

Appendix L. Multi-Tx Simultaneous Transmission Analysis Results

This device contains transmitters that may operate simultaneously. Therefore, simultaneous transmission analysis is required. Per KDB Publication 447498 D01v06 section 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 1g SAR and 10g SAR for all the simultaneous transmitting antennas in a specific a physical test configuration is $\leq 1.6\text{W/kg}$ for 1g SAR and $\leq 4\text{ W/kg}$ for 10g SAR. The different test positions in an exposure condition may be considered collectively to determine SAR exclusion according to the sum of 1g or 10g SAR.

When operating in the same antenna group, Samsung S.LSI TAS algorithm in WWAN directly adds the time-averaged RF exposure from 4G and time-averaged RF exposure from 5G NR. S.LSI 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.

This device is enabled with S.LSI Time average SAR algorithm with pre-defined sub6 antenna groups (AG0 and AG1). Simultaneous transmission analysis is performed per antenna groups. Section 14.5 contains analysis to demonstrate the AG0 and AG1 are operate mutually exclusive.

L.1 Sub6 Antenna Groups

S.LSI Time average SAR(TAS) algorithm operates based on pre-defined sub6 antenna groups (AG). 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:

Sum of SAR of one antenna from each of the sub6 AGs and the RF exposure from radios outside TAS is less than regulatory limits. This condition must be demonstrated for all antenna combinations of sub6 AGs. This device supports two sub6 AG: AG0 and AG1, with AG0 having 3 antennas (A, B, C) and AG1 having 3 antennas (E, F, I). The conditions are verified through the following criteria.

The highest reported SAR at Plimit (or Pmax when Plimit > Pmax) for each antenna should be obtained out of all supported WWAN technologies and frequency bands for each exposure condition. Demonstrate that the sum of reported SAR of antenna from each of the sub6 AGs and the sum of RF exposure of TAS should be less than the regulatory limit as given below for each RSI.

Obtain the worst-case reported SAR for each antenna group (i.e., maximum reported SAR at Plimit (or Pmax when Plimit > Pmax) 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, and demonstrate that the sum of these RF exposures meets

$$[\text{Max.SAR.AG0} + \text{Max.SAR.AG1}] + [\text{Max.WLAN} + \text{Max.Bluetooth}] \leq 1.6 \text{ (for 1g SAR or 4.0 for 10g)}$$

If the sum result with each antenna group and BT/WLAN exceeds the FCC SAR limit of 1.6 W/kg 1g, 4.0 W/kg 10g, SAR Simultaneous Transmission evaluation was performed by combining the worst case results of each antenna group with each other using fast volume scan measurements to verify compliance with FCC limits.

AG0, AG1, WLAN/BT are described in the table below.

AG0	
Ant. A	GSM850, UMTS 5, LTE 5/12/13/26, NR n5/n71
Ant. B	GSM1900, UMTS 2/4, LTE 2/4/25/41/66, NR n2/n25/n41/n66
Ant. C	NR n41 SRS2/NR n77 SRS3

AG1	
Ant. E	GSM850, UMTS 5, LTE 5/12/13/26, NR n5/n71 NR n77 SRS2
Ant. F	NR n77
Ant. G	NR n41 SRS3
Ant. I	UMTS 2/4, LTE 2/4/25/41/66, NR n2/n25/n41/n66 NR n41 SRS1/NR n77 SRS1

WLAN/BT	
Ant. F	WLAN 5 GHz, 6 GHz Ant.1
Ant. G	WLAN 2.4 GHz Ant.1, BT Ant.1
Ant. H	WLAN 2.4 GHz, 5 GHz, 6 GHz, BT Ant.2

L.1 Head SAR Simultaneous Transmission Analysis

The Maximum measurement result for AG0 [W/kg]				
Position	Ant. A	Ant. B	Ant. C	Max.AG0
Left Touch	0.249	0.169	0.112	0.249
Left Tilt	0.175	0.071	0.003	0.175
Right Touch	0.422	0.121	0.011	0.422
Right Tilt	0.194	0.057	0.000	0.194

The Maximum measurement result for AG1 [W/kg]					
Position	Ant. E	Ant. F	Ant. G	Ant. I	Max.AG1
Left Touch	0.261	0.372	0.147	0.758	0.758
Left Tilt	0.110	0.123	0.181	0.135	0.181
Right Touch	0.527	0.271	0.297	0.17	0.527
Right Tilt	0.206	0.317	0.302	0.037	0.317

The measurement result for WLAN [W/kg]						
Position	WLAN 2.4 GHz Ant. G	WLAN 2.4 GHz Ant. H	WLAN 2.4 GHz Ant. G+H	WLAN 5 GHz Ant. F	WLAN 5 GHz Ant. H	WLAN 5 GHz Ant. F+H
Left Touch	0.135	0.258	0.427	0.109	0.208	0.161
Left Tilt	0.234	0.198	0.592	0.101	0.219	0.194
Right Touch	0.301	0.075	0.405	0.238	0.147	0.233
Right Tilt	0.290	0.077	0.546	0.255	0.117	0.148

The measurement result for WLAN/BT [W/kg]						
Position	WLAN 6 GHz Ant. F	WLAN 6 GHz Ant. H	WLAN 6 GHz Ant. F+H	BT Ant. G	BT Ant. H	BT Ant. G+H
Left Touch	0.021	0.132	0.153	0.070	0.148	0.104
Left Tilt	0.022	0.000	0.022	0.095	0.120	0.126
Right Touch	0.118	0.010	0.128	0.161	0.052	0.152
Right Tilt	0.045	0.037	0.082	0.126	0.036	0.140

Summation for Main Head SAR [W/kg]			
Position	Max. AG0	Max. AG1	Main Max
Left Touch	0.249	0.758	1.007
Left Tilt	0.175	0.181	0.356
Right Touch	0.422	0.527	0.949
Right Tilt	0.194	0.317	0.511

Simultaneous Transmission analysis for Head SAR [W/kg]							
Position	AG0+AG1 +BT Ant.G	AG0+AG1 +BT Ant.H	AG0+AG1 +BT Ant .G+H	AG0+AG1 +WLAN	AG0+AG1 +WLAN+ BT Ant. G	AG0+AG1 +WLAN+ BT Ant. H	AG0+AG1 +WLAN+BT Ant.G+H
Left Touch	1.077	1.155	1.111	1.434	1.335	1.363	1.319
Left Tilt	0.451	0.476	0.482	0.948	0.670	0.695	0.701
Right Touch	1.110	1.001	1.101	1.354	1.348	1.239	1.339
Right Tilt	0.637	0.547	0.651	1.057	0.892	0.802	0.906

L.2 Body Flip Open SAR Simultaneous Transmission Analysis

The Maximum measurement result for AG0 [W/kg]				
Position	Ant. A	Ant. B	Ant. C	Max.AG0
Rear	1.146	1.199	0.757	1.199
Front	0.774	0.524	0.944	0.944
Left		0.373	0.794	0.794
Right	0.764			0.764
Top				
Bottom	1.021	1.176	0.115	1.176

The Maximum measurement result for AG1 [W/kg]					
Position	Ant. E	Ant. F	Ant.G	Ant.I	Max.AG1
Rear	0.418	0.266	0.071	0.609	0.609
Front	0.588	0.251	0.068	0.574	0.588
Left	0.530	0.669	0.029		0.669
Right				1.086	1.086
Top	0.062	0.208	0.163	0.154	0.208
Bottom					

The measurement result for WLAN [W/kg]						
Position	WLAN 2.4 GHz Ant. G	WLAN 2.4 GHz Ant. H	WLAN 2.4 GHz Ant. G+H	WLAN 5 GHz Ant. F	WLAN 5 GHz Ant. H	WLAN 5 GHz Ant. F+H
Rear	0.176	0.032	0.437	0.297	0.341	0.441
Front	0.161	0.130	0.256	0.295	0.256	0.338
Left	0.028		0.035	0.659		0.685
Right		0.021	0.039		0.145	0.105
Top	0.418	0.080	0.880	0.429	0.080	0.451
Bottom						

The measurement result for WLAN/BT [W/kg]						
Position	WLAN 6 GHz Ant. F	WLAN 6 GHz Ant. H	WLAN 6 GHz Ant. F+H	BT Ant. G	BT Ant. H	BT Ant. G+H
Rear	0.025	0.021	0.046	0.284	0.072	0.175
Front	0.065	0.000	0.065	0.226	0.430	0.191
Left	0.103		0.103	0.056		0.037
Right		0.000	0.000		0.049	0.031
Top	0.036	0.000	0.036	0.606	0.256	0.522
Bottom						

[illegible]

L.3 Body Flip Closed SAR Simultaneous Transmission Analysis

The Maximum measurement result for AG0 [W/kg]								
Position	Ant. A	Ant. B	Ant. C	Ant. E	Ant. F	Ant.G	Ant.I	Max.AG0
Rear	0.916	1.001	0.462	0.109	0.047	0.013	0.236	1.001
Front	0.192	0.115	0.053	0.314	0.243	0.072	0.458	0.458
Left		0.274	0.780	0.361	0.312	0.028		0.780
Right	0.637						1.047	1.047
Top			0.023	0.020			0.032	0.032
Bottom	0.752	1.094	0.079	0.034	0.236	0.122	0.132	1.094

The measurement result for WLAN [W/kg]						
Position	WLAN 2.4 GHz Ant. G	WLAN 2.4 GHz Ant. H	WLAN 2.4 GHz Ant. G+H	WLAN 5 GHz Ant. F	WLAN 5 GHz Ant. H	WLAN 5 GHz Ant. F+H
Rear	0.023	0.024	0.040	0.042	0.014	0.046
Front	0.132	0.049	0.614	0.289	0.337	0.192
Left	0.014		0.026	0.570		0.561
Right		0.031	0.028		0.281	0.140
Top						
Bottom	0.284	0.057	0.610	0.353	0.161	0.423

The measurement result for WLAN/BT [W/kg]						
Position	WLAN 6 GHz Ant. F	WLAN 6 GHz Ant. H	WLAN 6 GHz Ant. F+H	BT Ant. G	BT Ant. H	BT Ant. G+H
Rear	0.000	0.000	0.000	0.062	0.117	0.047
Front	0.000	0.000	0.000	0.258	0.179	0.128
Left	0.090		0.090	0.046		0.038
Right		0.059	0.059		0.104	0.037
Top						
Bottom	0.026	0.008	0.034	0.336	0.178	0.392

Simultaneous Transmission analysis for Hotspot Flip Closed SAR [W/kg]							
Position	AG0+AG1 +BT Ant.G	AG0+AG1 +BT Ant.H	AG0+AG1 +BT Ant. G+H	AG0+AG1 +WLAN	AG0+AG1 +WLAN+ BT Ant. G	AG0+AG1 +WLAN+ BT Ant. H	AG0+AG1 +WLAN+BT Ant.G+H
Rear	1.063	1.118	1.048	1.047	1.109	1.164	1.094
Front	0.716	0.637	0.586	1.072	1.053	0.974	0.923
Left	0.826	0.780	0.818	1.350	1.396	1.350	1.388
Right	1.047	1.151	1.084	1.328	1.328	1.432	1.365
Top	0.032	0.032	0.032	0.032	0.032	0.032	0.032
Bottom	1.430	1.272	1.486	Sec.5.2.1	Sec.5.2.1	Sec.5.2.1	Sec.5.2.1

L.4 Phablet SAR Simultaneous Transmission Analysis

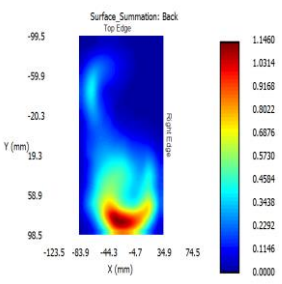
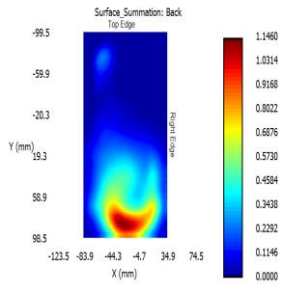
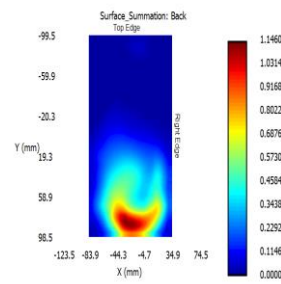
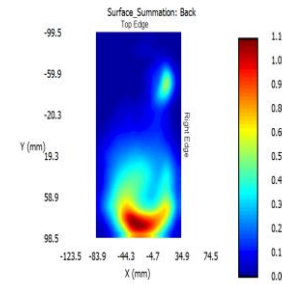
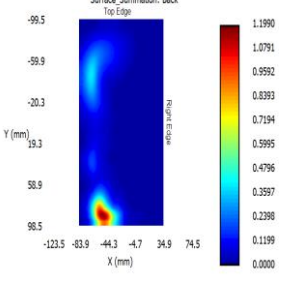
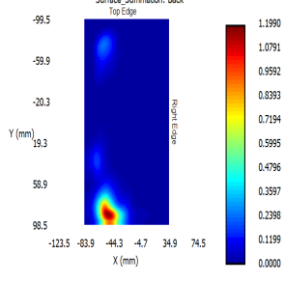
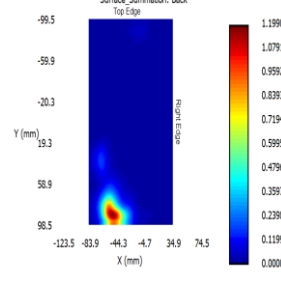
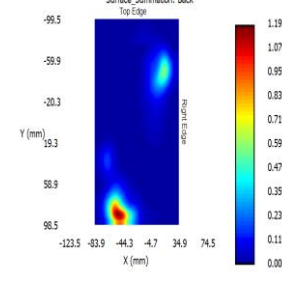
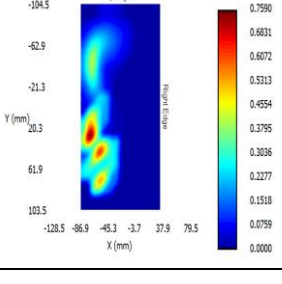
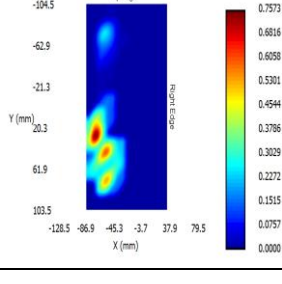
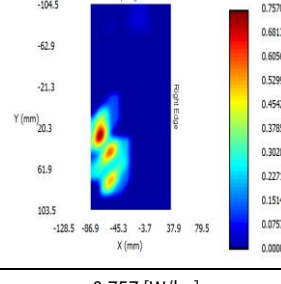
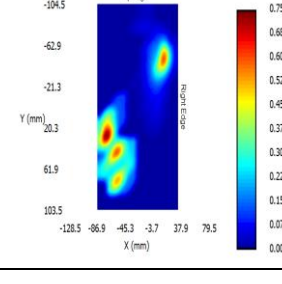
Position	NFC [W/kg]	Worst [W/kg]
Rear	0.000021	0.000021
Front	0.00000253	0.00000253
Left	0.000000688	0.000000688
Right	0.0000000291	0.0000000291
Top	0.000000097	0.000000097
Bottom	0	0

L.5 Fast Volume Scan Combine Analysis

According to the antenna group-based SAR evaluation, it has been sufficiently demonstrated that AG0 is mutually exclusive with AG1 and that SAR limits are not exceeded even in simultaneous transmission scenarios for all antenna group combinations.

L.5.1 Body Flip Open

L.5.1.1 Rear

	Ant. E 0.418 [W/kg]	Ant. F 0.266 [W/kg]	Ant. G 0.071 [W/kg]	Ant. I 0.609 [W/kg]
Ant. A 1.146 [W/kg]				
	1.146 [W/kg]	1.146 [W/kg]	1.146 [W/kg]	1.146 [W/kg]
Ant. B 1.199 [W/kg]				
	1.199 [W/kg]	1.199 [W/kg]	1.199 [W/kg]	1.199 [W/kg]
Ant. C 0.757 [W/kg]				
	0.759 [W/kg]	0.7573 [W/kg]	0.757 [W/kg]	0.757 [W/kg]

Each antenna is independent Exposure assessment of each antenna combination has no influence on each other. (Except Ant. C+E, Ant. C+F)

L.5.1.1.1 Simultaneous Evaluation

L.5.1.1.1.1 Summation Rear

	WWAN	WWAN +BT Ant. G	WWAN +BT Ant. H	WWAN +BT Ant. G+H	WWAN +WLAN	WWAN+WLAN +BT Ant. G	WWAN+WLAN +BT Ant. H	WWAN+WLAN +BT Ant. G+H
Ant. A	1.146	1.430	1.218	1.321	1.587	Sec.5.1.1.1.2	Sec.5.1.1.1.2	Sec.5.1.1.1.2
Ant. B	1.199	1.483	1.271	1.374	Sec.5.1.1.1.2	Sec.5.1.1.1.2	Sec.5.1.1.1.2	Sec.5.1.1.1.2
Ant. C+E	0.759	1.043	0.831	0.934	1.200	1.484	1.272	1.375
Ant. C+F	0.757	1.041	0.829	0.932	1.198	1.482	1.270	1.373
Ant. G	0.071	0.355	0.143	0.246	0.512	0.796	0.584	0.687
Ant. I	0.609	0.893	0.681	0.784	1.050	1.334	1.122	1.225

L.5.1.1.1.2 Combined Result for Rear Side

	WWAN +WLAN	WWAN+WLAN +BT Ant. G	WWAN+WLAN +BT Ant. H	WWAN+WLAN +BT Ant. G+H
Ant. A				
		1.1564 [W/kg]	1.146 [W/kg]	1.146 [W/kg]
Ant. B				
	1.199 [W/kg]	1.2027 [W/kg]	1.199 [W/kg]	1.199 [W/kg]

L.5.1.2 Front

	Ant. E 0.588 [W/kg]	Ant. F 0.251 [W/kg]	Ant. G 0.068 [W/kg]	Ant. I 0.574 [W/kg]
Ant. A 0.774 [W/kg]				
	0.774 [W/kg]	0.774 [W/kg]	0.774 [W/kg]	0.774 [W/kg]
Ant. B 0.524 [W/kg]				
	0.588 [W/kg]	0.524 [W/kg]	0.524 [W/kg]	0.574 [W/kg]
Ant. C 0.944 [W/kg]				
	0.9768 [W/kg]	0.944 [W/kg]	0.944 [W/kg]	0.944 [W/kg]

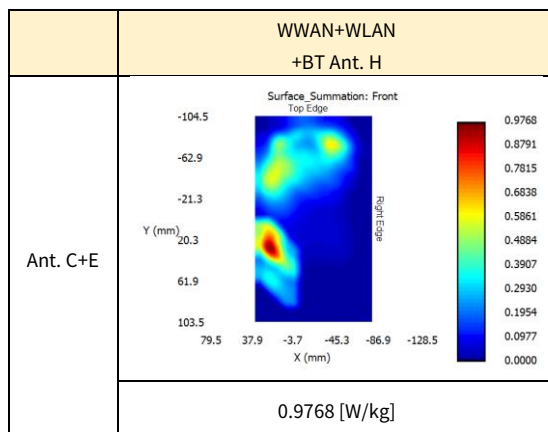
Each antenna is independent Exposure assessment of each antenna combination has no influence on each other. (Except Ant. C+E)

L.5.1.2.1 Simultaneous Evaluation

L. 5.1.2.1.1 Summation Front

	WWAN	WWAN +BT Ant. G	WWAN +BT Ant. H	WWAN +BT Ant. G+H	WWAN +WLAN	WWAN+WLAN +BT Ant. G	WWAN+WLAN +BT Ant. H	WWAN+WLAN +BT Ant. G+H
Ant. A	0.774	1.000	1.204	0.965	1.112	1.338	1.542	1.303
Ant. B	0.524	0.750	0.954	0.715	0.862	1.088	1.292	1.053
Ant. C+E	0.9768	1.203	1.407	1.168	1.315	1.541	Sec.5.1.2.1.2	1.506
Ant. F	0.251	0.477	0.681	0.442	0.589	0.815	1.019	0.780
Ant. G	0.068	0.294	0.498	0.259	0.406	0.632	0.836	0.597
Ant. I	0.574	0.800	1.004	0.765	0.912	1.138	1.342	1.103

L. 5.1.2.1.2 Combined Result for Front Side



L.5.1.3 Left

	Ant. E 0.530 [W/kg]	Ant. F 0.669 [W/kg]	Ant. G 0.029 [W/kg]	Ant. I
Ant. A	N/A	N/A	N/A	N/A
Ant. B 0.373 [W/kg]	Surface_Summation: Left Front Edge X (mm) Y (mm) 0.530 [W/kg]	Surface_Summation: Left Front Edge X (mm) Y (mm) 0.669 [W/kg]	Surface_Summation: Left Front Edge X (mm) Y (mm) 0.373 [W/kg]	N/A
	0.530 [W/kg]	0.669 [W/kg]	0.373 [W/kg]	
Ant. C 0.794 [W/kg]	Surface_Summation: Left Front Edge X (mm) Y (mm) 0.9682 [W/kg]	Surface_Summation: Left Front Edge X (mm) Y (mm) 0.8889 [W/kg]	Surface_Summation: Left Front Edge X (mm) Y (mm) 0.794 [W/kg]	N/A
	0.9682 [W/kg]	0.8889 [W/kg]	0.794 [W/kg]	

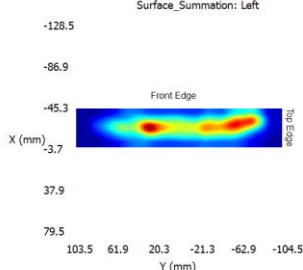
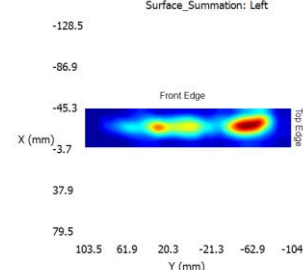
Each antenna is independent Exposure assessment of each antenna combination has no influence on each other. (Except Ant. C+E, Ant. C+F)

L.5.1.3.1 Simultaneous Evaluation

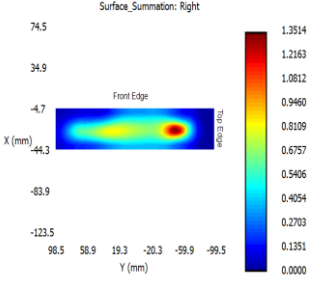
L.5.1.3.1.1 Summation Left

	WWAN	WWAN +BT Ant. G	WWAN +BT Ant. H	WWAN +BT Ant. G+H	WWAN +WLAN	WWAN+WLAN +BT Ant. G	WWAN+WLAN +BT Ant. H	WWAN+WLAN +BT Ant. G+H
Ant. B	0.373	0.429	0.373	0.410	1.058	1.114	1.058	1.095
Ant. C+E	0.9682	1.024	0.968	1.005	Sec.5.1.3.1.2	Sec.5.1.3.1.2	Sec.5.1.3.1.2	Sec.5.1.3.1.2
Ant. C+F	0.8889	0.945	0.889	0.926	1.574	Sec.5.1.3.1.2	1.574	Sec.5.1.3.1.2
Ant. G	0.029	0.085	0.029	0.066	0.714	0.770	0.714	0.751

L. 5.1.3.1.2 Combined Result for Left Side

	Ant. C+E	Ant. C+F
WWAN+ Worst WLAN +Worst BT	Surface_Summation: Left  0.9879 [W/kg]	Surface_Summation: Left  1.1633 [W/kg]

L.7.2.4 Right

	Ant. E	Ant. F	Ant. I 1.086 [W/kg]
Ant. A 0.764 [W/kg]	N/A	N/A	
Ant. B	N/A	N/A	1.3514 [W/kg]
Ant. C	N/A	N/A	N/A

L.7.2.4.1 Simultaneous Evaluation

L.7.2.4.1.1 Summation Right

	WWAN	WWAN +BT Ant. G	WWAN +BT Ant. H	WWAN +BT Ant. G+H	WWAN +WLAN	WWAN+WLAN +BT Ant. G	WWAN+WLAN +BT Ant. H	WWAN+WLAN +BT Ant. G+H
Ant. A+I	1.3514	1.351	1.400	1.382	1.496	1.496	1.545	1.527

L.7.2.5 Top

L.7.2.5.1 Simultaneous Evaluation

L.7.2.5.1.1 Summation Top

	WWAN	WWAN +BT Ant. G	WWAN +BT Ant. H	WWAN +BT Ant. G+H	WWAN +WLAN	WWAN+WLAN +BT Ant. G	WWAN+WLAN +BT Ant. H	WWAN+WLAN +BT Ant. G+H
Ant. E	0.154	0.760	0.410	0.676	1.034	1.211	0.861	1.127
Ant. F	0.208	0.814	0.464	0.730	1.088	1.265	0.915	1.181
Ant. G	0.163	0.769	0.419	0.685	1.043	1.220	0.870	1.136
Ant. I	0.154	0.760	0.410	0.676	1.034	1.211	0.861	1.127

L.7.3 Hotspot Flip Closed

L.7.3.1 Bottom

L.7.3.1.1 Simultaneous Evaluation

L.7.3.1.1.1 Summation Bottom

	WWAN	WWAN +BT Ant. G	WWAN +BT Ant. H	WWAN +BT Ant. G+H	WWAN +WLAN	WWAN+WLAN +BT Ant. G	WWAN+WLAN +BT Ant. H	WWAN+WLAN +BT Ant. G+H
Ant. A	0.752	1.088	0.930	1.144	1.362	1.511	1.353	1.567
Ant. B	1.094	1.430	1.272	1.486	Sec.7.3.1.1.2	Sec.7.3.1.1.2	Sec.7.3.1.1.2	Sec.7.3.1.1.2
Ant. C	0.079	0.415	0.257	0.471	0.689	0.838	0.680	0.894
Ant. E	0.034	0.370	0.212	0.426	0.644	0.793	0.635	0.849
Ant. F	0.236	0.572	0.414	0.628	0.846	0.995	0.837	1.051
Ant. G	0.122	0.458	0.300	0.514	0.732	0.881	0.723	0.937
Ant. I	0.132	0.468	0.310	0.524	0.742	0.891	0.733	0.947

L. 7.3.1.1.2 Combined Result for Bottom Side

	WWAN +WLAN	WWAN+WLAN +BT Ant. G	WWAN+WLAN +BT Ant. H	WWAN+WLAN +BT Ant. G+H
Ant. B				
	1.3773 [W/kg]	1.2616 [W/kg]	1.137 [W/kg]	1.2161 [W/kg]