

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, NR n5
Ant. B	GSM1900, LTE 2/4/41/66, NR n41/n66

AG1	
Ant. E	GSM850, UMTS 5, LTE 5/12/13, NR n5
Ant. I	LTE 2/4/41/66, NR n41/n66

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	Max.AG0
Left Touch	0.205	0.105	0.205
Left Tilt	0.149	0.060	0.149
Right Touch	0.342	0.119	0.342
Right Tilt	0.171	0.066	0.171

The Maximum measurement result for AG1 [W/kg]			
Position	Ant. E	Ant. F	Max.AG1
Left Touch	0.351	0.805	0.805
Left Tilt	0.135	0.130	0.135
Right Touch	0.639	0.190	0.639
Right Tilt	0.205	0.040	0.205

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	0.175	0.243	0.386	0.035	0.197	0.237
Left Tilt	0.251	0.161	0.542	0.031	0.176	0.245
Right Touch	0.314	0.063	0.433	0.134	0.091	0.090
Right Tilt	0.307	0.054	0.462	0.091	0.101	0.091

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	0.042	0.128	0.170	0.114	0.345	0.143
Left Tilt	0.050	0.058	0.108	0.157	0.215	0.156
Right Touch	0.103	0.021	0.124	0.271	0.105	0.153
Right Tilt	0.051	0.016	0.067	0.321	0.083	0.158

Summation for Main Head SAR [W/kg]			
Position	Max. AG0	Max. AG1	Main Summation
Left Touch	0.205	0.805	1.010
Left Tilt	0.149	0.135	0.284
Right Touch	0.342	0.639	0.981
Right Tilt	0.171	0.205	0.376

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	1.124	1.355	1.153	1.396	1.367	1.592	1.390
Left Tilt	0.441	0.499	0.440	0.826	0.686	0.744	0.686
Right Touch	1.252	1.086	1.134	1.414	1.386	1.219	1.268
Right Tilt	0.697	0.459	0.534	0.838	0.798	0.560	0.635

L.2 Body Flip Open SAR Simultaneous Transmission Analysis

The Maximum measurement result for AG0 [W/kg]			
Position	Ant. A	Ant. B	Max.AG0
Rear	1.199	0.985	1.199
Front	0.777	0.537	0.777
Left		0.440	0.440
Right	0.669		0.669
Top			
Bottom	1.113	1.153	1.153

The Maximum measurement result for AG1 [W/kg]			
Position	Ant. E	Ant. I	Max.AG1
Rear	0.507	0.491	0.507
Front	0.544	0.497	0.544
Left	0.666		0.666
Right		0.987	0.987
Top	0.042	0.133	0.133
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	0.262	0.050	0.325	0.548	0.171	0.507
Front	0.229	0.114	0.320	0.271	0.187	0.321
Left	0.039		0.056	0.661		0.748
Right		0.011	0.037		0.058	0.102
Top	0.472	0.067	0.474	0.192	0.084	0.244
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	0.000	0.004	0.004	0.129	0.116	0.225
Front	0.010	0.032	0.042	0.092	0.327	0.239
Left	0.076		0.076	0.020		0.020
Right		0.000	0.000		0.036	0.033
Top	0.026	0.005	0.031	0.370	0.211	0.641
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. E	Ant. I	Max.AG0
Rear	0.935	0.753	0.217	0.203	0.935
Front	0.132	0.172	0.401	0.420	0.420
Left		0.260	0.401		0.401
Right	0.602			0.955	0.955
Top			0.021	0.038	0.038
Bottom	0.743	1.004	0.034	0.136	1.004

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	0.060	0.035	0.104	0.033	0.028	0.063
Front	0.137	0.044	0.354	0.419	0.101	0.520
Left	0.039		0.063	0.631		0.726
Right		0.014	0.049		0.079	0.084
Top						
Bottom	0.336	0.067	0.517	0.178	0.154	0.233

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	0.053	0.091	0.078
Front	0.029	0.000	0.029	0.129	0.125	0.311
Left	0.044		0.044	0.027		0.032
Right		0.058	0.058		0.044	0.022
Top						
Bottom	0.000	0.000	0.000	0.311	0.188	0.574

Simultaneous Transmission analysis for Hotspot Flip Closed SAR [W/kg]							
Position	AG0 +BT Ant.G	AG0 +BT Ant.H	AG0 +BT Ant .G+H	AG0 +WLAN	AG0 +WLAN+ BT Ant. G	AG0 +WLAN+ BT Ant. H	AG0 +WLAN+BT Ant.G+H
Rear	0.988	1.026	1.013	1.039	1.051	1.089	1.076
Front	0.549	0.545	0.731	0.940	1.069	1.065	1.251
Left	0.428	0.401	0.433	1.127	1.154	1.127	1.159
Right	0.955	0.999	0.977	1.039	1.039	1.083	1.061
Top	0.038	0.038	0.038	0.038	0.038	0.038	0.038
Bottom	1.312	1.189	1.578	1.518	1.545	1.422	Sec.L.5.2.1

L.4 Phablet SAR Simultaneous Transmission Analysis

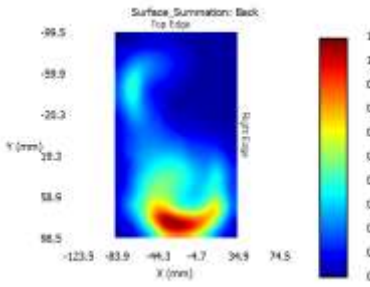
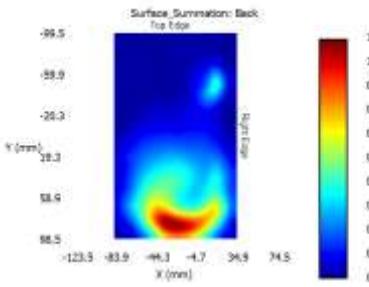
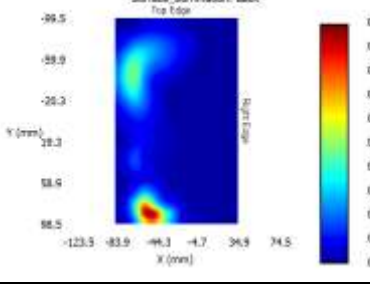
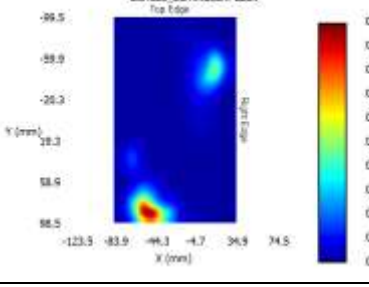
Position	NFC [W/kg]	Worst [W/kg]
Rear	0.00705	0.00705
Front	0.00765	0.00765
Left	6.59E-07	6.59E-07
Right	3.50E-07	3.50E-07
Top	1.35E-06	1.35E-06
Bottom	1.72E-06	1.72E-06

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 0.507 [W/kg]	Ant. I 0.491 [W/kg]
Ant. A 1.190 [W/kg]		
	1.190 [W/kg]	1.190 [W/kg]
Ant. B 0.985 [W/kg]		
	0.985 [W/kg]	0.985 [W/kg]

Each antenna is independent Exposure assessment of each antenna combination has no influence on each other.

L.5.1.1.1 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	1.190	1.319	1.306	1.415	See .Sec.L.5.1.1.2	See .Sec.L.5.1.1.2	See .Sec.L.5.1.1.2	See .Sec.L.5.1.1.2
Ant. B	0.985	1.114	1.101	1.210	1.534	See .Sec.L.5.1.1.2	See .Sec.L.5.1.1.2	See .Sec.L.5.1.1.2
Ant. G	0.507	0.636	0.623	0.732	1.056	1.185	1.172	1.281
Ant. I	0.491	0.620	0.607	0.716	1.040	1.169	1.156	1.265

L.5.1.1.2 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	1.1900 [W/kg]	1.2034 [W/kg]	1.1990 [W/kg]	1.1990 [W/kg]
Ant. B	0.9867 [W/kg]	0.9867 [W/kg]	0.9850 [W/kg]	0.9850 [W/kg]

L.5.1.2 Front

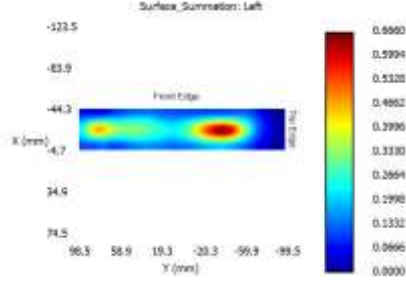
	Ant. E 0.507 [W/kg]	Ant. I 0.497 [W/kg]
Ant. A 0.777 [W/kg]		
	0.777 [W/kg]	0.777 [W/kg]
Ant. B 0.537 [W/kg]		
	0.544 [W/kg]	0.537 [W/kg]

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

L. 5.1.2.1 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	0.777	0.869	1.104	1.016	1.098	1.190	1.425	1.337
Ant. B+E	0.544	0.636	0.871	0.783	0.865	0.957	1.192	1.104
Ant. I	0.497	0.589	0.824	0.736	0.818	0.910	1.145	1.057

L.5.1.3 Left

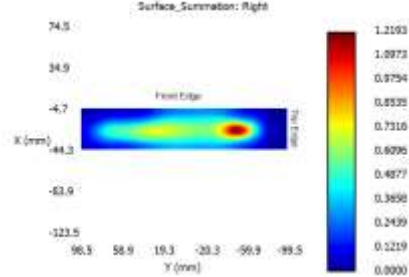
	Ant. E 0.666 [W/kg]	Ant. I
Ant. A	N/A	N/A
Ant. B 0.440 [W/kg]		N/A
	0.666 [W/kg]	

Each antenna is independent Exposure assessment of each antenna combination has no influence on each other.

L.5.1.3.1 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	0.440	0.460	0.440	0.460	1.188	1.208	1.188	1.208
Ant. E	0.666	0.686	0.666	0.686	1.414	1.434	1.414	1.434

L.5.1.4 Right

	Ant. E	Ant. I 0.987 [W/kg]
Ant. A 0.669 [W/kg]	N/A	
		1.2193 [W/kg]
Ant. B	N/A	N/A

L.5.1.4.1 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	1.2193	1.219	1.255	1.252	1.321	1.321	1.357	1.354

L.5.2 Hotspot Flip Closed

L.5.2.1 Bottom

L.5.2.1.1 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	0.743	1.054	0.931	1.317	1.260	1.287	1.267	1.550
Ant. B	1.004	1.336	1.213	1.578	1.542	1.569	1.549	See sec.L.5.2.1.2
Ant. E	0.034	0.345	0.222	0.608	0.551	0.578	0.558	0.841
Ant. I	0.136	0.447	0.324	0.710	0.653	0.680	0.660	0.943

L. 5.2.1.2 Combined Result for Bottom Side

