

APPENDIX E: MULTI-TX AND ANTENNA SAR CONSIDERATIONS

E.1 Introduction

The following procedures adopted from FCC KDB Publication 447498 D04v01 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 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.

E.3 Tablet SAR Analysis

Table E-1
Simultaneous Transmission Scenarios for WLAN/BT

Configuration	2.4 GHz WLAN Ant 1 SAR (W/kg)	2.4 GHz WLAN Ant 1 at 12.5 dBm SAR (W/kg)	2.4 GHz WLAN Ant 2 SAR (W/kg)	2.4 GHz WLAN Ant 2 at 12.5 dBm SAR (W/kg)	2.4 GHz WLAN Ant 2 at 11.5 dBm SAR (W/kg)	2.4 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN MIMO at 15.5 dBm SAR (W/kg)	2.4 GHz WLAN MIMO at 14.5 dBm SAR (W/kg)	5 GHz WLAN Ant 1 SAR (W/kg)	5 GHz WLAN Ant 1 at 8.5 dBm SAR (W/kg)	5 GHz WLAN Ant 2 SAR (W/kg)	5 GHz WLAN Ant 2 at 8.5 dBm SAR (W/kg)	5 GHz WLAN MIMO SAR (W/kg)	5 GHz WLAN MIMO at 11.5 dBm SAR (W/kg)	5 GHz WLAN MIMO at 10.5 dBm SAR (W/kg)	6 GHz WLAN Ant 1 SAR (W/kg)	6 GHz WLAN Ant 1 at 8.0 dBm SAR (W/kg)	6 GHz WLAN Ant 2 SAR (W/kg)	6 GHz WLAN Ant 2 at 8.0 dBm SAR (W/kg)	6 GHz WLAN MIMO SAR (W/kg)	6 GHz WLAN MIMO at 11.0 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 2 SAR (W/kg)	2.4 GHz Bluetooth Ant 2 at 10.5 dBm SAR (W/kg)
Back	0.148	0.750	0.112	0.432	0.397	0.098	0.740	0.652	0.126	0.840	0.078	0.148	0.148	1.134	0.843	0.007	0.452	0.008	0.184	0.010	0.450	0.086	0.334	0.049	0.264
Top	0.067	0.186	0.086	0.214	0.195	0.076	0.236	0.226	0.063	0.186	0.047	0.074	0.078	0.256	0.167	0.006	0.049	0.004	0.056	0.006	0.061	0.039	0.095	0.048	0.131
Right	0.013	0.013*	0.472	0.716	0.603	0.450	0.751	0.616	0.017	0.017*	0.552	0.443	0.527	0.567	0.457	0.002	0.002*	0.054	0.432	0.061	0.376	0.003	0.003*	0.196	0.454
Left	0.300	0.643	0.009	0.009*	0.009*	0.331	0.795	0.631	0.602	0.802	0.006	0.006*	0.732	0.933	0.656	0.055	0.367	0.002	0.002*	0.093	0.495	0.198	0.323	0.005	0.005*
Configuration	2.4 GHz Bluetooth Ant 2 at 10.5 dBm + 6 GHz WLAN MIMO at 11.0 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 2 at 10.5 dBm + 5 GHz WLAN MIMO at 11.5 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 6 GHz WLAN MIMO at 11.0 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 5 GHz WLAN MIMO at 11.5 dBm SAR (W/kg)	2.4 GHz WLAN MIMO at 14.5 dBm + 6 GHz WLAN MIMO at 11.0 dBm SAR (W/kg)	2.4 GHz WLAN MIMO at 14.5 dBm + 5 GHz WLAN MIMO at 10.5 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 2.4 GHz WLAN Ant 2 at 11.5 dBm + 5 GHz WLAN MIMO at 10.5 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 2.4 GHz WLAN Ant 2 at 11.5 dBm + 6 GHz WLAN MIMO at 11.0 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 2.4 GHz WLAN Ant 2 at 11.5 dBm + 6 GHz WLAN MIMO at 11.0 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 2.4 GHz WLAN Ant 2 at 11.5 dBm + 6 GHz WLAN MIMO at 11.0 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 2.4 GHz WLAN Ant 2 at 11.5 dBm + 6 GHz WLAN MIMO at 11.0 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 2.4 GHz WLAN Ant 2 at 11.5 dBm + 6 GHz WLAN MIMO at 11.0 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 2.4 GHz WLAN Ant 2 at 11.5 dBm + 6 GHz WLAN MIMO at 11.0 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 2.4 GHz WLAN Ant 2 at 11.5 dBm + 6 GHz WLAN MIMO at 11.0 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 2.4 GHz WLAN Ant 2 at 11.5 dBm + 6 GHz WLAN MIMO at 11.0 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 2.4 GHz WLAN Ant 2 at 11.5 dBm + 6 GHz WLAN MIMO at 11.0 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 2.4 GHz WLAN Ant 2 at 11.5 dBm + 6 GHz WLAN MIMO at 11.0 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 2.4 GHz WLAN Ant 2 at 11.5 dBm + 6 GHz WLAN MIMO at 11.0 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 2.4 GHz WLAN Ant 2 at 11.5 dBm + 6 GHz WLAN MIMO at 11.0 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 2.4 GHz WLAN Ant 2 at 11.5 dBm + 6 GHz WLAN MIMO at 11.0 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 2.4 GHz WLAN Ant 2 at 11.5 dBm + 6 GHz WLAN MIMO at 11.0 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 2.4 GHz WLAN Ant 2 at 11.5 dBm + 6 GHz WLAN MIMO at 11.0 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 2.4 GHz WLAN Ant 2 at 11.5 dBm + 6 GHz WLAN MIMO at 11.0 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 2.4 GHz WLAN Ant 2 at 11.5 dBm + 6 GHz WLAN MIMO at 11.0 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 2.4 GHz WLAN Ant 2 at 11.5 dBm + 6 GHz WLAN MIMO at 11.0 dBm SAR (W/kg)
Back	0.714	1.398	0.784	1.468	1.102	1.495	1.574	1.181	0.766	1.574	1.181	0.766	1.574	1.181	0.766	1.574	1.181	0.766	1.574	1.181	0.766	1.574	1.181	0.766	1.574
Top	0.192	0.387	0.156	0.351	0.287	0.393	0.457	0.351	0.309	0.457	0.351	0.309	0.457	0.351	0.309	0.457	0.351	0.309	0.457	0.351	0.309	0.457	0.351	0.309	0.457
Right	0.830	1.021	0.379	0.570	0.992	1.073	1.063	0.982	0.719	1.063	0.982	0.719	1.063	0.982	0.719	1.063	0.982	0.719	1.063	0.982	0.719	1.063	0.982	0.719	1.063
Left	0.500	0.938	0.818	1.256	1.126	1.287	0.988	0.827	0.332	0.988	0.827	0.332	0.988	0.827	0.332	0.988	0.827	0.332	0.988	0.827	0.332	0.988	0.827	0.332	0.988

Notes:

- For all combinations where the sum of WLAN + BT is less than 1.6 W/kg, there's no further analysis required for compliance demonstration.
- Values with * were tested at a higher, more conservative power level.

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E.4 Laptop SAR Analysis

Table E-2
Simultaneous Transmission Scenarios for WLAN/BT

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 Ant 2 SAR (W/kg)	5 GHz WLAN MIMO SAR (W/kg)	6 GHz WLAN Ant 1 SAR (W/kg)	6 GHz WLAN Ant 2 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)
	1	2	3	4	5	6	7	8	9	10	11
Bottom	0.425	0.001	0.362	0.240	0.011	0.495	0.219	0.004	0.186	0.192	0.002
Configuration	2.4 GHz Bluetooth Ant 2 + 6 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 2 + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 1 + 6 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 1 + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN MIMO + 6 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN MIMO + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 1 + 2.4 GHz WLAN Ant 2 + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 1 + 2.4 GHz WLAN Ant 2 + 6 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 1 + 2.4 GHz WLAN Ant 2 SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	
	11+9	11+6	10+9	10+6	3+9	3+6	10+2+6	10+2+9	10+2		
Bottom	0.188	0.497	0.378	0.687	0.548	0.857	0.688	0.379	0.193	0.857	

Notes:

- For all combinations where the sum of WLAN + BT is less than 1.6, there's no further analysis required for compliance demonstration.

E.5 Conclusion

The above numerical summed SAR results for all the worst-case simultaneous transmission conditions were below the SAR limit. Therefore, the above analysis 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 6.3.4.1.2

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