

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 D04v01 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 top edge, AG0 testing was excluded and for bottom edge AG1 testing was excluded, therefore, no spatial analysis required for those edges. For left and right edges, not every band was tested, therefore, not every combination between AG0 and AG1 was evaluated.

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.

This device is enabled with Samsung S.LSI TAS (Time Average SAR) algorithms, specifically F-TAS for cellular bands and DC-TAS for unlicensed bands (WLAN/BT over Cellular). The device is configured with pre-defined antenna groups where AG0 represents the Cellular antennas, and AG1 represents the worst-case SAR from Cellular/WLAN/BT. Per the R-Matrix defining the relationship between antenna groups, the analysis demonstrates that the 1g SAR for both AG0 and AG1 independently remains ≤ 1.6 W/kg. Although AG0 and AG1 are decoupled, the sum of AG0 + AG1 was evaluated to further demonstrate this decoupling. While FCC compliance is determined by the 1.6 W/kg limit ($TER \leq 1.0$), this report conservatively applies SPLSR analysis for scenarios where the summed SAR exceeds the design target of 1.0 W/kg ($ER > 0.625$). Analysis demonstrates:

1. The mutually exclusive operation of AG1 and AG0 via SAR summation ($SAR \leq 1.0$ W/kg, $TER \leq 0.625$) or SPLSR evaluation.
2. The compliance between AG1 and NFC, and between AG0 and NFC.

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.

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E.3 Antenna Groups

The Samsung S.LSI TAS operates based on pre-defined antenna groups (AG). Tx antennas in the device (Sub6, WLAN, and Bluetooth) are grouped based on the spatial variation of RF exposure distributions, where the RF exposure of one AG is mutually exclusive from that of other AGs.

This is accomplished by demonstrating the conditions below for all exposure scenarios:

1. Each antenna combination between the two AGs (Sub6/WLAN/Bluetooth) sums to less than the manufacturer's design target.
2. If the sum for antenna combination is greater than SAR design target, then that combination meets SPLSR criteria (Section 4.3.2(c) in FCC KDB 447498 D04).

This device supports two sub6 AG: AG0 and AG1, with AG0 having 2 antennas (A, B) and AG1 having 4 antennas (E, F, G, H), and NFC external radio antennas. Demonstrating that AG0 is fully uncorrelated to AG1 through the following criteria:

- A. For each antenna, obtain the highest reported SAR for each of the supported technologies and bands (including Sub6, WLAN, and Bluetooth) along with the peak SAR locations. Using these values, demonstrate for a given position in an exposure condition that every antenna from one antenna group (AG) (Sub6/WLAN/BT) meets SPLSR criteria with every antenna in another AG (Sub6/WLAN/BT) for all frequency bands. This criterion must be demonstrated for all antenna pair combinations according to simultaneous transmission scenarios.

The following formula is used to calculate the SPLSR between antenna pair for each exposure configuration:

$$SPLSR = \frac{(SAR_i + SAR_j)^{1.5}}{\sqrt{(x_i - x_j)^2 + (y_i - y)^2 + (z_i - z_j)^2}}$$

Where i and j are bands/modes that can transmit simultaneously across AG0 and AG1, with x/y/z coordinates.

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E.4 Exposure Ratios

Exposure ratio (ER) for different transmitters is calculated as following:

$$ER_{SAR,n} = \frac{SAR_n}{SAR_{limit}}$$

Where:

- SAR_n is the SAR value for the n -th transmitter/test frequency
- SAR_{limit} is the basic restriction limit that is applicable to the n -th transmitter/test frequency

Compliance with the SAR based RF exposure limits is achieved if $TER_{SAR} \leq 1$. When $TER_{SAR} > 1$, SPLSR is additionally evaluated per below equation:

$$SPLSR = \frac{(ER_j + ER_k)^{1.5}}{R}$$

Where:

- ER_j and ER_k are exposure ratio of transmitter j and k
- R is the distance between transmitter j and k

When SPLSR is ≤ 0.02 for 1g exposure conditions or SPLSR is ≤ 0.013 for 10g exposure conditions simultaneous SAR evaluation is not required.

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E.5 Head (RSI = 1) SAR Antenna Group Analysis

Table E-1
RSI = 1 Held-to-ear AG Verification

Head	Configuration	AG0 Ratio to Limit	AG1 Ratio to Limit	AG0 + AG1 Ratio to Limit
	Right Cheek	0.149	0.559	See table below
	Right Tilt	0.064	0.441	0.505
	Left Cheek	0.122	0.521	See table below
	Left Tilt	0.074	0.470	0.544

Right Cheek						
AG0 Band/Antenna	AG1 Band/Antenna	AG0 ER	AG1 ER	Standalone Sum ER	Distance (mm)	SPLSR
AG0: Ant A_LTE Band 12	AG1: Ant F_LTE Band 41	0.111	0.559	0.67	82.6	0.01
AG0: Ant A_LTE Band 2	AG1: Ant F_LTE Band 41	0.074	0.559	0.633	94.96	0.01
AG0: Ant A_LTE Band 5	AG1: Ant F_LTE Band 41	0.149	0.559	0.708	87.81	0.01
AG0: Ant A_NR Band n5	AG1: Ant F_LTE Band 41	0.129	0.559	0.688	82.57	0.01
AG0: Ant A_UMTS 850	AG1: Ant F_LTE Band 41	0.101	0.559	0.66	83.8	0.01
AG0: Ant A_LTE Band 5	AG1: Ant E_UMTS 850	0.149	0.472	0.621	78.44	N/A

Note: The light gray highlighted row shows the worst case sum of all AG combinations under 1W/kg. Since the sum of these combinations is less than or equal to 1 W/kg (SAR design target for this EUT), therefore no further analysis is needed.

Left Cheek						
AG0 Band/Antenna	AG1 Band/Antenna	AG0 ER	AG1 ER	Standalone Sum ER	Distance (mm)	SPLSR
AG0: Ant A_LTE Band 66	AG1: Ant E_LTE Band 5	0.107	0.521	0.628	92.71	0.01
AG0: Ant B_NR Band n41	AG1: Ant E_LTE Band 5	0.122	0.521	0.643	90.67	0.01
AG0: Ant A_LTE Band 2	AG1: Ant E_LTE Band 5	0.102	0.521	0.623	93.58	N/A

Note: The light gray highlighted row shows the worst case sum of all AG combinations under 1W/kg. Since the sum of these combinations is less than or equal to 1 W/kg (SAR design target for this EUT), therefore no further analysis is needed.

Notes:

1. For Right Tilt and Left Tilt, since the worst case sum of all AG combinations are under 1 W/kg (0.625 Ratio to Limit), the AGs are considered fully uncoupled and no further analysis is needed.
2. No evaluation was performed to determine the aggregate 1g SAR for these configurations as the SPLSR ratio between the antenna pairs was not greater than 0.02 per FCC KDB 447498 D04v01. Please see the Highest Report SAR and Hotspot Location Section for peak locations

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E.6 Body-worn (RSI = 0) SAR Antenna Group Analysis

Table E-2
RSI=0 Body-worn AG Verification

Bodyworn	Configuration	AG0 Ratio to Limit	AG1 Ratio to Limit	AG0 + AG1 Ratio to Limit
	Back	0.609	0.683	See table below
	Front	0.579	0.497	See table below

Body-worn Back Side						
AGO Band/Antenna	AG1 Band/Antenna	AGO ER	AG1 ER	Standalone Sum ER	Distance (mm)	SPLSR
AGO: Ant A, GSM 1900	AG1: Ant E, GSM 850	0.609	0.24	0.849	165.49	0
AGO: Ant A, GSM 1900	AG1: Ant E, LTE Band 12	0.609	0.223	0.832	173.12	0
AGO: Ant A, GSM 1900	AG1: Ant E, LTE Band 5	0.609	0.439	1.048	172.55	0.01
AGO: Ant A, GSM 1900	AG1: Ant E, NR Band n5	0.609	0.345	0.954	169.81	0.01
AGO: Ant A, GSM 1900	AG1: Ant E, UMTS 850	0.609	0.46	1.069	166.83	0.01
AGO: Ant A, GSM 1900	AG1: Ant F, LTE Band 2	0.609	0.243	0.852	167.9	0
AGO: Ant A, GSM 1900	AG1: Ant F, LTE Band 41	0.609	0.278	0.887	160.21	0.01
AGO: Ant A, GSM 1900	AG1: Ant F, LTE Band 66	0.609	0.218	0.827	167.98	0
AGO: Ant A, GSM 1900	AG1: Ant G, 5 GHz WIFI	0.609	0.626	1.235	163.8	0.01
AGO: Ant A, GSM 1900	AG1: Ant G, 6 GHz WIFI	0.609	0.03	0.639	152.86	0
AGO: Ant A, GSM 1900	AG1: Ant H, 2.4 GHz Bluetooth	0.609	0.214	0.823	149.21	0.01
AGO: Ant A, GSM 1900	AG1: Ant H, 2.4 GHz WIFI	0.609	0.253	0.862	150.13	0.01
AGO: Ant A, GSM 1900	AG1: Ant MIMO, 2.4 GHz WIFI	0.609	0.273	0.882	158.46	0.01
AGO: Ant A, GSM 1900	AG1: Ant MIMO, 5 GHz WIFI	0.609	0.683	1.292	157.14	0.01
AGO: Ant A, GSM 1900	AG1: Ant MIMO, 6 GHz WIFI	0.609	0.023	0.632	154.6	0
AGO: Ant A, GSM 850	AG1: Ant E, LTE Band 5	0.29	0.439	0.729	164.26	0
AGO: Ant A, GSM 850	AG1: Ant E, NR Band n5	0.29	0.345	0.635	161.28	0
AGO: Ant A, GSM 850	AG1: Ant E, UMTS 850	0.29	0.46	0.75	158.9	0
AGO: Ant A, GSM 850	AG1: Ant G, 5 GHz WIFI	0.29	0.626	0.916	150.19	0.01
AGO: Ant A, GSM 850	AG1: Ant MIMO, 5 GHz WIFI	0.29	0.683	0.973	142.95	0.01
AGO: Ant A, LTE Band 12	AG1: Ant E, LTE Band 5	0.303	0.439	0.742	166.68	0
AGO: Ant A, LTE Band 12	AG1: Ant E, NR Band n5	0.303	0.345	0.648	163.72	0
AGO: Ant A, LTE Band 12	AG1: Ant E, UMTS 850	0.303	0.46	0.763	161.28	0
AGO: Ant A, LTE Band 12	AG1: Ant G, 5 GHz WIFI	0.303	0.626	0.929	153.06	0.01
AGO: Ant A, LTE Band 12	AG1: Ant MIMO, 5 GHz WIFI	0.303	0.683	0.986	145.86	0.01
AGO: Ant A, LTE Band 2	AG1: Ant E, GSM 850	0.446	0.24	0.686	160.91	0
AGO: Ant A, LTE Band 2	AG1: Ant E, LTE Band 12	0.446	0.223	0.669	168.91	0
AGO: Ant A, LTE Band 2	AG1: Ant E, LTE Band 5	0.446	0.439	0.885	168.11	0
AGO: Ant A, LTE Band 2	AG1: Ant E, NR Band n5	0.446	0.345	0.791	165.44	0
AGO: Ant A, LTE Band 2	AG1: Ant E, UMTS 850	0.446	0.46	0.906	162.3	0.01
AGO: Ant A, LTE Band 2	AG1: Ant F, LTE Band 2	0.446	0.243	0.689	164.8	0
AGO: Ant A, LTE Band 2	AG1: Ant F, LTE Band 41	0.446	0.278	0.724	156.91	0
AGO: Ant A, LTE Band 2	AG1: Ant F, LTE Band 66	0.446	0.218	0.664	164.72	0
AGO: Ant A, LTE Band 2	AG1: Ant G, 5 GHz WIFI	0.446	0.626	1.072	160.98	0.01
AGO: Ant A, LTE Band 2	AG1: Ant H, 2.4 GHz Bluetooth	0.446	0.214	0.66	146.81	0
AGO: Ant A, LTE Band 2	AG1: Ant H, 2.4 GHz WIFI	0.446	0.253	0.699	147.45	0
AGO: Ant A, LTE Band 2	AG1: Ant MIMO, 2.4 GHz WIFI	0.446	0.273	0.719	155.44	0
AGO: Ant A, LTE Band 2	AG1: Ant MIMO, 5 GHz WIFI	0.446	0.683	1.129	154.53	0.01
AGO: Ant A, LTE Band 5	AG1: Ant E, LTE Band 5	0.318	0.439	0.757	163.75	0
AGO: Ant A, LTE Band 5	AG1: Ant E, NR Band n5	0.318	0.345	0.663	160.79	0
AGO: Ant A, LTE Band 5	AG1: Ant E, UMTS 850	0.318	0.46	0.778	158.35	0
AGO: Ant A, LTE Band 5	AG1: Ant G, 5 GHz WIFI	0.318	0.626	0.944	150.23	0.01
AGO: Ant A, LTE Band 5	AG1: Ant MIMO, 5 GHz WIFI	0.318	0.683	1.001	143.06	0.01
AGO: Ant A, LTE Band 66	AG1: Ant E, GSM 850	0.404	0.24	0.644	159.61	0
AGO: Ant A, LTE Band 66	AG1: Ant E, LTE Band 12	0.404	0.223	0.627	167.1	0
AGO: Ant A, LTE Band 66	AG1: Ant E, LTE Band 5	0.404	0.439	0.843	166.62	0
AGO: Ant A, LTE Band 66	AG1: Ant E, NR Band n5	0.404	0.345	0.749	163.86	0
AGO: Ant A, LTE Band 66	AG1: Ant E, UMTS 850	0.404	0.46	0.864	160.93	0
AGO: Ant A, LTE Band 66	AG1: Ant F, LTE Band 2	0.404	0.243	0.647	161.62	0
AGO: Ant A, LTE Band 66	AG1: Ant F, LTE Band 41	0.404	0.278	0.682	153.96	0
AGO: Ant A, LTE Band 66	AG1: Ant G, 5 GHz WIFI	0.404	0.626	1.03	157.48	0.01
AGO: Ant A, LTE Band 66	AG1: Ant H, 2.4 GHz WIFI	0.404	0.253	0.657	143.8	0
AGO: Ant A, LTE Band 66	AG1: Ant MIMO, 2.4 GHz WIFI	0.404	0.273	0.677	152.17	0
AGO: Ant A, LTE Band 66	AG1: Ant MIMO, 5 GHz WIFI	0.404	0.683	1.087	150.8	0.01
AGO: Ant A, NR Band n5	AG1: Ant E, GSM 850	0.549	0.24	0.789	155.54	0
AGO: Ant A, NR Band n5	AG1: Ant E, LTE Band 12	0.549	0.223	0.772	161.47	0
AGO: Ant A, NR Band n5	AG1: Ant E, LTE Band 5	0.549	0.439	0.988	161.94	0.01
AGO: Ant A, NR Band n5	AG1: Ant E, NR Band n5	0.549	0.345	0.894	158.92	0.01
AGO: Ant A, NR Band n5	AG1: Ant E, UMTS 850	0.549	0.46	1.009	156.64	0.01
AGO: Ant A, NR Band n5	AG1: Ant F, LTE Band 2	0.549	0.243	0.792	152.11	0
AGO: Ant A, NR Band n5	AG1: Ant F, LTE Band 41	0.549	0.278	0.827	145.21	0.01
AGO: Ant A, NR Band n5	AG1: Ant F, LTE Band 66	0.549	0.218	0.767	152.75	0
AGO: Ant A, NR Band n5	AG1: Ant G, 5 GHz WIFI	0.549	0.626	1.175	147.13	0.01
AGO: Ant A, NR Band n5	AG1: Ant H, 2.4 GHz Bluetooth	0.549	0.214	0.763	131.37	0.01
AGO: Ant A, NR Band n5	AG1: Ant H, 2.4 GHz WIFI	0.549	0.253	0.802	133.17	0.01
AGO: Ant A, NR Band n5	AG1: Ant MIMO, 2.4 GHz WIFI	0.549	0.273	0.822	142.51	0.01
AGO: Ant A, NR Band n5	AG1: Ant MIMO, 5 GHz WIFI	0.549	0.683	1.232	139.83	0.01
AGO: Ant A, UMTS 850	AG1: Ant E, GSM 850	0.488	0.24	0.728	159.36	0
AGO: Ant A, UMTS 850	AG1: Ant E, LTE Band 12	0.488	0.223	0.711	165.34	0
AGO: Ant A, UMTS 850	AG1: Ant E, LTE Band 5	0.488	0.439	0.927	165.78	0.01
AGO: Ant A, UMTS 850	AG1: Ant E, NR Band n5	0.488	0.345	0.833	162.77	0
AGO: Ant A, UMTS 850	AG1: Ant E, UMTS 850	0.488	0.46	0.948	160.47	0.01
AGO: Ant A, UMTS 850	AG1: Ant F, LTE Band 2	0.488	0.243	0.731	156	0
AGO: Ant A, UMTS 850	AG1: Ant F, LTE Band 41	0.488	0.278	0.766	149.11	0
AGO: Ant A, UMTS 850	AG1: Ant F, LTE Band 66	0.488	0.218	0.706	156.65	0
AGO: Ant A, UMTS 850	AG1: Ant G, 5 GHz WIFI	0.488	0.626	1.114	151.01	0.01
AGO: Ant A, UMTS 850	AG1: Ant H, 2.4 GHz Bluetooth	0.488	0.214	0.702	135.23	0
AGO: Ant A, UMTS 850	AG1: Ant H, 2.4 GHz WIFI	0.488	0.253	0.741	137.05	0
AGO: Ant A, UMTS 850	AG1: Ant MIMO, 2.4 GHz WIFI	0.488	0.273	0.761	146.41	0
AGO: Ant A, UMTS 850	AG1: Ant MIMO, 5 GHz WIFI	0.488	0.683	1.171	143.7	0.01
AGO: Ant B, LTE Band 41	AG1: Ant E, LTE Band 5	0.311	0.439	0.75	178.79	0
AGO: Ant B, LTE Band 41	AG1: Ant E, NR Band n5	0.311	0.345	0.656	175.72	0
AGO: Ant B, LTE Band 41	AG1: Ant E, UMTS 850	0.311	0.46	0.771	173.59	0
AGO: Ant B, LTE Band 41	AG1: Ant G, 5 GHz WIFI	0.311	0.626	0.937	162.08	0.01
AGO: Ant B, LTE Band 41	AG1: Ant MIMO, 5 GHz WIFI	0.311	0.683	0.994	154.52	0.01
AGO: Ant B, NR Band n41	AG1: Ant E, GSM 850	0.547	0.24	0.787	171.55	0
AGO: Ant B, NR Band n41	AG1: Ant E, LTE Band 12	0.547	0.223	0.77	176.9	0
AGO: Ant B, NR Band n41	AG1: Ant E, LTE Band 5	0.547	0.439	0.986	177.71	0.01
AGO: Ant B, NR Band n41	AG1: Ant E, NR Band n5	0.547	0.345	0.892	174.62	0
AGO: Ant B, NR Band n41	AG1: Ant E, UMTS 850	0.547	0.46	1.007	172.57	0.01
AGO: Ant B, NR Band n41	AG1: Ant F, LTE Band 2	0.547	0.243	0.79	165.83	0
AGO: Ant B, NR Band n41	AG1: Ant F, LTE Band 41	0.547	0.278	0.825	159.37	0
AGO: Ant B, NR Band n41	AG1: Ant F, LTE Band 66	0.547	0.218	0.765	166.75	0
AGO: Ant B, NR Band n41	AG1: Ant G, 5 GHz WIFI	0.547	0.626	1.173	160.42	0.01
AGO: Ant B, NR Band n41	AG1: Ant H, 2.4 GHz Bluetooth	0.547	0.214	0.761	144.12	0
AGO: Ant B, NR Band n41	AG1: Ant H, 2.4 GHz WIFI	0.547	0.253	0.8	146.42	0
AGO: Ant B, NR Band n41	AG1: Ant MIMO, 2.4 GHz WIFI	0.547	0.273	0.82	156.23	0
AGO: Ant B, NR Band n41	AG1: Ant MIMO, 5 GHz WIFI	0.547	0.683	1.23	152.82	0.01
AGO: Ant A, LTE Band 66	AG1: Ant F, LTE Band 66	0.404	0.218	0.622	161.72	N/A

Note: The light gray highlighted row shows the worst case sum of all AG combinations under 1W/kg. Since the sum of these combinations is less than or equal to 1 W/kg (SAR design target for this EUT), therefore no further analysis is needed.

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Body-worn Front Side						
AG0 Band/Antenna	AG1 Band/Antenna	AG0 ER	AG1 ER	Standalone Sum ER	Distance (mm)	SPLSR
AG0: Ant A_GSM 1900	AG1: Ant E_GSM 850	0.579	0.186	0.765	169.04	0
AG0: Ant A_GSM 1900	AG1: Ant E_LTE Band 12	0.579	0.127	0.706	179.31	0
AG0: Ant A_GSM 1900	AG1: Ant E_LTE Band 5	0.579	0.371	0.95	170.39	0.01
AG0: Ant A_GSM 1900	AG1: Ant E_NR Band n5	0.579	0.248	0.827	175.25	0
AG0: Ant A_GSM 1900	AG1: Ant E_UMTS 850	0.579	0.391	0.97	168.47	0.01
AG0: Ant A_GSM 1900	AG1: Ant F_LTE Band 2	0.579	0.181	0.76	172.11	0
AG0: Ant A_GSM 1900	AG1: Ant F_LTE Band 41	0.579	0.164	0.743	165.01	0
AG0: Ant A_GSM 1900	AG1: Ant F_LTE Band 66	0.579	0.18	0.759	172.64	0
AG0: Ant A_GSM 1900	AG1: Ant G_5 GHz WIFI	0.579	0.354	0.933	152.84	0.01
AG0: Ant A_GSM 1900	AG1: Ant H_2.4 GHz Bluetooth	0.579	0.191	0.77	146.59	0
AG0: Ant A_GSM 1900	AG1: Ant H_2.4 GHz WIFI	0.579	0.142	0.721	144.29	0
AG0: Ant A_GSM 1900	AG1: Ant MIMO_2.4 GHz WIFI	0.579	0.13	0.709	154.19	0
AG0: Ant A_GSM 1900	AG1: Ant MIMO_5 GHz WIFI	0.579	0.497	1.076	150.54	0.01
AG0: Ant A_GSM 850	AG1: Ant MIMO_5 GHz WIFI	0.163	0.497	0.66	139.1	0
AG0: Ant A_LTE Band 2	AG1: Ant E_GSM 850	0.458	0.186	0.644	167.13	0
AG0: Ant A_LTE Band 2	AG1: Ant E_LTE Band 5	0.458	0.371	0.829	168.47	0
AG0: Ant A_LTE Band 2	AG1: Ant E_NR Band n5	0.458	0.248	0.706	173.32	0
AG0: Ant A_LTE Band 2	AG1: Ant E_UMTS 850	0.458	0.391	0.849	166.55	0
AG0: Ant A_LTE Band 2	AG1: Ant F_LTE Band 2	0.458	0.181	0.639	170.29	0
AG0: Ant A_LTE Band 2	AG1: Ant F_LTE Band 66	0.458	0.18	0.638	170.81	0
AG0: Ant A_LTE Band 2	AG1: Ant G_5 GHz WIFI	0.458	0.354	0.812	151.11	0
AG0: Ant A_LTE Band 2	AG1: Ant H_2.4 GHz Bluetooth	0.458	0.191	0.649	144.93	0
AG0: Ant A_LTE Band 2	AG1: Ant MIMO_5 GHz WIFI	0.458	0.497	0.955	148.84	0.01
AG0: Ant A_LTE Band 5	AG1: Ant E_LTE Band 5	0.319	0.371	0.69	165.68	0
AG0: Ant A_LTE Band 5	AG1: Ant E_UMTS 850	0.319	0.391	0.71	164.22	0
AG0: Ant A_LTE Band 5	AG1: Ant G_5 GHz WIFI	0.319	0.354	0.673	143.86	0
AG0: Ant A_LTE Band 5	AG1: Ant MIMO_5 GHz WIFI	0.319	0.497	0.816	140.96	0.01
AG0: Ant A_LTE Band 66	AG1: Ant E_LTE Band 5	0.333	0.371	0.704	168.59	0
AG0: Ant A_LTE Band 66	AG1: Ant E_UMTS 850	0.333	0.391	0.724	166.79	0
AG0: Ant A_LTE Band 66	AG1: Ant G_5 GHz WIFI	0.333	0.354	0.687	149.93	0
AG0: Ant A_LTE Band 66	AG1: Ant MIMO_5 GHz WIFI	0.333	0.497	0.83	147.49	0.01
AG0: Ant A_NR Band n5	AG1: Ant E_LTE Band 5	0.339	0.371	0.71	162.93	0
AG0: Ant A_NR Band n5	AG1: Ant E_UMTS 850	0.339	0.391	0.73	161.56	0
AG0: Ant A_NR Band n5	AG1: Ant G_5 GHz WIFI	0.339	0.354	0.693	140.34	0
AG0: Ant A_NR Band n5	AG1: Ant MIMO_5 GHz WIFI	0.339	0.497	0.836	137.34	0.01
AG0: Ant A_UMTS 850	AG1: Ant E_LTE Band 5	0.26	0.371	0.631	169.84	0
AG0: Ant A_UMTS 850	AG1: Ant E_UMTS 850	0.26	0.391	0.651	168.51	0
AG0: Ant A_UMTS 850	AG1: Ant MIMO_5 GHz WIFI	0.26	0.497	0.757	143.53	0
AG0: Ant B_LTE Band 41	AG1: Ant MIMO_5 GHz WIFI	0.178	0.497	0.675	152.23	0
AG0: Ant B_NR Band n41	AG1: Ant E_LTE Band 5	0.364	0.371	0.735	170.98	0
AG0: Ant B_NR Band n41	AG1: Ant E_UMTS 850	0.364	0.391	0.755	168.8	0
AG0: Ant B_NR Band n41	AG1: Ant G_5 GHz WIFI	0.364	0.354	0.718	156.15	0
AG0: Ant B_NR Band n41	AG1: Ant MIMO_5 GHz WIFI	0.364	0.497	0.861	154.24	0.01
AG0: Ant A_LTE Band 2	AG1: Ant F_LTE Band 41	0.458	0.164	0.622	163.21	N/A

Note: The light gray highlighted row shows the worst case sum of all AG combinations under 1W/kg. Since the sum of these combinations is less than or equal to 1 W/kg (SAR design target for this EUT), therefore no further analysis is needed.

Notes:

1. For Back Side and Front Side, since the worst case sum of all AG combinations are under 1 W/kg (0.625 Ratio to Limit), the AGs are considered fully uncoupled and no further analysis is needed.
2. No evaluation was performed to determine the aggregate 1g SAR for these configurations as the SPLSR ratio between the antenna pairs was not greater than 0.02 per FCC KDB 447498 D04v01. Please see the Highest Report SAR and Hotspot Location Section for peak locations

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E.7 Hotspot (RSI = 0) SAR Antenna Group Analysis

Table E-3
RSI = 0 Hotspot AG Verification

	Configuration	AG0 Ratio to Limit	AG1 Ratio to Limit	AG0 + AG1 Ratio to Limit
Hotspot	Back	0.609	0.460	See table below
	Front	0.579	0.497	See table below
	Top	-	0.231	0.231
	Bottom	0.421	-	0.421
	Right	0.132	0.124	0.256
	Left	0.143	0.182	0.325

Hotspot Back Side						
AG0 Band/Antenna	AG1 Band/Antenna	AG0 ER	AG1 ER	Standalone Sum ER	Distance (mm)	SPLSR
AG0: Ant A_GSM 1900	AG1: Ant G_5 GHz WIFI	0.609	0.424	1.033	156.59	0.01
AG0: Ant A_GSM 1900	AG1: Ant MIMO_5 GHz WIFI	0.609	0.381	0.99	151.79	0.01
AG0: Ant A_GSM 850	AG1: Ant G_5 GHz WIFI	0.29	0.424	0.714	141.59	0
AG0: Ant A_GSM 850	AG1: Ant MIMO_5 GHz WIFI	0.29	0.381	0.671	137.53	0
AG0: Ant A_LTE Band 12	AG1: Ant G_5 GHz WIFI	0.303	0.424	0.727	144.56	0
AG0: Ant A_LTE Band 12	AG1: Ant MIMO_5 GHz WIFI	0.303	0.381	0.684	140.45	0
AG0: Ant A_LTE Band 2	AG1: Ant G_5 GHz WIFI	0.446	0.424	0.87	154.28	0.01
AG0: Ant A_LTE Band 2	AG1: Ant MIMO_5 GHz WIFI	0.446	0.381	0.827	149.23	0.01
AG0: Ant A_LTE Band 5	AG1: Ant G_5 GHz WIFI	0.318	0.424	0.742	141.79	0
AG0: Ant A_LTE Band 5	AG1: Ant MIMO_5 GHz WIFI	0.318	0.381	0.699	137.64	0
AG0: Ant A_LTE Band 66	AG1: Ant G_5 GHz WIFI	0.404	0.424	0.828	150.24	0.01
AG0: Ant A_LTE Band 66	AG1: Ant MIMO_5 GHz WIFI	0.404	0.381	0.785	145.45	0
AG0: Ant A_NR Band n5	AG1: Ant G_5 GHz WIFI	0.549	0.424	0.973	138.36	0.01
AG0: Ant A_NR Band n5	AG1: Ant MIMO_5 GHz WIFI	0.549	0.381	0.93	134.4	0.01
AG0: Ant A_UMTS 850	AG1: Ant G_5 GHz WIFI	0.488	0.424	0.912	142.21	0.01
AG0: Ant A_UMTS 850	AG1: Ant MIMO_5 GHz WIFI	0.488	0.381	0.869	138.28	0.01
AG0: Ant B_LTE Band 41	AG1: Ant G_5 GHz WIFI	0.311	0.424	0.735	152.6	0
AG0: Ant B_LTE Band 41	AG1: Ant MIMO_5 GHz WIFI	0.311	0.381	0.692	149.1	0
AG0: Ant B_NR Band n41	AG1: Ant G_5 GHz WIFI	0.547	0.424	0.971	150.8	0.01
AG0: Ant B_NR Band n41	AG1: Ant MIMO_5 GHz WIFI	0.547	0.381	0.928	147.4	0.01
Hotspot Front Side						
AG0 Band/Antenna	AG1 Band/Antenna	AG0 ER	AG1 ER	Standalone Sum ER	Distance (mm)	SPLSR
AG0: Ant A_GSM 1900	AG1: Ant G_5 GHz WIFI	0.579	0.316	0.895	155.98	0.01
AG0: Ant A_LTE Band 2	AG1: Ant G_5 GHz WIFI	0.458	0.316	0.774	154.26	0
AG0: Ant A_LTE Band 5	AG1: Ant G_5 GHz WIFI	0.319	0.316	0.635	146.7	0
AG0: Ant A_LTE Band 66	AG1: Ant G_5 GHz WIFI	0.333	0.316	0.649	153	0
AG0: Ant A_NR Band n5	AG1: Ant G_5 GHz WIFI	0.339	0.316	0.655	143.13	0
AG0: Ant B_NR Band n41	AG1: Ant G_5 GHz WIFI	0.364	0.316	0.68	159.45	0

Notes:

1. Because body-worn and hotspot back and front sides contain duplicate combinations, this section includes only those combinations that are unique to hotspot. Combinations that are common to both exposure conditions are presented in Section E.5 and are not repeated here.
2. For Right and Left edges, since the worst case sum of all AG combinations are under 1 W/kg (0.625 Ratio to Limit), the AGs are considered fully uncoupled and no further analysis is needed.
3. No evaluation was performed to determine the aggregate 1g SAR for these configurations as the SPLS ratio between the antenna pairs was not greater than 0.02 per FCC KDB 447498 D04v01. Please see the Highest Report SAR and Hotspot Location Section for peak locations

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E.8 Phablet (RSI = 0) 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 E-4
RSI = 0 Phablet AG0 Highest Adjusted Ratio to Limit

AG0 Ratio to Limit				
	Configuration	A	B	Max
Phablet	Bottom	0.238	0.403	0.403

Table E-5
RSI = 0 Phablet AG1 Highest Ratio to Limit

AG1 Ratio to Limit				
	Configuration	G	MIMO	Max
Phablet	Back	0.394	0.384	0.394
	Front	0.283	0.351	0.351
	Top	0.123	0.098	0.123
	Bottom	-	-	-
	Right	-	0.092	0.092
	Left	0.331	0.286	0.331

Table E-6
Phablet NFC Highest Ratio to Limit

	Configuration	NFC
Phablet	Back	0.0045
	Front	0
	Top	0
	Bottom	0
	Right	0
	Left	0

Table E-7
RSI = 0 Phablet AG Verification

	Configuration	AG0 Ratio to Limit	AG1 Ratio to Limit	NFC Ratio to Limit	AG0 + AG1 + NFC Ratio to Limit
Phablet	Back	-	0.394	0.005	0.399
	Front	-	0.351	0.000	0.351
	Top	-	0.123	0.000	0.123
	Bottom	0.403	-	0.000	0.403
	Right	-	0.092	0.000	0.092
	Left	-	0.331	0.000	0.331

Notes:

- For all combinations where the TER sum of AG0+AG1+NFC is not greater than 1, there's no further analysis required for compliance demonstration.

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E.9 Highest ER and SAR Hotspot Locations

As a conservative assessment, the distances between Bottom Set and Top Set were determined using the coordinates of the peak locations (assumes 0 mm separation on z axis for Body only)

Table E-8
RSI = 1 Held-to-ear Right Cheek Peak X, Y, Z Coordinates

Antenna Group	Antenna	Mode/Band	Ratio to Limit	X-Coord	Y-Coord	Z-Coord
AG0	A	GSM 850	0.011	61.5	-258.2	-169.8
AG1	E	GSM 850	0.253	6.6	-308.1	-167.9
AG0	A	GSM 1900	0.040	56.8	-244.3	-168.1
AG0	A	UMTS 850	0.101	59.7	-257.9	-170.3
AG1	E	UMTS 850	0.472	5.3	-308.8	-167.8
AG0	A	LTE Band 12	0.111	58.6	-258.6	-169.5
AG1	E	LTE Band 12	0.181	3.4	-315.2	-167.9
AG0	A	LTE Band 5	0.149	62.0	-254.6	-168.5
AG1	E	LTE Band 5	0.413	1.1	-311.2	-167.3
AG0	A	LTE Band 66	0.059	59.8	-307.4	-169.7
AG1	F	LTE Band 66	0.392	24.6	-328.4	-169.7
AG0	A	LTE Band 2	0.074	60.5	-245.3	-167.4
AG1	F	LTE Band 2	0.416	23.6	-328.8	-169.7
AG0	B	LTE Band 41	0.027	61.8	-305.1	-169.4
AG1	F	LTE Band 41	0.559	13.5	-327.8	-169.0
AG0	A	NR Band n5	0.129	57.9	-258.2	-170.5
AG1	E	NR Band n5	0.324	2.4	-309.9	-168.3
AG0	B	NR Band n41	0.061	63.2	-289.0	-171.7
AG1	H	2.4 GHz WIFI	0.388	47.1	-332.6	-168.8
AG1	MIMO	2.4 GHz WIFI	0.239	47.1	-332.6	-168.8
AG1	G	5 GHz WIFI	0.491	40.8	-327.6	-170.0
AG1	MIMO	5 GHz WIFI	0.446	42.0	-326.6	-170.0
AG1	G	6 GHz WIFI	0.088	39.9	-327.8	-170.0
AG1	MIMO	6 GHz WIFI	0.154	40.2	-326.7	-170.1
AG1	H	2.4 GHz Bluetooth	0.348	41.9	-332.7	-169.3

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Table E-9
RSI = 1 Held-to-ear Right Tilt Exposure Ratio

Antenna Group	Antenna	Mode/Band	Ratio to Limit
AG0	A	GSM 850	0.005
AG1	E	GSM 850	0.216
AG0	A	GSM 1900	0.019
AG0	A	UMTS 850	0.044
AG1	E	UMTS 850	0.409
AG0	A	LTE Band 12	0.055
AG1	E	LTE Band 12	0.155
AG0	A	LTE Band 5	0.064
AG1	E	LTE Band 5	0.368
AG0	A	LTE Band 66	0.050
AG1	F	LTE Band 66	0.433
AG0	A	LTE Band 2	0.046
AG1	F	LTE Band 2	0.441
AG0	B	LTE Band 41	0.021
AG1	F	LTE Band 41	0.366
AG0	A	NR Band n5	0.055
AG1	E	NR Band n5	0.280
AG0	B	NR Band n41	0.049
AG1	H	2.4 GHz WIFI	0.189
AG1	MIMO	2.4 GHz WIFI	0.185
AG1	G	5 GHz WIFI	0.158
AG1	MIMO	5 GHz WIFI	0.153
AG1	G	6 GHz WIFI	0.060
AG1	MIMO	6 GHz WIFI	0.031
AG1	H	2.4 GHz Bluetooth	0.263

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Table E-10
RSI = 1 Held-to-ear Left Cheek Peak X, Y, Z Coordinates

Antenna Group	Antenna	Mode/Band	Ratio to Limit	X-Coord	Y-Coord	Z-Coord
AG0	A	GSM 850	0.008	67.2	285.8	-168.7
AG1	E	GSM 850	0.254	17.5	331.7	-169.1
AG0	A	GSM 1900	0.036	55.4	255.6	-169.7
AG0	A	UMTS 850	0.063	64.5	291.1	-169.3
AG1	E	UMTS 850	0.491	20.5	332.6	-169.2
AG0	A	LTE Band 12	0.094	59.1	280.4	-170.5
AG1	E	LTE Band 12	0.273	16.8	329.3	-169.2
AG0	A	LTE Band 5	0.093	60.6	284.9	-170.3
AG1	E	LTE Band 5	0.521	16.6	330.9	-169.1
AG0	A	LTE Band 66	0.107	53.8	246.0	-170.7
AG1	F	LTE Band 66	0.249	4.8	304.6	-167.5
AG0	A	LTE Band 2	0.102	55.5	245.8	-170.4
AG1	F	LTE Band 2	0.246	5.7	307.6	-167.8
AG0	B	LTE Band 41	0.051	52.5	247.3	-170.4
AG1	F	LTE Band 41	0.211	-1.4	297.9	-165.7
AG0	A	NR Band n5	0.093	64.0	286.6	-169.5
AG1	E	NR Band n5	0.418	18.5	329.8	-170.0
AG0	B	NR Band n41	0.122	52.8	247.8	-171.2
AG1	H	2.4 GHz WIFI	0.093	32.4	258.0	-168.2
AG1	MIMO	2.4 GHz WIFI	0.108	61.1	320.6	-168.0
AG1	G	5 GHz WIFI	0.072	-9.4	294.9	-163.5
AG1	MIMO	5 GHz WIFI	0.211	26.3	326.1	-169.9
AG1	G	6 GHz WIFI	0.020	-4.5	298.5	-165.1
AG1	MIMO	6 GHz WIFI	0.011	11.9	323.5	-169.0
AG1	H	2.4 GHz Bluetooth	0.089	34.4	255.9	-168.4

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Table E-11
RS I= 1 Held-to-ear Left Tilt Exposure Ratio

Antenna Group	Antenna	Mode/Band	Ratio to Limit
AG0	A	GSM 850	0.004
AG1	E	GSM 850	0.256
AG0	A	GSM 1900	0.016
AG0	A	UMTS 850	0.039
AG1	E	UMTS 850	0.470
AG0	A	LTE Band 12	0.069
AG1	E	LTE Band 12	0.206
AG0	A	LTE Band 5	0.057
AG1	E	LTE Band 5	0.435
AG0	A	LTE Band 66	0.041
AG1	F	LTE Band 66	0.360
AG0	A	LTE Band 2	0.037
AG1	F	LTE Band 2	0.325
AG0	B	LTE Band 41	0.025
AG1	F	LTE Band 41	0.194
AG0	A	NR Band n5	0.056
AG1	E	NR Band n5	0.334
AG0	B	NR Band n41	0.074
AG1	H	2.4 GHz WIFI	0.063
AG1	MIMO	2.4 GHz WIFI	0.071
AG1	G	5 GHz WIFI	0.070
AG1	MIMO	5 GHz WIFI	0.169
AG1	G	6 GHz WIFI	0.028
AG1	MIMO	6 GHz WIFI	0.015
AG1	H	2.4 GHz Bluetooth	0.074

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Table E-12
RSI = 0 Body-worn Back Side Peak X, Y Coordinates

Antenna Group	Antenna	Mode/Band	Ratio to Limit	X-Coord	Y-Coord
AG0	A	GSM 850	0.290	-42.0	73.9
AG1	E	GSM 850	0.240	-13.1	-81.2
AG0	A	GSM 1900	0.609	-21.0	84.1
AG0	A	UMTS 850	0.488	-44.7	75.0
AG1	E	UMTS 850	0.460	-14.5	-82.6
AG0	A	LTE Band 12	0.303	-40.3	76.6
AG1	E	LTE Band 12	0.223	-23.7	-89.0
AG0	A	LTE Band 5	0.318	-39.9	73.7
AG1	E	LTE Band 5	0.439	-16.7	-88.4
AG0	A	LTE Band 66	0.404	-23.1	78.1
AG1	F	LTE Band 66	0.218	-48.6	-81.6
AG0	A	LTE Band 2	0.446	-15.2	79.7
AG1	F	LTE Band 2	0.243	-52.6	-80.8
AG0	B	LTE Band 41	0.311	-53.3	86.6
AG1	F	LTE Band 41	0.278	-46.3	-74.1
AG0	A	NR Band n5	0.549	-44.7	71.1
AG1	E	NR Band n5	0.345	-18.8	-85.7
AG0	B	NR Band n41	0.547	-55.6	85.0
AG1	H	2.4 GHz WIFI	0.253	-58.0	-61.4
AG1	MIMO	2.4 GHz WIFI	0.273	-52.5	-71.2
AG1	G	5 GHz WIFI	0.626	-58.3	-75.4
AG1	MIMO	5 GHz WIFI	0.683	-61.6	-67.7
AG1	G	6 GHz WIFI	0.030	-62.2	-63.1
AG1	MIMO	6 GHz WIFI	0.023	-67.3	-63.4
AG1	H	2.4 GHz Bluetooth	0.214	-63.6	-58.9

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Table E-13
RSI = 0 Body-worn Front Side Peak X, Y Coordinates

Antenna Group	Antenna	Mode/Band	Ratio to Limit	X-Coord	Y-Coord
AG0	A	GSM 850	0.163	-3.5	78.7
AG1	E	GSM 850	0.186	-31.6	-83.4
AG0	A	GSM 1900	0.579	-27.8	85.6
AG0	A	UMTS 850	0.260	-5.7	82.9
AG1	E	UMTS 850	0.391	-37.4	-82.6
AG0	A	LTE Band 12	0.059	-11.3	72.4
AG1	E	LTE Band 12	0.127	-36.4	-93.5
AG0	A	LTE Band 5	0.319	-11.1	79.5
AG1	E	LTE Band 5	0.371	-33.2	-84.7
AG0	A	LTE Band 66	0.333	-23.4	83.6
AG1	F	LTE Band 66	0.180	-8.0	-85.9
AG0	A	LTE Band 2	0.458	-28.3	83.7
AG1	F	LTE Band 2	0.181	-5.8	-85.1
AG0	B	LTE Band 41	0.178	-35.6	85.0
AG1	F	LTE Band 41	0.164	-3.4	-77.6
AG0	A	NR Band n5	0.339	-8.2	76.3
AG1	E	NR Band n5	0.248	-37.1	-89.4
AG0	B	NR Band n41	0.364	-38.3	86.2
AG1	H	2.4 GHz WIFI	0.142	17.8	-51.3
AG1	MIMO	2.4 GHz WIFI	0.130	15.1	-62.5
AG1	G	5 GHz WIFI	0.354	7.1	-63.2
AG1	MIMO	5 GHz WIFI	0.497	12.3	-59.5
AG1	G	6 GHz WIFI	0.020	-21.3	-85.2
AG1	MIMO	6 GHz WIFI	0.039	13.3	-59.0
AG1	H	2.4 GHz Bluetooth	0.191	16.3	-54.2

Table E-14
RSI = 0 Hotspot Back Side Peak X, Y Coordinates

Antenna Group	Antenna	Mode/Band	Ratio to Limit	X-Coord	Y-Coord
AG1	G	5 GHz WIFI	0.424	-67.9	-65.3
AG1	MIMO	5 GHz WIFI	0.381	-61.1	-62.3

Note: Because body-worn and hotspot back contain duplicate bands, this table only includes bands that are unique to hotspot. Bands that are common to both exposure conditions can be found in Table E-12

Table E-15
RSI = 0 Hotspot Front Side Peak X, Y Coordinates

Antenna Group	Antenna	Mode/Band	Ratio to Limit	X-Coord	Y-Coord
AG1	G	5 GHz WIFI	0.316	10.5	-65.6

Note: Because body-worn and hotspot front contain duplicate bands, this table only includes bands that are unique to hotspot. Bands that are common to both exposure conditions can be found in Table E-13

Table E-16
RSI = 0 Hotspot Right Edge Exposure Ratio

Antenna Group	Antenna	Mode/Band	Ratio to Limit
AG0	A	GSM 850	0.051
AG1	E	GSM 850	0.052
AG0	A	GSM 1900	0.021
AG0	A	UMTS 850	0.132
AG1	E	UMTS 850	0.116
AG0	A	LTE Band 12	0.098
AG1	E	LTE Band 12	0.067
AG0	A	LTE Band 5	0.098
AG1	E	LTE Band 5	0.124
AG0	A	LTE Band 66	0.021
AG0	A	LTE Band 2	0.040
AG0	A	NR Band n5	0.129
AG1	E	NR Band n5	0.086
AG1	MIMO	2.4 GHz WIFI	0.008
AG1	MIMO	5 GHz WIFI	0.062

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Table E-17
RSI = 0 Hotspot Left Edge Exposure Ratio

Antenna Group	Antenna	Mode/Band	Ratio to Limit
AG0	A	GSM 850	0.021
AG0	A	GSM 1900	0.013
AG0	A	UMTS 850	0.070
AG0	A	LTE Band 12	0.087
AG0	A	LTE Band 5	0.078
AG0	A	LTE Band 66	0.030
AG1	F	LTE Band 66	0.055
AG0	A	LTE Band 2	0.013
AG1	F	LTE Band 2	0.054
AG0	B	LTE Band 41	0.083
AG1	F	LTE Band 41	0.017
AG0	A	NR Band n5	0.071
AG0	B	NR Band n41	0.143
AG1	H	2.4 GHz WIFI	0.141
AG1	MIMO	2.4 GHz WIFI	0.112
AG1	G	5 GHz WIFI	0.182
AG1	MIMO	5 GHz WIFI	0.134
AG1	G	6 GHz WIFI	0.007
AG1	MIMO	6 GHz WIFI	0.005
AG1	H	2.4 GHz Bluetooth	0.154

E.10 Conclusion

The above numerical summed TER results and SPLSR for all the combinations of antenna groups are sufficient to show that AG0 is mutually exclusive from AG1 and TER is < 1. TER simultaneous transmission cases will not exceed the SAR limit and therefore no measured volumetric simultaneous SAR summation is required per FCC KDB Publication 447498 D04v01 and IEEE 1528-2013 Section 6.3.4.1.2

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