

APPENDIX D: MULTI-TX AND ANTENNA SAR CONSIDERATIONS

D.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.

D.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 (“-“).

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 with BT/WLAN/UWB and AG1 with 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.

D.3 Sub6 Antenna Groups

The 2nd generation of Smart Transmit (GEN2) operates based on pre-defined sub6 antenna groups (AG) and mmW module groups (MG). Sub6 Tx antennas in the device are grouped based on spatial variation of RF exposure distributions, where the RF exposure of one AG is mutually exclusive from other AG. This is accomplished by demonstrating either of below conditions for all exposure scenarios:

- a) Sum of SAR of one antenna from each of the sub6 AGs and the RF exposure from radios outside Smart Transmit is less than regulatory limits. This condition must be demonstrated for all antenna combinations of sub6 AGs.

(or)

- b) Every antenna from each sub6 AG meets SPLSR criteria (Section 4.3.2(c) in FCC KDB 447498 D01) with every antenna from another sub6 AG. This criteria must be demonstrated for all antenna combinations for each pair of AGs.

This device supports two sub6 AG: AG0 and AG1, with AG0 having 4 antennas (A, B, C, D) and AG1 having 4 antennas (E, F, G), and two WIFI/BT antennas outside of Smart Transmit. The conditions are verified through the following criterias:

- i) (SAR1 + SAR2 criteria): If SPLSR criteria is not used, then the highest reported SAR at P_{limit} (or P_{max} when $P_{limit} > P_{max}$) for each antenna should be obtained out of all supported technologies and

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frequency bands for each DSI. Demonstrate that the sum of reported SAR of one antenna from each of the sub6 AGs and the sum of RF exposure from all supported radios outside of Smart Transmit should be less than the regulatory limit as given below for each DSI.

1. Obtain the worst-case reported SAR for each antenna group (i.e., maximum *reported* SAR at P_{limit} (or P_{max} when $P_{limit} > P_{max}$) out of all supported technologies, frequency bands and antennas in AG0 and AG1), denoted as max.SAR.AG0 and max.SAR.AG1, and obtain the worst-case RF exposure for each external radio, and demonstrate that the sum of these RF exposures meets: $\{ [\text{max.SAR.AG0} + \text{max.SAR.AG1}] + \text{WIFI/BT Ant 1} + \text{WIFI/BT Ant 2} \} \leq 1.6$ (for 1g, or 4.0 for 10g).

ii) (SPLSR criteria): For each antenna, obtain the highest reported SAR value at P_{limit} out of all supported technologies for each frequency band. Using these values, demonstrate for a given DSI that every antenna from one sub6 AG meets SPLSR criteria with every antenna in another sub6 AG for all frequency bands. This criteria must be demonstrated for all antenna pair combinations irrespective of supported simultaneous transmission scenarios as given below for each DSI:

SPLSR criteria should be met for all antenna pair combinations of AG0 and AG1: {antenna (A, B, C, D) in AG0; antenna (E, F, G) in AG1. As it can be seen, these include all combinations of antenna groups, antennas, and frequency bands.

iii) (combination of SPLSR & SAR1+SAR2 criteria): If SPLSR criteria for all the combinations of sub6 antenna groups in (i) is demonstrated to show that each AG is mutually exclusive from other AGs, and if the WIFI/BT antennas supported outside of Smart Transmit do not meet SPLSR criteria, then the condition in (ii) reduces to: $\{ \text{max.SAR.AG0} + \text{WIFI/BT Ant 1} + \text{WIFI/BT Ant 2} \} \leq 1.6$ and $\{ \text{max.SAR.AG1} + \text{WIFI/BT Ant 1} + \text{WIFI/BT Ant 2} \} \leq 1.6$ for compliance demonstration (for 1g, or 4.0 for 10g).

If SPLSR criteria evaluation and analysis is needed to determine compliance for a certain DSI configuration, SPLSR is performed by taking the highest reported SAR for each of the supported technologies and bands per antenna, along with the peak SAR locations. Per Qualcomm guidance, only Y-axis coordinates are recorded in the analysis for calculation simplicity (assumes all 0mm of separation on the x-axis).

For bottom AG0, Y_max coordinate represents the worst case hotspot location that is closest to the top AG1. Similarly, for top AG1, Y_min coordinate represents the worst case hotspot location that is closest to the bottom AG0.

The following formula is used to calculate the SPLSR between AG0 and AG1 for each exposure configuration:

$$SPLSR = \frac{(Max\ SAR\ AG0 + Max\ SAR\ AG1)^{1.5}}{|Y_{max} - Y_{min}|}$$

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D.4 Head (DSI = 5) SAR Antenna Group Analysis

Table D-1
DSI=5 Held-to-ear AG0 Highest Reported SAR

AGO SAR (W/kg)							
Head SAR	Configuration	A	A+B	B	C	D	Max
	Right Cheek	0.144	0.185	0.112	0.001	0.008	0.185
	Right Tilt	0.069	0.092	0.103	0.004	0.000	0.103
	Left Cheek	0.116	0.140	0.111	0.008	0.005	0.140
	Left Tilt	0.060	0.073	0.066	0.000	0.000	0.073

Table D-2
DSI=5 Held-to-ear AG1 Highest Reported SAR

AG1 SAR (W/kg)					
Head SAR	Configuration	E	F	G	Max
	Right Cheek	0.228	0.552	0.001	0.552
	Right Tilt	0.341	0.724	0.000	0.724
	Left Cheek	0.664	0.491	0.000	0.664
	Left Tilt	0.577	0.798	0.003	0.798

Table D-3
Simultaneous Transmission Scenarios of WLAN/BT (Held to Ear)

Configuration	2.4 GHz WLAN Ant 2 at 12 dBm SAR (W/kg)	2.4 GHz WLAN MIMO at 15 dBm SAR (W/kg)	5 GHz WLAN MIMO at 14 dBm SAR (W/kg)	6 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 2 at 8.5 dBm SAR (W/kg)
	1	2	3	4	5	6
Right Cheek	0.004	0.330	0.318	0.488	0.297	0.000
Right Tilt	0.000	0.311	0.443	0.447	0.277	0.000
Left Cheek	0.003	0.183	0.173	0.270	0.147	0.000
Left Tilt	0.000	0.231	0.205	0.279	0.163	0.000

2.4 GHz Bluetooth Ant 2 at 8.5 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 2.4 GHz WLAN Ant 2 at 12 dBm SAR (W/kg)	2.4 GHz WLAN MIMO at 15 dBm SAR (W/kg)	5 GHz WLAN MIMO at 14 dBm SAR (W/kg)	6 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 2 at 8.5 dBm + 6 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 2 at 8.5 dBm + 5 GHz WLAN MIMO at 14 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 6 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 5 GHz WLAN MIMO at 14 dBm SAR (W/kg)	2.4 GHz WLAN MIMO at 15 dBm + 6 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN MIMO at 14 dBm SAR (W/kg)	2.4 GHz WLAN MIMO at 15 dBm + 5 GHz WLAN MIMO at 14 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 2.4 GHz WLAN Ant 2 at 12 dBm + 5 GHz WLAN MIMO at 14 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 10.5 dBm + 2.4 GHz WLAN Ant 2 at 12 dBm + 6 GHz WLAN MIMO SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)
6	5	5+1	2	3	4	6+4	6+3	5+4	5+3	2+4	2+3	5+1+3	5+1+4		
0.000	0.297	0.301	0.330	0.318	0.488	0.488	0.318	0.785	0.615	0.818	0.648	0.619	0.789	0.818	
0.000	0.277	0.277	0.311	0.443	0.447	0.447	0.443	0.724	0.720	0.758	0.754	0.720	0.724	0.758	
0.000	0.147	0.150	0.183	0.173	0.270	0.270	0.173	0.417	0.320	0.453	0.356	0.323	0.420	0.453	
0.000	0.163	0.163	0.231	0.205	0.279	0.279	0.205	0.442	0.368	0.510	0.436	0.368	0.442	0.510	

Table D-4
DSI=5 Held-to-ear AG Verification

Head SAR	Configuration	AGO SAR (W/kg)	AG1 SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	AGO + AG1 + WLAN/BT SAR (W/kg)
	Right Cheek	0.185	0.552	0.818	1.555
	Right Tilt	0.103	0.724	0.758	1.585
	Left Cheek	0.140	0.664	0.453	1.257
	Left Tilt	0.073	0.798	0.510	1.381

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D.5 Body-worn (DSI = 1) SAR Antenna Group Analysis

Table D-5
DSI=1 Body-worn AG0 Highest Reported SAR

AGO SAR (W/kg)							
Bodyworn SAR	Configuration	A	A+B	B	C	D	Max
		Back	0.172	0.251	0.923	0.007	0.027

Table D-6
DSI=1 Body-worn AG1 Highest Reported SAR

AG1 SAR (W/kg)					
Bodyworn SAR	Configuration	E	F	G	Max
		Back	0.186	0.240	0.037

Table D-7
Simultaneous Transmission Scenarios of WLAN/BT (Body-worn)

Configuration	SAR (W/kg)						
	2.4 GHz WLAN Ant 2	2.4 GHz WLAN MIMO	5 GHz WLAN MIMO	6 GHz WLAN MIMO	2.4 GHz Bluetooth Ant 1	2.4 GHz Bluetooth Ant 2	
	1	2	3	4	5	6	
Back	0.023	0.040	0.024	0.008	0.031	0.014	

Configuration	2.4 GHz Bluetooth Ant 2	2.4 GHz Bluetooth Ant 1	2.4 GHz Bluetooth Ant 1 + 2.4 GHz WLAN Ant 2	2.4 GHz WLAN MIMO	5 GHz WLAN MIMO	6 GHz WLAN MIMO	2.4 GHz Bluetooth Ant 2 + 6 GHz WLAN MIMO	2.4 GHz Bluetooth Ant 2 + 5 GHz WLAN MIMO	2.4 GHz Bluetooth Ant 1 + 6 GHz WLAN MIMO	2.4 GHz Bluetooth Ant 1 + 5 GHz WLAN MIMO	2.4 GHz WLAN MIMO + 6 GHz WLAN MIMO	2.4 GHz WLAN MIMO + 5 GHz WLAN MIMO	2.4 GHz Bluetooth Ant 1 + 2.4 GHz WLAN Ant 2 + 5 GHz WLAN MIMO	2.4 GHz Bluetooth Ant 1 + 2.4 GHz WLAN Ant 2 + 6 GHz WLAN MIMO	WLAN/BT Worst-case Combination
	6	5	5+1	2	3	4	6+4	6+3	5+4	5+3	2+4	2+3	5+1+3	5+1+4	SAR (W/kg)
Back	0.014	0.031	0.054	0.040	0.024	0.008	0.022	0.038	0.039	0.055	0.048	0.064	0.078	0.062	0.078

Table D-8
DSI=1 Body-worn AG Verification

Bodyworn SAR	Configuration	AGO SAR (W/kg)	AG1 SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	AGO + AG1 + WLAN/BT SAR (W/kg)
		Back	0.923	0.240	0.078

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D.6 Hotspot (DSI = 7) SAR Antenna Group Analysis

Table D-9
DSI=7 Hotspot AG0 Highest Reported SAR

AG0 SAR (W/kg)							
Hotspot SAR	Configuration	A	A+B	B	C	D	Max
	Back	0.336	0.356	0.493	0.012	0.052	0.493
	Front	0.131	0.172	0.151	0.000	0.007	0.172
	Top	-	-	-	-	-	-
	Bottom	0.119	0.103	0.704	0.016	0.097	0.704
	Right	0.289	0.400	0.142	-	-	0.400
	Left	-	0.167	0.066	0.003	0.012	0.167

Table D-10
DSI=7 Hotspot AG1 Highest Reported SAR

AG1 SAR (W/kg)					
Hotspot SAR	Configuration	E	F	G	Max
	Back	0.300	0.455	0.155	0.455
	Front	0.077	0.096	0.007	0.096
	Top	0.615	0.712	0.069	0.712
	Bottom	-	-	-	-
	Right	0.161	-	0.008	0.161
	Left	-	0.108	-	0.108

Table D-11
Simultaneous Transmission Scenarios of WLAN/BT (Hotspot)

Configuration	2.4 GHz WLAN Ant 2 SAR (W/kg)	2.4 GHz WLAN MIMO 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
Back	0.039	0.059	0.037	0.042	0.020
Front	0.089	0.329	0.174	0.213	0.056
Top	-	0.344	0.210	0.263	-
Bottom	0.179	0.119	0.117	-	0.096
Right	-	-	-	-	-
Left	0.037	0.108	0.044	0.083	0.016

Configuration	2.4 GHz Bluetooth Ant 2 SAR (W/kg)	2.4 GHz Bluetooth Ant 1 SAR (W/kg)	2.4 GHz Bluetooth Ant 1 + 2.4 GHz WLAN Ant 2 SAR (W/kg)	2.4 GHz WLAN MIMO SAR (W/kg)	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 1 + 5 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)	WLAN/BT Worst-case Combination SAR (W/kg)
	5	4	4+1	2	3	5+3	4+3	2+3	4+1+3	
Back	0.020	0.042	0.081	0.059	0.037	0.057	0.079	0.096	0.118	0.118
Front	0.056	0.213	0.302	0.329	0.174	0.230	0.387	0.503	0.476	0.503
Top	-	0.263	0.263	0.344	0.210	0.210	0.473	0.554	0.473	0.554
Bottom	0.096	-	0.179	0.119	0.117	0.213	0.117	0.236	0.296	0.296
Right	-	-	-	-	-	-	-	-	-	-
Left	0.016	0.083	0.120	0.108	0.044	0.060	0.127	0.152	0.164	0.164

Table D-12
DSI=7 Hotspot AG Verification

Hotspot SAR	Configuration	AG0 SAR (W/kg)	AG1 SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	AG0 + AG1 + WLAN/BT SAR (W/kg)
	Back	0.493	0.455	0.118	1.066
	Front	0.172	0.096	0.503	0.771
	Top	-	0.712	0.554	1.266
	Bottom	0.704	-	0.296	1.000
	Right	0.400	0.161	-	0.561
	Left	0.167	0.108	0.164	0.439

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D.7 Max Phablet (DSI = 1) SAR Antenna Group 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 D-13
DSI=1 Max Phablet AG0 Highest Reported SAR

AG0 SAR (W/kg)							
Phablet SAR	Configuration	A	A+B	B	C	D	Max
	Back	-	-	0.660	-	-	0.660
	Front	-	-	1.589	-	-	1.589
	Top	-	-	-	-	-	-
	Bottom	-	-	0.787	-	-	0.787
	Right	-	-	1.295	-	-	1.295
	Left	-	-	0.321	-	-	0.321

Table D-14
DSI=1 Max Phablet AG1 Highest Reported SAR

AG1 SAR (W/kg)					
Phablet SAR	Configuration	E	F	G	Max
	Back	-	1.047	-	1.047
	Front	-	-	-	-
	Top	1.460	2.603	-	2.603
	Bottom	-	-	-	-
	Right	-	-	-	-
	Left	-	-	-	-

Table D-15
Simultaneous Transmission Scenarios of WLAN/BT (Phablet)

Configuration	5 GHz WLAN MIMO SAR (W/kg)	6 GHz WLAN MIMO SAR (W/kg)	Configuration	5 GHz WLAN MIMO SAR (W/kg)	6 GHz WLAN MIMO SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)
	1	2		1	2	
	Back	0.083		0.013	Back	
Front	0.920	0.356	Front	0.920	0.356	0.920
Top	1.150	0.414	Top	1.150	0.414	1.150
Bottom	1.175	0.225	Bottom	1.175	0.225	1.175
Right	-	-	Right	-	-	-
Left	0.106	0.029	Left	0.106	0.029	0.106

Table D-16
Simultaneous Transmission Scenarios of NFC/UWB (Phablet)

Configuration	NFC SAR (W/kg)	UWB Ant 0 SAR (W/kg)	UWB Ant 1 SAR (W/kg)	NFC + UWB Ant 0 SAR (W/kg)	NFC + UWB Ant 1 SAR (W/kg)	NFC/UWB Worst-Case combination SAR (W/kg)
	Phablet SAR					
Back	0.009	0.001	0.001	0.010	0.010	0.010
Front	0.000	0.000	0.000	0.000	0.000	0.000
Top	-	0.000	0.000	0.000	0.000	0.000
Bottom	-	-	-	-	-	-
Right	0.000	0.001	-	0.000	0.001	0.001
Left	0.000	-	0.000	0.000	0.000	0.000

Table D-17
DSI=1 Max Phablet AG Verification

Phablet SAR	Configuration	AG0 SAR (W/kg)	AG1 SAR (W/kg)	NFC/UWB SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	AG0 + NFC + WLAN/BT SAR (W/kg)
	Back	0.660	1.047	0.010	0.083	1.800
	Front	1.589	-	0.000	0.920	2.509
	Top	-	2.603	0.000	1.150	3.753
	Bottom	0.787	-	-	1.175	1.962
	Right	1.295	-	0.001	-	1.296
	Left	0.321	-	0.000	0.106	0.427

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D.8 Reduced Phablet (DSI = 3) SAR Antenna Group 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 D-18
DSI=3 Reduced Phablet AG0 Highest Reported SAR

AG0 SAR (W/kg)							
Phablet SAR	Configuration	A	A+B	B	C	D	Max
	Back	-	-	1.616	-	-	1.616
	Front	-	-	1.589	-	-	1.589
	Top	-	-	-	-	-	-
	Bottom	-	-	2.203	-	-	2.203
	Right	-	-	1.295	-	-	1.295
	Left	-	-	0.321	-	-	0.321

Table D-19
DSI=3 Reduced Phablet AG1 Highest Reported SAR

AG1 SAR (W/kg)					
Phablet SAR	Configuration	E	F	G	Max
	Back	-	1.047	-	1.047
	Front	-	-	-	-
	Top	1.460	2.603	-	2.603
	Bottom	-	-	-	-
	Right	-	-	-	-
	Left	-	-	-	-

Please refer to section D.7 for highest reported simultaneous phablet SAR of WLAN/BT/NFC/UWB antennas.

Table D-20
DSI=3 Reduced Phablet AG Verification

Phablet SAR	Configuration	AG0 SAR (W/kg)	AG1 SAR (W/kg)	NFC/UWB SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	AG0 + AG1 + NFC/UWB + WLAN/BT SAR (W/kg)
	Back	1.616	1.047	0.010	0.083	2.756
	Front	1.589	-	0.000	0.920	2.509
	Top	-	2.603	0.000	1.150	3.753
	Bottom	2.203	-	-	1.175	3.378
	Right	1.295	-	0.001	-	1.296
	Left	0.321	-	0.000	0.106	0.427

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D.9 Max UMPC Body (DSI = 0) SAR Antenna Group Analysis

Table D-21
DSI=0 Max UMPC Body AG0 Highest Reported SAR

AG0 SAR (W/kg)						
UMPC Body SAR	Configuration	A+B	B	C	D	Max
	Back	0.627	0.665	0.010	0.090	0.665
	Front	0.427	0.765	0.005	0.057	0.765
	Top	-	-	-	-	-
	Bottom	0.365	0.489	0.014	0.141	0.489
	Right	0.391	0.578	-	-	0.578
	Left	-	-	-	-	-

Table D-22
DSI=0 Max UMPC Body AG1 Highest Reported SAR

AG1 SAR (W/kg)					
Hotspot SAR	Configuration	E	F	G	Max
	Back	0.241	0.351	0.072	0.351
	Front	0.326	0.225	0.050	0.326
	Top	0.913	0.569	0.092	0.913
	Bottom	-	-	-	-
	Right	0.405	-	0.015	0.405
	Left	-	-	-	-

Table D-23
Simultaneous Transmission Scenarios of WLAN/BT (UMPC Body)

Configuration	2.4 GHz WLAN 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 Bluetooth Ant 1 SAR (W/kg)	2.4 GHz Bluetooth Ant 2 SAR (W/kg)
	1	2	3	4	5	6
	Back	0.156	0.283	0.112	0.041	0.239
Front	0.135	0.255	0.165	0.035	0.200	0.049
Top	-	0.405	0.269	0.065	0.330	-
Bottom	0.253	0.243	0.215	0.032	-	0.096
Right	-	-	-	-	-	-
Left	-	-	-	-	-	-

Configuration	2.4 GHz Bluetooth Ant 2 SAR (W/kg)	2.4 GHz Bluetooth Ant 1 SAR (W/kg)	2.4 GHz Bluetooth Ant 1 + 2.4 GHz WLAN 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 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)	WLAN/BT Worst-case Combination SAR (W/kg)
	6	5	5+1	2	3	4	6+4	6+3	5+4	5+3	2+4	2+3	5+1+3	5+1+4	
Back	0.054	0.239	0.395	0.283	0.112	0.041	0.095	0.166	0.280	0.351	0.324	0.395	0.507	0.436	0.507
Front	0.049	0.200	0.335	0.255	0.165	0.035	0.084	0.214	0.235	0.365	0.290	0.420	0.500	0.370	0.500
Top	-	0.330	0.330	0.405	0.269	0.065	0.065	0.269	0.395	0.599	0.470	0.674	0.599	0.395	0.674
Bottom	0.096	-	0.253	0.243	0.215	0.032	0.128	0.311	0.032	0.215	0.275	0.458	0.468	0.285	0.468
Right	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Left	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Table D-24
DSI=0 Max UMPC Body AG Verification

UMPC Body SAR	Configuration	AG0 SAR (W/kg)	AG1 SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	AG0 + AG1 + WLAN/BT SAR (W/kg)
	Back	0.665	0.351	0.507	1.523
	Front	0.765	0.326	0.500	1.591
	Top	-	0.913	0.674	1.587
	Bottom	0.489	-	0.468	0.957
	Right	0.578	0.405	-	0.983
	Left	-	-	-	-

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D.10 Reduced UMPC Body (DSI = 2) SAR Antenna Group Analysis

Table D-25
DSI=2 Reduced UMPC Body AG0 Highest Reported SAR

AG0 SAR (W/kg)						
UMPC Body SAR	Configuration	A+B	B	C	D	Max
	Back	0.627	0.302	0.010	0.090	0.627
	Front	0.427	0.268	0.005	0.057	0.427
	Top	-	-	-	-	-
	Bottom	0.365	0.558	0.014	0.141	0.558
	Right	0.391	0.578	-	-	0.578
	Left	-	-	-	-	-

Table D-26
DSI=2 Reduced UMPC Body AG1 Highest Reported SAR

AG1 SAR (W/kg)					
Hotspot SAR	Configuration	E	F	G	Max
	Back	0.241	0.351	0.072	0.351
	Front	0.326	0.225	0.050	0.326
	Top	0.913	0.569	0.092	0.913
	Bottom	-	-	-	-
	Right	0.405	-	0.015	0.405
	Left	-	-	-	-

Please refer to section D.9 for highest reported simultaneous phablet SAR of WLAN/BT antennas

Table D-27
DSI=2 Reduced UMPC Body AG Verification

UMPC Body	Configuration	AG0 SAR (W/kg)	AG1 SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	AG0 + AG1 + WLAN/BT SAR (W/kg)
	Back	0.627	0.351	0.507	1.485
	Front	0.427	0.326	0.500	1.253
	Top	-	0.913	0.674	1.587
	Bottom	0.558	-	0.468	1.026
	Right	0.578	0.405	-	0.983
	Left	-	-	-	-

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D.11 Max UMPC Extremity (DSI = 0) SAR Antenna Group Analysis

Table D-28
DSI=0 Max UMPC Extremity AG0 Highest Reported SAR

AG0 SAR (W/kg)						
UMPC Extremity SAR	Configuration	A+B	B	C	D	Max
	Back	1.359	1.167	0.089	0.495	1.359
	Front	1.107	0.615	0.023	0.195	1.107
	Top	-	-	-	-	-
	Bottom	1.195	2.127	0.120	0.253	2.127
	Right	1.467	1.592	-	-	1.592
	Left	-	-	-	-	-

Table D-29
DSI=1 Max UMPC Extremity AG0 Highest Reported SAR

AG1 SAR (W/kg)					
UMPC Extremity SAR	Configuration	E	F	G	Max
	Back	0.592	1.005	0.095	1.005
	Front	1.183	1.257	0.143	1.257
	Top	1.857	2.432	0.478	2.432
	Bottom	-	-	-	-
	Right	1.279	-	0.033	1.279
	Left	-	-	-	-

AG1 LTE SAR (W/kg)				
UMPC Extremity SAR	Configuration	E	F	Max
	Top	-	1.832	1.832

AG1 LTE SAR (W/kg)				
UMPC Extremity SAR	Configuration	E	F	Max
	Top	1.857	2.432	2.432

Table D-30
Simultaneous Transmission Scenarios of WLAN/BT (UMPC Extremity)

Configuration	2.4 GHz WLAN Ant 2 SAR (W/kg)	2.4 GHz WLAN Ant 2 at 14 dBm SAR (W/kg)	2.4 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN MIMO at 17 dBm SAR (W/kg)	5 GHz WLAN MIMO SAR (W/kg)	5 GHz WLAN MIMO at 17 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 1 at 15 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 2 SAR (W/kg)	2.4 GHz Bluetooth Ant 2 at 12 dBm SAR (W/kg)
	1	2	3	4	5	6	7	8	9	10	11
Back	0.736	0.387	0.875	0.352	1.111	0.442	0.376	0.879	0.110	0.225	0.121
Front	0.523	0.065	0.860	0.335	0.885	0.566	0.257	0.769	0.038	0.190	0.094
Top	-	-	1.330	0.522	1.614	0.967	0.448	1.166	0.477	-	-
Bottom	0.904	0.452	0.859	0.406	1.154	0.592	0.214	-	-	0.311	0.153
Right	-	-	-	-	-	-	-	-	-	-	-
Left	-	-	-	-	-	-	-	-	-	-	-

Configuration	2.4 GHz Bluetooth Ant 2 SAR (W/kg)	2.4 GHz Bluetooth Ant 1 SAR (W/kg)	2.4 GHz Bluetooth Ant 1 + 2.4 GHz WLAN 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 Bluetooth Ant 2 + 6 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 2 at 12 dBm + 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 at 15 dBm + 5 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN MIMO at 17 dBm + 6 GHz WLAN MIMO at 17 dBm SAR (W/kg)	2.4 GHz WLAN MIMO at 17 dBm + 5 GHz WLAN MIMO at 17 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 15 dBm + 2.4 GHz WLAN Ant 2 at 14 dBm + 5 GHz WLAN MIMO at 17 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 15 dBm + 2.4 GHz WLAN Ant 2 at 14 dBm + 6 GHz WLAN MIMO SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)
	9	8	8+9	3	5	7	9+7	11+5	8+7	9+5	6+7	4+6	9+2+6	9+2+7	
Back	0.225	0.879	1.615	0.875	1.111	0.376	0.601	1.232	1.255	1.221	0.728	0.794	0.939	0.873	1.615
Front	0.190	0.769	1.292	0.860	0.885	0.257	0.447	0.979	1.026	0.923	0.592	0.901	0.669	0.360	1.292
Top	-	1.166	1.166	1.330	1.614	0.448	0.448	1.614	1.614	2.091	0.970	1.489	1.444	0.925	2.091
Bottom	0.311	-	0.904	0.859	1.154	0.214	0.525	1.307	0.214	1.154	0.620	0.998	1.044	0.666	1.307
Right	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Left	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

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Table D-31
Simultaneous Transmission Scenarios of WLAN/BT (UMPC Extremity) when NR is Active

Configuration	2.4 GHz WLAN Ant 2 at 14 dBm SAR (W/kg)		2.4 GHz WLAN MIMO at 17 dBm SAR (W/kg)		5 GHz WLAN MIMO at 17 dBm SAR (W/kg)		6 GHz WLAN MIMO SAR (W/kg)		2.4 GHz Bluetooth Ant 1 at 15 dBm SAR (W/kg)		2.4 GHz Bluetooth Ant 2 at 12 dBm SAR (W/kg)				
	1		2		3		4		5		6				
	Top		-		0.522		0.967		0.448		0.477		-		
Configuration	2.4 GHz Bluetooth Ant 2 at 12 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 15 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 15 dBm + 2.4 GHz WLAN Ant 2 at 14 dBm SAR (W/kg)	2.4 GHz WLAN MIMO at 17 dBm SAR (W/kg)	5 GHz WLAN MIMO at 17 dBm SAR (W/kg)	6 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 15 dBm + 6 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 2 at 12 dBm + 5 GHz WLAN MIMO at 17 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 2 at 12 dBm + 6 GHz WLAN MIMO SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 15 dBm + 5 GHz WLAN MIMO at 17 dBm SAR (W/kg)	2.4 GHz WLAN MIMO at 17 dBm + 6 GHz WLAN MIMO SAR (W/kg)	2.4 GHz WLAN MIMO at 17 dBm + 5 GHz WLAN MIMO at 17 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 15 dBm + 2.4 GHz WLAN Ant 2 at 14 dBm + 5 GHz WLAN MIMO at 17 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant 1 at 15 dBm + 2.4 GHz WLAN Ant 2 at 14 dBm + 6 GHz WLAN MIMO SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)
	6	5	5+1	2	3	4	5+4	6+3	6+4	5+3	2+4	2+3	5+1+3	5+1+4	
Top	-	0.477	0.477	0.522	0.967	0.448	0.925	0.967	0.448	1.444	0.970	1.489	1.444	0.925	1.489

Table D-32
Simultaneous Transmission Scenarios of NFC/UWB (UMPC Extremity)

Configuration	NFC SAR (W/kg)	UWB Ant 0 SAR (W/kg)	UWB Ant 1 SAR (W/kg)	NFC + UWB Ant 0 SAR (W/kg)	NFC + UWB Ant 1 SAR (W/kg)	NFC/UWB Worst-case combination SAR (W/kg)
Back	0.009	0.000	0.000	0.009	0.009	0.009
Front	0.000	0.001	0.001	0.001	0.001	0.001
Top	-	0.000	0.000	0.000	0.000	0.000
Bottom	-	-	-	-	-	-
Right	0.000	0.000	-	0.000	0.000	0.000
Left	-	-	-	-	-	-

Table D-33
DSI=0 Max UMPC Extremity AG Verification with

Configuration	AG0 SAR (W/kg)	AG1 SAR (W/kg)	NFC/UWB SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	AG0 + AG1 + NFC/UWB + WLAN/BT SAR (W/kg)
Back	1.359	1.005	0.009	1.615	3.988
Front	1.107	1.257	0.001	1.292	3.657
Top	-	2.432	0.000	2.091	See Table Below
Bottom	2.127	-	-	1.307	3.434
Right	1.592	1.279	0.000	-	2.871
Left	-	-	-	-	-

UMPC Extremity	Configuration	AG0 SAR (W/kg)	AG1 NR SAR (W/kg)	AG1 LTE SAR (W/kg)	NFC/UWB SAR (W/kg)	WLAN/BT Worst-case Combination With NR Active SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	AG0 + AG1 NR SAR + NFC/UWB WLAN/BT SAR (W/kg)	AG0 + AG1 LTE SAR + NFC/UWB WLAN/BT SAR (W/kg)
						1.489	2.091	3.921	3.923
Top	-	2.432	1.832	0.000	1.489	2.091	3.921	3.923	

D.12 Reduced UMPC Extremity (DSI = 2) SAR Antenna Group Analysis

Table D-34
DSI=2 Reduced UMPC Extremity AG0 Highest Reported SAR

AG0 SAR (W/kg)						
UMPC Extremity SAR	Configuration	A+B	B	C	D	Max
	Back	1.359	1.357	0.089	0.495	1.359
	Front	1.107	1.056	0.023	0.195	1.107
	Top	-	-	-	-	-
	Bottom	1.195	2.505	0.120	0.253	2.505
	Right	1.467	1.592	-	-	1.592
	Left	-	-	-	-	-

Table D-35
DSI=2 Reduced UMPC Extremity AG1 Highest Reported SAR

AG1 SAR (W/kg)					
UMPC Extremity SAR	Configuration	E	F	G	Max
	Back	0.592	1.005	0.095	1.005
	Front	1.183	1.257	0.143	1.257
	Top	1.857	2.432	0.478	2.432
	Bottom	-	-	-	-
	Right	1.279	-	0.033	1.279
	Left	-	-	-	-

AG1 LTE SAR (W/kg)					
UMPC Extremity SAR	Configuration	E	F	G	Max
	Top	-	1.832	-	1.832

AG1 LTE SAR (W/kg)					
UMPC Extremity SAR	Configuration	E	F	G	Max
	Top	1.857	2.432	0.478	2.432

Please refer to section D.11 for highest reported simultaneous UMPC Extremity SAR of WLAN/BT/NFC/UWB antennas.

Table D-36
DSI=2 Reduced UMPC Extremity AG Verification

UMPC Extremity	Configuration	AG0 SAR (W/kg)	AG1 SAR (W/kg)	NFC/UWB SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	AG0 + AG1 + NFC/UWB + WLAN/BT SAR (W/kg)
	Back	1.359	1.005	0.009	1.615	3.988
	Front	1.107	1.257	0.001	1.292	3.657
	Top	-	2.432	0.000	2.091	See Table Below
	Bottom	2.505	-	-	1.307	3.812
	Right	1.592	1.279	0.000	-	2.871
	Left	-	-	-	-	-

UMPC Extremity	Configuration	AG0 SAR (W/kg)	AG1 NR SAR (W/kg)	AG1 LTE SAR (W/kg)	NFC/UWB SAR (W/kg)	WLAN/BT Worst-case Combination With NR Active SAR (W/kg)	WLAN/BT Worst-case Combination SAR (W/kg)	AG0 + AG1 NR SAR + NFC/UWB WLAN/BT SAR (W/kg)	AG0 + AG1 LTE SAR + NFC/UWB WLAN/BT SAR (W/kg)
	Top	-	2.432	1.832	0.000	1.489	2.091	3.921	3.923

D.13 Conclusion

The above numerical summed SAR results and SPLSR for all of the combinations of sub6 antenna groups are sufficient to show that AG0 is mutually exclusive from AG1 and 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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