (W/kg)	5 GHz WLAN Ant 1 SAR (W/kg)	5 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 WLAN Ant 1 + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN Ant 2 + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN MIMO + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN Ant 2 + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	5 GHz WLAN Ant 1 + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	5 GHz WLAN MIMO + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	5 GHz WLAN Ant 1 + 2.4 GHz Bluetooth Ant 2 SAR (W/kg)	5 GHz WLAN MIMO + 2.4 GHz Bluetooth Ant 2 SAR (W/kg)	2.4 GHz WLAN Ant 2 + 5 GHz WLAN Ant 1 + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	2.4 GHz WLAN Ant 2 + 5 GHz WLAN MIMO + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)
	1	2	3	4	5	6	7	1+5	2+5	3+5	2+6	4+6	5+6	4+7	5+7	2+4+6	2+5+6	
Back	0.116	0.225	0.170	0.200	0.111	0.077	0.168	0.227	0.336	0.281	0.302	0.277	0.188	0.368	0.279	0.502	0.413	0.502
Front	0.136	0.172	0.170	0.073	0.084	0.072	0.119	0.220	0.256	0.254	0.244	0.145	0.156	0.192	0.203	0.317	0.328	0.328
Top	0.055	0.129	0.136	0.058	0.122	0.049	0.112	0.177	0.251	0.258	0.178	0.107	0.171	0.170	0.234	0.236	0.300	0.300
Bottom	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Right	-	0.009	0.038	-	0.075	-	0.034	0.075	0.084	0.113	0.009	-	0.075	0.034	0.109	0.009	0.084	0.113
Left	0.224	-	0.160	0.166	0.147	0.119	-	0.371	0.147	0.307	0.119	0.285	0.266	0.166	0.147	0.285	0.266	0.371

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)	Licensed + WLAN/BT SAR (W/kg)
	Back	0.508	0.502	1.010
	Front	0.457	0.328	0.785
	Top	-	0.300	0.300
	Bottom	0.716	-	0.716
	Right	0.357	0.113	0.470
	Left	0.289	0.371	0.660

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 SAR (W/kg)	5 GHz WLAN MIMO SAR (W/kg)
	1	2
Back	0.495	0.592
Front	0.627	0.710
Top	0.276	0.560
Bottom	-	-
Right	-	0.230
Left	1.103	1.124

Configuration	5 GHz WLAN Ant 1 SAR (W/kg)	5 GHz WLAN MIMO SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)
	1	2	
Back	0.495	0.592	0.592
Front	0.627	0.710	0.710
Top	0.276	0.560	0.560
Bottom	-	-	-
Right	-	0.230	0.230
Left	1.103	1.124	1.124

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Table E-8
Simultaneous Transmission Scenarios with WLAN/BT (Phablet Max DSI= 0)

Phablet SAR	Configuration	Licensed SAR (W/kg)	NFC SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	Licensed + NFC + WLAN/BT SAR (W/kg)
	Back	0.966	0.009	0.592	1.567
	Front	1.147	0.000	0.710	1.857
	Top	-	-	0.560	0.560
	Bottom	0.810	0.000	-	0.810
	Right	0.571	0.000	0.230	0.801
	Left	0.931	0.000	1.124	2.055

Table E-9
Simultaneous Transmission Scenarios with WLAN/BT (Phablet Reduced DSI= 1)

Phablet SAR	Configuration	Licensed SAR (W/kg)	NFC SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	Licensed + NFC + WLAN/BT SAR (W/kg)
	Back	1.379	0.009	0.592	1.980
	Front	1.184	0.000	0.710	1.894
	Top	-	-	0.560	0.560
	Bottom	1.792	0.000	-	1.792
	Right	0.571	0.000	0.230	0.801
	Left	0.931	0.000	1.124	2.055

E.7 Closed Body-worn Simultaneous Transmission Analysis

Table E-10
Simultaneous Transmission Scenarios of WLAN/BT (Body-worn at 1.5 cm)

Configuration	2.4 GHz WLAN Ant 1 SAR (W/kg)		2.4 GHz WLAN Ant 2 SAR (W/kg)		2.4 GHz WLAN MIMO SAR (W/kg)		5 GHz WLAN Ant 1 SAR (W/kg)		5 GHz WLAN MIMO SAR (W/kg)		2.4 GHz Bluetooth Ant 1 SAR (W/kg)		2.4 GHz Bluetooth Ant 2 SAR (W/kg)	
	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Back	0.035	0.026	0.027	0.033	0.033	0.019	0.019	0.068	0.059	0.060	0.045	0.052	0.052	0.052

Configuration	2.4 GHz WLAN Ant 1 SAR (W/kg)	2.4 GHz WLAN Ant 2 SAR (W/kg)	2.4 GHz WLAN MIMO SAR (W/kg)	5 GHz WLAN Ant 1 SAR (W/kg)	5 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 WLAN Ant 1 + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN Ant 2 + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN MIMO + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN Ant 2 + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	5 GHz WLAN Ant 1 + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	5 GHz WLAN MIMO + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	5 GHz WLAN Ant 1 + 2.4 GHz Bluetooth Ant 2 SAR (W/kg)	5 GHz WLAN MIMO + 2.4 GHz Bluetooth Ant 2 SAR (W/kg)	2.4 GHz WLAN Ant 2 + 5 GHz WLAN Ant 1 + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	2.4 GHz WLAN Ant 2 + 5 GHz WLAN MIMO + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)
	1	2	3	4	5	6	7	1+5	2+5	3+5	2+6	4+6	5+6	4+7	5+7	2+4+6	2+5+6	0.078
Back	0.035	0.026	0.027	0.033	0.033	0.019	0.019	0.068	0.059	0.060	0.045	0.052	0.052	0.052	0.052	0.078	0.078	0.078

Table E-11
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	0.342	0.078	0.420

E.8 Closed Hotspot Simultaneous Transmission Analysis

Table E-12
Simultaneous Transmission Scenarios of WLAN/BT (Hotspot at 0.5 cm)

Configuration	2.4 GHz WLAN Ant 1 SAR (W/kg)	2.4 GHz WLAN Ant 2 SAR (W/kg)	2.4 GHz WLAN Ant 2 at 12 dBm SAR (W/kg)	2.4 GHz WLAN MIMO SAR (W/kg)	5 GHz WLAN Ant 1 SAR (W/kg)	5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 1 SAR (W/kg)	2.4 GHz Bluetooth Ant 2 SAR (W/kg)
	1	2	3	4	5	6	7	8
Back	0.147	0.083	0.017	0.146	0.009	0.048	0.083	0.073
Front	0.229	0.428	0.115	0.361	0.480	0.246	0.130	0.386
Top	-	-	-	-	-	-	-	-
Bottom	0.401	0.306	0.072	0.302	0.080	0.126	0.266	0.256
Right	-	0.085	0.013	0.095	-	0.111	-	0.078
Left	0.423	-	-	0.290	0.295	0.247	0.267	-

Configuration	2.4 GHz WLAN Ant 1 SAR (W/kg)	2.4 GHz WLAN Ant 2 SAR (W/kg)	2.4 GHz WLAN MIMO SAR (W/kg)	5 GHz WLAN Ant 1 SAR (W/kg)	5 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 WLAN Ant 1 + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN Ant 2 + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN MIMO + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN Ant 2 + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	5 GHz WLAN Ant 1 + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	5 GHz WLAN MIMO + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	5 GHz WLAN Ant 1 + 2.4 GHz Bluetooth Ant 2 SAR (W/kg)	5 GHz WLAN MIMO + 2.4 GHz Bluetooth Ant 2 SAR (W/kg)	2.4 GHz WLAN Ant 2 at 12 dBm + 5 GHz WLAN MIMO + 2.4 GHz Bluetooth Ant 1 SAR (W/kg)	2.4 GHz WLAN Ant 2 at 12 dBm + 5 GHz WLAN MIMO + 2.4 GHz Bluetooth Ant 2 SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)
	1	2	4	5	6	7	8	1+6	2+6	4+6	2+7	5+7	6+7	5+8	6+8	3+5+7	3+6+7	
Back	0.147	0.083	0.146	0.009	0.048	0.083	0.073	0.195	0.131	0.194	0.166	0.092	0.131	0.082	0.121	0.109	0.148	0.195
Front	0.229	0.428	0.361	0.480	0.246	0.130	0.386	0.475	0.674	0.607	0.558	0.610	0.376	0.866	0.632	0.725	0.491	0.866
Top	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Bottom	0.401	0.306	0.302	0.080	0.126	0.266	0.256	0.527	0.432	0.428	0.572	0.346	0.392	0.336	0.382	0.418	0.464	0.572
Right	-	0.085	0.095	-	0.111	-	0.078	0.111	0.196	0.206	0.085	-	0.111	0.078	0.189	0.013	0.124	0.206
Left	0.423	-	0.290	0.295	0.247	0.267	-	0.670	0.247	0.537	0.267	0.562	0.514	0.295	0.247	0.562	0.514	0.670

Table E-13
Simultaneous Transmission Scenarios with WLAN/BT (Hotspot at 0.5 cm)

Hotspot SAR	Configuration	Licensed SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	Licensed + WLAN/BT SAR (W/kg)
	Back	1.027	0.195	1.222
	Front	0.308	0.866	1.174
	Bottom	0.985	0.572	1.557
	Right	0.190	0.206	0.396
	Left	0.295	0.670	0.965

E.9 Simultaneous Transmission 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 6.3.4.1.

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