

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 1-g SAR for all simultaneously transmitting antennas in a specific physical test configuration is ≤ 1.6 W/kg. The different test positions within an exposure condition may be considered collectively to determine SAR test exclusion based on the sum of the 1-g SAR values. Alternatively, simultaneous transmission SAR test exclusion may be evaluated using the Total Exposure Ratio (TER).

The host device incorporates an NFC Reader, an NFC-based wireless power transfer (WPT) function, and two previously certified transmitter modules: the WLAN/Bluetooth module FCC ID C3K00002101 and the WWAN module FCC ID C3K2114.

The applicable WWAN and WLAN/Bluetooth SAR results used in this simultaneous transmission assessment were obtained from their respective host-integration RF exposure test reports, Report Nos. 1M2606300059-01.C3K and 1M2606300058-01.C3K, submitted under the corresponding FCC Class II Permissive Change (C2PC) filings. The NFC Reader and NFC-based WPT SAR results were measured under this host filing. These results are combined as applicable to evaluate the overall co-location and simultaneous transmission conditions of the final host configuration.

The WLAN/Bluetooth module incorporates Qualcomm® FastConnect with predefined sub-6 GHz WLAN antenna groups AG0 and AG1. The WWAN module incorporates Qualcomm® Smart Transmit Gen2 with one WWAN antenna group. Simultaneous transmission analysis is performed based on the applicable antenna groups and transmitter combinations. The following analysis demonstrates the mutually exclusive operation of WLAN antenna groups AG0 and AG1 and evaluates the applicable simultaneous transmission combinations involving WLAN, Bluetooth, WWAN, NFC Reader, and NFC-based WPT.

The Qualcomm Smart Transmit algorithm for WWAN accounts for the time-averaged RF exposure from 4G and 5G NR and controls the aggregate RF exposure to ensure compliance with the applicable FCC exposure limit. The Qualcomm FastConnect algorithm controls the aggregate WLAN RF exposure within the applicable limit. Accordingly, simultaneous transmission compliance for applicable intra-module transmission combinations is addressed through the corresponding algorithm validation, while inter-module and host-transmitter combinations are evaluated in this appendix..

E.3 Sub6 Antenna Groups

The 2nd generation of Smart Transmit (GEN2) 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:

- 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.

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(or)

- b) Every antenna from each sub6 AG meets SPLSR criteria (Section 4.3.2(c) in FCC KDB 447498 D04) with every antenna from another sub6 AG. This criteria must be demonstrated for all antenna combinations for each pair of AGs.

This device supports one WWAN AG having 5 antennas (1, 2, 6, 7, 8) using Qualcomm's Smart Transmit, two WLAN AG: AG0 and AG1, with AG0 having 1 antenna (3) and AG1 having 1 antenna (4) using Qualcomm's FastConnect, and two Bluetooth and NFC antennas outside of TAS. The conditions are verified through the following criteria:

i) (TER1 + TER2 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 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 ER for each antenna group (i.e., maximum reported TER 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, max.SAR.AG1, and max.SAR.WWAN, and obtain the worst-case RF exposure for each external radio, and demonstrate that the sum of these RF exposures meets: $\{ [\text{max.SAR.AG0} + \text{max.SAR.AG1}] + \text{max.SAR.WWAN} + \text{BT Ant 1} + \text{BT Ant 2} + \text{NFC} \} \leq 1.0$ (for 1g).

ii) (SPLSR criteria): For each antenna, obtain the highest reported TER 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: {Chain 0 in AG0; Chain 1 in AG1. As it can be seen, these include all combinations of antenna groups, antennas, and frequency bands.

iii) (combination of SPLSR & TER1+TER2 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 WWAN and BT antennas do not meet SPLSR criteria, then the condition in (ii) reduces to: $\{\text{max.SAR.AG0} + \text{max.SAR.WWAN} + \text{BT Ant 1} + \text{BT Ant 2} + \text{NFC}\} \leq 1.0$ and $\{\text{max.SAR.AG1} + \text{max.SAR.WWAN} + \text{BT Ant 1} + \text{BT Ant 2} + \text{NFC}\} \leq 1.0$ for compliance demonstration.

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. Peak locations are documented in the Highest Report TER and Hotspot Location Section below for each DSI configuration.

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For this device, licensed antennas 1, 2 and 8 as well as Bluetooth Antenna 3 and WIFI AG0 are located on the right edge of the device and licensed antennas 6 and 7 as well as Bluetooth Antenna 4 and WIFI AG1 are located on the left edge of the device. Per April 2022 TCB Workshop Notes, AG0 was summed algebraically with the WWAN/BT antennas for the purposes of hybrid SPLSR combination, identified in this report as the “right set”. Similarly, AG1 and the WWAN/BT are located at the left edge of the device and were summed algebraically together as the “left set” for hybrid SPLSR calculation. The minimum distance when considering all transmissions between the right set and left set groups was considered when calculating the SPLSR. The sum of the transmissions within set are less than the SAR limit (for ex: AG0+BT Ant 3+WWAN Ant 1/2/8 < 1.6 W/kg (1g) for right set, and AG1+BT Ant 4+WWAN Ant 6/7 < 1.6 W/kg (1g) for left set). The following formula is used to calculate the SPLSR between the left and right sets for each exposure configuration:

$$SPLSR = \frac{(Max\ TER\ Set\ 1 + Max\ TER\ Set\ 2)^{1.5}}{Distance_{min}}$$

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E.4 No Motion with Keyboard attached <210deg - SAR Antenna Group Analysis

For this device configuration:

- DSI = 3 (No Motion with Keyboard attached <210deg) for WWAN
- Index = 0 (No Motion with Keyboard attached <210deg) for WLAN

Table 1
WLAN AG0 Highest Reported TER

AG0 Ratio to Limit					
Body	Configuration	2.4 GHz	5 GHz	6 GHz	Max
	Bottom	0.001	0.014	0.008	0.014

Table 2
WLAN AG1 Highest Reported TER

AG1 Ratio to Limit					
Body	Configuration	2.4 GHz	5 GHz	6 GHz	Max
	Bottom	0.004	0.010	0.003	0.010

Table 3
WWAN Highest Reported TER

WWAN Ratio to Limit							
Body	Configuration	1	2	6	7	8	Max
	Bottom	0.239	0.143	0.246	0.739	0.224	0.739

Table 4
Bluetooth Highest Reported TER

Bluetooth Ratio to Limit					
Body	Configuration	2.4 GHz Bluetooth Ant 3	2.4 GHz Bluetooth Ant 4	2.4 GHz Bluetooth Ant 3 + 2.4 GHz Bluetooth Ant 4	Max
	Bottom	0.000	0.001	0.001	0.001

Table 5
NFC Highest Reported TER

NFC Ratio to Limit					
Body	Configuration	NFC Reader	NFC WPT Charger	NFC Reader + NFC Charger	Max
	Bottom	0.000	0.000	0.000	0.000

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Table 6
No Motion with Keyboard attached <210deg Simultaneous Analysis

Body	Configuration	AG0	AG1	WWAN	Bluetooth	NFC Reader + NFC Charger	AG0 + AG1 + WWAN + Bluetooth
	Bottom	0.014	0.010	0.739	0.001	0.000	0.764

Note:

1. For all combinations where the sum of AG0/AG1/WWAN/Bluetooth/NFC is less than 1.0 TER, there is no further analysis required for compliance demonstration.

E.5 No Motion without Keyboard or with Keyboard attached >210deg - SAR Antenna Group Analysis

For this device configuration:

- DSI = 3 (No Motion without Keyboard or Keyboard attached >210deg) for WWAN
- Index = 0 (No Motion without Keyboard or Keyboard attached >210deg) for WLAN

Table 7
WLAN AG0 Highest Reported TER

AG0 Ratio to Limit					
Body	Configuration	2.4 GHz	5 GHz	6 GHz	Max
	Back	0.075	0.561	0.133	0.561
	Top	0.098	0.123	0.129	0.129
	Right	0.018	0.015	0.011	0.018
	Left	0.009	0.000	0.004	0.009

Table 8
WLAN AG1 Highest Reported TER

AG1 Ratio to Limit					
Body	Configuration	2.4 GHz	5 GHz	6 GHz	Max
	Back	0.127	0.294	0.149	0.294
	Top	0.160	0.084	0.131	0.160
	Right	0.024	0.000	0.007	0.024
	Left	0.026	0.007	0.026	0.026

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Table 9
Simultaneous Combinations with Bluetooth

Bluetooth Ratio to Limit					
Body	Configuration	2.4 GHz Bluetooth Ant 3	2.4 GHz Bluetooth Ant 4	2.4 GHz Bluetooth Ant 3 + 2.4 GHz Bluetooth Ant 4	Max
	Back	0.026	0.059	0.085	0.085
	Top	0.043	0.074	0.117	0.117
	Right	0.005	0.010	0.015	0.015
	Left	0.001	0.013	0.014	0.014

Table 10
Simultaneous Combinations with NFC

NFC Ratio to Limit					
Body	Configuration	NFC Reader	NFC WPT Charger	NFC Reader + NFC Charger	Max
	Back	0.000	0.004	0.004	0.004
	Top	0.000	0.000	0.000	0.000
	Right	0.000	0.000	0.000	0.000
	Left	0.000	0.000	0.000	0.000

Table 11
WWAN Highest Reported TER

WWAN Ratio to Limit							
Body	Configuration	1	2	6	7	8	Max
	Back	0.403	0.409	0.623	0.129	0.113	0.623
	Top	0.636	0.618	0.625	0.084	0.133	0.636
	Right	0.214	0.230	0.099	0.004	0.616	0.616
	Left	0.111	0.098	0.407	0.616	0.004	0.616

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Table 12
WWAN Highest Reported TER Right Set

WWAN Ratio to Limit					
Body	Configuration	1	2	8	Right Set Max
	Back	0.403	0.409	0.113	0.409
	Top	0.636	0.618	0.133	0.636
	Right	0.214	0.230	0.616	0.616
	Left	0.111	0.098	0.004	0.111

Table 13
WWAN Highest Reported TER Left Set

WWAN Ratio to Limit				
Body	Configuration	6	7	Left Set Max
	Back	0.623	0.129	0.623
	Top	0.625	0.084	0.625
	Right	0.099	0.004	0.099
	Left	0.407	0.616	0.616

Table 14
No Motion Simultaneous Analysis

Body	Configuration	AG0	AG1	WWAN	Bluetooth	NFC Reader + NFC Charger	AG0 + AG1 + WWAN + Bluetooth
	Back	0.561	0.294	0.623	0.085	0.004	See Table Below
	Top	0.129	0.160	0.636	0.117	0.000	See Table Below
	Right	0.018	0.024	0.616	0.015	0.000	0.673
	Left	0.009	0.026	0.616	0.014	0.000	0.665

Note:

1. For all combinations where the sum of AG0/AG1/WWAN/Bluetooth/NFC is less than 1.0 TER, there is no further analysis required for compliance demonstration.

Table 15
Co-located Left and Right Sets

Left and Right Sets Analysis										
Body	Configuration	AG0	AG1	Bluetooth Ant 3	Bluetooth Ant 4	WWAN Left Set	WWAN Right Set	NFC Reader	Co-located Right Set: AG0 + Bluetooth Ant 3 + WWAN Right Set	Co-located Left Set: AG1 + Bluetooth Ant 4 + WWAN Left Set + NFC Reader
	Back	0.561	0.294	0.026	0.059	0.623	0.409	0.000	0.996	0.976
	Top	0.129	0.160	0.043	0.074	0.625	0.636	0.000	0.808	0.859

Note:

1. Per KDB Workshop Notes, if the sum of two overlapping TER is <1.0, those antennas can be determined to be co-located. In SPLSR analysis, the sum of the two TER values will be used with the worst-case coordinate.

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Table 16
Left and Right Sets SPLSR Analysis

Left and Right Sets Analysis								
Body	Configuration	Co-located Right Set: AG0 + Bluetooth Ant 3 + WWAN Right Set	Co-located Left Set: AG1 + Bluetooth Ant 4 + WWAN Left Set + NFC Reader	ER Sum of: Co-located Right Set + AG1 + Bluetooth Ant 4 + NFC Reader	ER Sum of: Co-located Left Set + AG0 + Bluetooth Ant 3	Max ER Sum	Minimal Distance	SPLSR
	Back	0.996	0.976	1.349	1.563	1.563	80.7	0.02
	Top	0.808	0.859	1.042	1.031	1.042	92.5	0.01

Note:

1. Per KDB Workshop Notes, if the sum of two overlapping TER is <1.0, those antennas can be determined to be co-located. In SPLSR analysis, the sum of the two TER values will be used with the worst-case coordinate.
2. 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.
3. Please see the tables below for the minimal distance calculation.

Table 17
NFC Charger and Left Set SPLSR Analysis

NFC Charger and Left Set Analysis						
Body	Configuration	NFC Charger	Co-located Left Set: AG1 + Bluetooth Ant 4 + WWAN Left Set + NFC Reader	ER Sum of: Co-located Left Set + NFC Charger	Minimal Distance	SPLSR
	Back	0.004	0.976	0.980	43.4	0.02
	Top	0.000	0.859	0.859	42.0	0.02

Note:

1. Per KDB Workshop Notes, if the sum of two overlapping TER is <1.0, those antennas can be determined to be co-located. In SPLSR analysis, the sum of the two TER values will be used with the worst-case coordinate.
2. 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.
3. Please see the tables below for the minimal distance calculation.

Table 18
NFC Charger and Right Set SPLSR Analysis

NFC Charger and Right Set Analysis						
Body	Configuration	NFC Charger	Co-located Right Set: AG0 + Bluetooth Ant 3 + WWAN Right Set	ER Sum of: Co-located Right Set + NFC Charger	Minimal Distance	SPLSR
	Back	0.004	0.996	1.000	43.6	0.02
	Top	0.000	0.808	0.808	55.4	0.01

Note:

1. Per KDB Workshop Notes, if the sum of two overlapping TER is <1.0, those antennas can be determined to be co-located. In SPLSR analysis, the sum of the two TER values will be used with the worst-case coordinate.
2. 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.

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3. Please see the tables below for the minimal distance calculation.

Table 19
Back Side Coordinates, Minimal Distance

Back Side Distance Matrix																			
Band	Antenna			2.4 GHz	5 GHz	6 GHz	BT	UMTS 1700	UMTS 1900	LTE Band 66	LTE Band 25	LTE Band 2	LTE Band 30	LTE Band 41	LTE Band 48	NR Band n66	NR Band n25	NR Band n30	NR Band n41
		X	Y	4	4	4	4	6	6	6	6	6	6	6	6	6	6	6	6
				53	49.4	48	48.8	100.6	96.3	98	97.6	95.6	115.4	77.5	124.7	93.5	106.6	106.9	84.2
Right co-located Set: Antennas 1, 2, 3 and NFC Charger	LTE Band 48	1	125.9	66.2	87.4	106.8	78.4	85.3	84.9	86	91.4	64.5	65.6	66.7	81.1	76.2	49.3	59.2	72.1
	NR Band n41	1	99.9	93.5	153.3	161.0	168.0	149.5	201.0	196.4	198.1	197.6	195.5	215.3	117.4	224.7	193.7	207.2	200.8
	NR Band n66	1	135.4	98.3	184.1	191.1	188.4	180.4	231.2	226.7	228.4	228.0	226.0	245.9	208.1	251.1	224.0	233.3	211.3
	NR Band n77	1	129	93.3	182.4	190.0	197.1	178.5	230.1	225.4	227.2	226.6	224.6	206.5	213.7	222.7	236.2	220.9	213.2
	UMTS B50	2	91.6	104.8	144.6	154.3	160.5	140.5	194.0	188.9	190.6	189.9	187.7	207.9	188.3	216.9	186.4	205.8	191.1
	LTE Band 25	2	111.6	77.4	166.9	172.0	179.9	163.4	232.2	228.1	229	229.6	227.2	227.6	190.1	216.6	205.2	218.2	211.8
	LTE Band 12	2	94.2	98	147.4	155.9	162.5	143.4	195.7	190.9	192.6	192.0	189.9	209.6	171.7	219.1	188.3	202.0	195.3
	LTE Band 13	2	94.2	98	147.4	155.9	162.5	143.4	195.7	190.9	192.6	192.0	189.9	209.6	171.7	219.1	188.3	202.0	195.3
	LTE Band 14	2	96.0	100.3	149.7	156.5	163.1	145.6	198.4	193.5	195.2	194.5	192.4	212.1	174.1	221.6	190.9	204.6	187.9
	LTE Band 5	2	92	96.9	145.2	153.5	160.3	141.3	193.4	188.7	190.4	189.7	187.2	207.4	188.5	216.9	186.0	199.7	193.0
	NR Band n71	2	104.2	94.4	157.6	165.4	172.3	153.7	205.4	200.7	202.4	201.6	199.8	219.6	181.7	229.0	198.0	211.6	205.2
	NR Band n22	2	98.0	96.2	152.0	160.7	167.0	148.1	200.2	195.4	197.1	196.2	194.5	214.2	176.3	221.6	190.4	199.8	189.0
	NR Band n14	2	95.4	96.1	148.7	156.9	163.6	144.8	196.9	192.0	193.7	193.1	191.1	210.9	172.9	220.2	189.3	203.0	196.4
	NR Band n5	2	91.7	101.9	144.7	153.9	160.4	140.7	193.7	188.7	190.5	189.7	187.6	207.2	189.3	216.6	186.2	200.0	193.0
	NR Band n26	2	91	99.9	146.1	154.9	161.5	142.1	194.7	189.9	191.6	190.9	188.8	209.6	170.9	216.0	184.2	177.3	220.9
	2.4 GHz	3	34.4	100.7	87.5	97.4	102.3	83.6	136.8	132.6	133.3	132.5	130.3	149.9	122.0	159.6	129.1	143.1	135.8
	5 GHz	3	53.9	95.6	108.0	114.8	121.9	104.5	154.9	150.7	151.3	150.5	148.5	168.4	141.6	176.6	147.5	161.1	154.8
	6 GHz	3	63.5	82.5	116.7	122.0	129.6	113.4	162.1	157.8	158.5	159.2	157.3	177.3	159.7	186.3	155.0	169.2	162.5
	BT	3	34.4	107.8	87.4	99.3	104.4	81.2	138.1	132.6	134.4	133.3	131.0	150.4	121.5	160.2	136.5	151.3	144.4
	NR Band n48	8	144.6	9.4	228.3	222.9	233.8	226.7	282.6	278.8	280.3	279.7	278.1	306.5	276.4	311.6	281.0	289.7	291.8
	NR Band n77	8	144.5	68.2	262.8	251.8	261.4	262.1	285.8	281.6	283.6	283.7	283.1	306.5	276.4	311.6	281.0	289.7	291.8
Min Distance (mm)																			80.7

Table 20
Back Side Coordinate, Minimal Distance – NFC Charger to Right Set

Back Side Distance Matrix																			
Band	Antenna			LTE Band 48	NR Band n41	NR Band n66	NR Band n77	UMTS B50	LTE Band 25	LTE Band 12	LTE Band 13	LTE Band 14	LTE Band 5	LTE Band 26	NR Band n71	NR Band n22	NR Band n14	NR Band n5	NR Band n26
		X	Y	1	1	1	1	2	2	2	2	2	2	2	2	2	2	2	2
NFC Charger	NFC Charger	WPT	-5.2	123.7	137.3	130.3	141.1	139.6	99.6	126.0	103.6	101.6	105.4	101.8	94.7	114.2	108.5	105.3	100.3
Min Distance (mm)																			43.6

Table 21
Back Side Coordinate, Minimal Distance – NFC Charger to Left Set

Back Side Distance Matrix																			
Band	Antenna			2.4 GHz	5 GHz	6 GHz	BT	UMTS 1700	UMTS 1900	LTE Band 66	LTE Band 25	LTE Band 2	LTE Band 30	LTE Band 41	LTE Band 48	NR Band n66	NR Band n25	NR Band n30	NR Band n41
		X	Y	4	4	4	4	6	6	6	6	6	6	6	6	6	6	6	6
NFC Charger	NFC Charger	WPT	-6.2	123.7	95.4	70.8	71.7	45.1	104.5	97.9	99.7	97.8	95.1	111.1	76.3	121.6	96.3	111.1	100.8
Min Distance (mm)																			41.4

Table 22
Top Edge Coordinates, Minimal Distance

Top Edge Distance Matrix																			
Band	Antenna			2.4 GHz	5 GHz	6 GHz	BT	UMTS 1700	UMTS 1900	LTE Band 66	LTE Band 25	LTE Band 2	LTE Band 30	LTE Band 41	LTE Band 48	NR Band n66	NR Band n25	NR Band n30	NR Band n41
		X	Y	4	4	4	4	6	6	6	6	6	6	6	6	6	6	6	6
Right co-located Set: Antennas 1, 2, 3 and NFC Charger	LTE Band 48	1	62.4	68.1	107.4	47.5	98.2	98.6	94.4	99.9	105	96	107.3	92	102	106.3	72.1	102	132.2
	NR Band n41	1	-0.1	121.7	178.1	199.6	213.1	173.2	224.1	224.1	220.1	223.6	216.6	220.7	221.7	221.7	222.7	222.0	227.8
	NR Band n66	1	-0.6	104.9	159.6	174.2	211.6	151.7	202.6	202.9	198.6	204.1	195.1	209.2	209.2	211.5	199.2	206.2	210.5
	NR Band n77	1	-0.3	119.6	172.0	189.2	227.0	167.1	217.0	218.2	220.5	219.5	211.6	224.6	223.6	221.6	225.9	197.7	221.6
	UMTS B50	2	0.8	81.1	190.5	153.6	190.5	130.6	181.8	181.7	177.5	180.4	188.1	179.3	188.0	179.3	180.1	180.4	155.2
	LTE Band 25	2	-1	77.7	130.1	148.0	185.1	125.2	176.1	176.3	172.1	177.6	168.6	182.7	171.7	183.0	169.7	178.7	134.0
	LTE Band 12	2	-3	82.1	134.5	152.3	189.5	129.6	180.5	180.5	176.3	182.0	171.0	178.1	189.4	174.1	184.1	164.7	184.1
	LTE Band 13	2	-0.4	81.1	190.5	153.4	190.5	130.6	181.5	181.7	177.5	180.3	187.0	188.1	179.1	190.5	176.1	180.1	189.4
	LTE Band 14	2	-0.7	78.7	131.1	149.3	186.1	126.3	177.2	177.2	173.1	178.6	169.6	181.7	174.7	186.5	176.7	180.7	160.9
	LTE Band 5	2	-1	62.1	134.5	152.3	189.5	129.6	180.5	180.5	176.3	182.0	171.0	178.1	189.4	174.1	184.1	164.7	184.1
	NR Band n71	2	0.8	80.8	133.2	151.4	188.2	128.3	179.3	179.4	175.2	180.7	172.7	185.8	176.8	188.2	172.8	182.8	187.1
	NR Band n22	2	-6.7	81.3	139.3	150.7	188.7	128.9	179.5	179.5	175.5	181.4	172.3	186.3	177.5	186.3	183.3	184.2	214.6
	NR Band n14	2	-15.5	85.8	138.4	150.9	191.2	133.4	184.9	184.5	180.2	185.9	176.9	180.8	181.8	191.1	177.9	187.8	219.2
	NR Band n5	2	-2.1	80.2	131.9	149.5	187.7	127.8	178.4	178.5	174.7	180.3	171.3	183.5	175.5	172.4	181.9	186.7	191.2
	NR Band n26	2	-12.6	85.2	138.3	153.9	192.9	133.1	183.4	184.2	179.9	185.6	178.6	190.5	181.5	192.7	177.7	187.5	215.9
	2.4 GHz	3	2	44.5	91.3	116.5	122.4	92.5	143.5	143.1	139.4	144.8	135.8	150.0	150.0	152.4	136.9	147.0	151.2
	5 GHz	3	22.1	49.2	123.8	137.4	177.7	118.5	167.9	169.2	164.5	159.6	161.6	175.3	166.4	172.3	162.8	172.3	201.9
	6 GHz	3	2.6	58.5	149.9	159.3	196.0	136.1	187.1	187.1	181.1	184.4	179.4	191.6	184.6	191.9	189.5	193.6	219.4
	BT	3	0.7	45.4	97.9	116.7	152.8	92.9	143.9	144.0	139.4	145.3	136.3	150.4	141.4	151.8	137.4	147.5	189.0
	NR Band n48	8	24.7	117.2	210.9	213.0	266.0	206.4	257.0	257.0	253.0	258.2	249.3	261.6	254.6	260.1	260.7	264.6	235.5
	NR Band n77	8	23.4	116.8	210.1	210.9	265.4	204.6	256.8	256.2	252.2	256.6	248.3	261.6	254.6	260.1	260.7	264.6	234.3
Min Distance (mm)																			31.1

Table 23
Top Edge Coordinate, Minimal Distance – NFC Charger to Right Set

Top Edge Distance Matrix																			
Band	Antenna			LTE Band 48	NR Band n41	NR Band n66	NR Band n77	UMTS B50	LTE Band 25	LTE Band 12	LTE Band 13	LTE Band 14	LTE Band 5	LTE Band 26	NR Band n71	NR Band n22	NR Band n14	NR Band n5	NR Band n26

E.6 Motion – WWAN Not Active, WLAN Not Active - SAR Antenna Group Analysis

Table 25
NFC Highest TER

NFC Ratio to Limit					
Body	Configuration	NFC Reader	NFC WPT Charger	NFC Reader + NFC Charger	Max
	Back	0.000	0.004	0.004	0.004
	Top	0.000	0.000	0.000	0.000
	Bottom	0.000	0.000	0.000	0.000
	Right	0.000	0.000	0.000	0.000
	Left	0.000	0.000	0.000	0.000

Table 26
Bluetooth During Conditions “WWAN OFF, WLAN OFF” Highest TER

Bluetooth Ratio to Limit			
Body	Configuration	2.4 GHz Bluetooth Ant 3 target of 15dBm	2.4 GHz Bluetooth Ant 4 target of 15dBm
	Back	0.206	0.283
	Top	0.226	0.288
	Bottom	0.000	0.000
	Right	0.005	0.003
	Left	0.001	0.002

Table 27
Bluetooth and NFC Simultaneous Analysis

Body	Configuration	NFC Reader	NFC Charger	Bluetooth Ant 3 target of 15 dBm	Bluetooth Ant 4 target of 15 dBm	NFC Reader + NFC Charger _+ Bluetooth Ant 3 + Bluetooth Ant 4
	Back	0.000	0.004	0.206	0.283	0.493
	Top	0.000	0.000	0.226	0.288	0.514
	Bottom	0.000	0.000	0.000	0.000	0.000
	Right	0.000	0.000	0.005	0.003	0.008
	Left	0.000	0.000	0.001	0.002	0.003

Note:

1. For all combinations where the sum of Bluetooth/NFC is less than 1.0 TER, there is no further analysis required for compliance demonstration.

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E.7 Motion – WWAN Not Active, WLAN Active - SAR Antenna Group Analysis

For this device configuration:

- Index = 3 (Motion) for WLAN

Table 28
WLAN AG0 Highest TER

AG0 Ratio to Limit					
Body	Configuration	2.4 GHz	5 GHz	6 GHz	Max
	Back	0.301	0.564	0.699	0.699
	Top	0.390	0.164	0.287	0.390
	Bottom	0.000	0.004	0.002	0.004
	Right	0.009	0.006	0.014	0.014
	Left	0.002	0.000	0.001	0.002

Table 29
WLAN AG1 Highest TER

AG1 Ratio to Limit					
Body	Configuration	2.4 GHz	5 GHz	6 GHz	Max
	Back	0.389	0.519	0.687	0.687
	Top	0.367	0.152	0.292	0.367
	Bottom	0.000	0.000	0.001	0.001
	Right	0.005	0.000	0.001	0.005
	Left	0.008	0.003	0.014	0.014

Table 30
Bluetooth During Conditions of “WWAN or WLAN on” Highest TER

Bluetooth Ratio to Limit			
Body	Configuration	2.4 GHz Bluetooth Ant 3 target of 10dBm	2.4 GHz Bluetooth Ant 4 target of 10dBm
	Back	0.031	0.111
	Top	0.036	0.106
	Bottom	0.000	0.000
	Right	0.005	0.003
	Left	0.001	0.002

Note:

1. Bluetooth MIMO is not supported for this power level

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Table 31
NFC Highest TER

NFC Ratio to Limit					
Body	Configuration	NFC Reader	NFC WPT Charger	NFC Reader + NFC Charger	Max
	Back	0.000	0.004	0.004	0.004
	Top	0.000	0.000	0.000	0.000
	Bottom	0.000	0.000	0.000	0.000
	Right	0.000	0.000	0.000	0.000
	Left	0.000	0.000	0.000	0.000

Table 32
AG Verification with AG0 + AG1 + Bluetooth + NFC

Body	Configuration	AG0	AG1	Bluetooth Ant 3 target of 10 dBm	Bluetooth Ant 4 target of 10 dBm	NFC Reader + NFC Charger	AG0 + AG1 + Bluetooth Ant 3 + NFC Reader + NFC Charger	AG0 + AG1 + Bluetooth Ant 4 + NFC Reader + NFC Charger
	Back	0.699	0.687	0.031	0.111	0.004	See Table Below	See Table Below
	Top	0.390	0.367	0.036	0.106	0.000	0.793	0.863
	Bottom	0.004	0.001	0.000	0.000	0.000	0.005	0.005
	Right	0.014	0.005	0.005	0.003	0.000	0.024	0.022
	Left	0.002	0.014	0.001	0.002	0.000	0.017	0.018

Note:

1. For all combinations where the sum of AG0/AG1/WWAN/Bluetooth/NFC is less than 1.0 TER, there is no further analysis required for compliance demonstration.

Table 33
Back Side WLAN and BT Antenna 3 Set with WLAN and BT Antenna 4 and NFC Reader Set – Minimal Distance, Sum and SPLSR

Distance Matrix									
Right Set: WLAN and BT Antenna 3 Set	Band	Antenna			Left Set: WLAN and BT Antenna 4 and NFC Reader				
					2.4 GHz	5 GHz	6 GHz	BT	NFC Reader
					4	4	4	4	NFC
			X		-45	-55	-51.8	-44.8	-46.3
				Y	99.1	86.5	89.6	96.9	107.2
	2.4 GHz	3	40.9	99.9	85.9	96.8	93.3	85.8	87.5
Right Set: WLAN and BT Antenna 3 Set	5 GHz	3	53.9	89.6	99.4	108.9	105.7	99.0	101.7
	6 GHz	3	44.2	90	89.7	99.3	96.0	89.3	92.1
	BT	3	51.9	105.9	97.1	108.6	105.0	97.1	98.2
Min Distance (mm):									85.8

ER Sum Matrix						
Left Set: WLAN and BT Antenna 4 and NFC	Band	Antenna	ER	Right Set: WLAN and BT Antenna 3		
				WIFI1+BT1	WIFI1	
				3	3	
				0.730	0.699	
	WIFI2+BT2+NFC Reader	4	0.798	N/A	1.497	Max:
	WIFI2+NFC Reader	4	0.687	1.417	1.386	

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Back				
Set 1	Set 2	Min Distance [mm]	Maximum ER Sum	SPLSR
Right Set: WLAN and BT Antenna 3	Left Set: WLAN and BT Antenna 4 Set and NFC Reader	85.8	1.497	0.02

Note:

1. Bluetooth MIMO is not supported for this power level.
2. 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.

Table 34
Back Side WLAN and BT Antenna 3 Set with NFC Minimal Distance, Sum and SPLSR

Distance Matrix								
					Left Set: WLAN and BT Antenna 3			
Band					2.4 GHz	5 GHz	6 GHz	BT
Antenna					3	3	3	3
			X		40.9	53.9	44.2	51.9
				Y	99.9	89.6	90	105.9
NFC Charger	NFC Charger	WPT	-6.2	123.7	52.8	69.1	60.6	60.8
Min Distance (mm):								
52.8								

Back				
Right Set: WLAN and BT Antenna 3	NFC Charger	Min Distance [mm]	Maximum ER Sum	SPLSR
0.730	0.004	52.8	0.734	0.01

Note:

1. 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.

Table 35
Back Side WLAN and BT and NFC Reader Antenna 4 Set with NFC Charger Minimal Distance, Sum and SPLSR

Distance Matrix									
					Left Set: WLAN and BT Antenna 4 and NFC Reader				
Band					2.4 GHz	5 GHz	6 GHz	BT	NFC Reader
Antenna					4	4	4	4	NFC
			X		-45	-55	-51.8	-44.8	-46.3
				Y	99.1	86.5	89.6	96.9	107.2
NFC Charger	NFC Charger	WPT	-6.2	123.7	45.9	61.4	56.9	47.0	43.4
Min Distance (mm):									
43.4									

Back				
Left Set: WLAN and BT Antenna 4 and NFC Reader	NFC Charger	Min Distance [mm]	Maximum ER Sum	SPLSR
0.798	0.004	43.4	0.802	0.02

Notes:

1. 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.

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E.8 Motion – WWAN Active, WLAN Not Active - SAR Antenna Group Analysis

For this device configuration:

- DSI = 6 (Motion) for WWAN

Table 36
WWAN Highest TER

WWAN Ratio to Limit							
Body	Configuration	1	2	6	7	8	Max
	Back	0.551	0.491	0.524	0.046	0.075	0.551
	Top	0.370	0.451	0.507	0.002	0.014	0.507
	Bottom	0.002	0.011	0.008	0.020	0.016	0.020
	Right	0.158	0.082	0.069	0.005	0.589	0.589
	Left	0.008	0.049	0.330	0.455	0.000	0.455

Table 37
Bluetooth During Conditions of “WWAN or WLAN on” Highest TER

Bluetooth Ratio to Limit			
Body	Configuration	2.4 GHz Bluetooth Ant 3 target of 10dBm	2.4 GHz Bluetooth Ant 4 target of 10dBm
	Back	0.031	0.111
	Top	0.036	0.106
	Bottom	0.000	0.000
	Right	0.005	0.003
	Left	0.001	0.002

Note:

1. Bluetooth MIMO is not supported for this power level

Table 38
NFC Highest TER

NFC Ratio to Limit					
Body	Configuration	NFC Reader	NFC WPT Charger	NFC Reader + NFC Charger	Max
	Back	0.000	0.004	0.004	0.004
	Top	0.000	0.000	0.000	0.000
	Bottom	0.000	0.000	0.000	0.000
	Right	0.000	0.000	0.000	0.000
	Left	0.000	0.000	0.000	0.000

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Table 39
AG Verification with WWAN + Bluetooth + NFC

Body	Configuration	WWAN	Bluetooth Ant 3 target of 10dBm	Bluetooth Ant 4 target of 10dBm	NFC Reader + NFC Charger	WWAN + Bluetooth Ant 3 + NFC	WWAN + Bluetooth Ant 4 + NFC
	Back	0.507	0.031	0.111	0.004	0.542	0.622
	Top	0.020	0.036	0.106	0.000	0.056	0.126
	Bottom	0.589	0.000	0.000	0.000	0.589	0.589
	Right	0.455	0.005	0.003	0.000	0.460	0.458
	Left	0.000	0.001	0.002	0.000	0.001	0.002

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E.9 Motion – WWAN Active, WLAN Active - SAR Antenna Group Analysis

For this device configuration:

- DSI = 6 (Motion) for WWAN
- Index = 4 (Motion) for WLAN

Table 40
WLAN AG0 Highest TER

AG0 Ratio to Limit					
Body	Configuration	2.4 GHz	5 GHz	6 GHz	Max
	Back	0.129	0.199	0.207	0.207
	Top	0.141	0.049	0.050	0.141
	Bottom	0.000	0.004	0.002	0.004
	Right	0.009	0.006	0.014	0.014
	Left	0.002	0.000	0.001	0.002

Table 41
WLAN AG1 Highest TER

AG1 Ratio to Limit					
Body	Configuration	2.4 GHz	5 GHz	6 GHz	Max
	Back	0.101	0.197	0.256	0.256
	Top	0.153	0.042	0.108	0.153
	Bottom	0.000	0.000	0.001	0.001
	Right	0.005	0.000	0.001	0.005
	Left	0.008	0.003	0.014	0.014

Table 42
WWAN Highest TER

WWAN Ratio to Limit							
Body	Configuration	1	2	6	7	8	Max
	Back	0.551	0.491	0.524	0.046	0.075	0.551
	Top	0.370	0.451	0.507	0.002	0.014	0.507
	Bottom	0.002	0.011	0.008	0.020	0.016	0.020
	Right	0.158	0.082	0.069	0.005	0.589	0.589
	Left	0.008	0.049	0.330	0.455	0.000	0.455

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Table 43
NFC Highest TER

NFC Ratio to Limit					
	Configuration	NFC Reader	NFC WPT Charger	NFC Reader + NFC Charger	Max
Body	Back	0.000	0.004	0.004	0.004
	Top	0.000	0.000	0.000	0.000
	Bottom	0.000	0.000	0.000	0.000
	Right	0.000	0.000	0.000	0.000
	Left	0.000	0.000	0.000	0.000

Table 44
Bluetooth Highest TER

Bluetooth Ratio to Limit			
	Configuration	2.4 GHz Bluetooth Ant 3 target of 7dBm	2.4 GHz Bluetooth Ant 4 target of 8.5dBm
Body	Back	0.009	0.028
	Top	0.013	0.030
	Bottom	0.000	0.000
	Right	0.005	0.003
	Left	0.001	0.002

Note:

1. Bluetooth MIMO is not supported for this power level

Table 45
AG Verification with WWAN + AG0 + AG1 + Bluetooth + NFC

	Configuration	AG0	AG1	WWAN	Bluetooth Ant 3 target of 7dBm	Bluetooth Ant 4 target of 8.5dBm	NFC Reader + NFC Charger	AG0 + AG1 + WWAN + Bluetooth Ant 3 + NFC	AG0 + AG1 + WWAN + Bluetooth Ant 4 + NFC
Body	Back	0.199	0.256	0.551	0.009	0.028	0.004	See Table Below	See Table Below
	Top	0.141	0.153	0.507	0.013	0.030	0.000	0.814	0.831
	Bottom	0.004	0.001	0.020	0.000	0.000	0.000	0.025	0.025
	Right	0.014	0.005	0.589	0.005	0.003	0.000	0.613	0.611
	Left	0.002	0.014	0.455	0.001	0.002	0.000	0.472	0.473

Note:

1. For all combinations where the sum of AG0/AG1/WWAN/Bluetooth/NFC is less than 1.0 TER, there is no further analysis required for compliance demonstration.

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Table 46
Back Side Maximum ER Sum Matrix

ER Sum Matrix						
				WLAN and BT and NFC Co-location		
	Band			AG0+AG1+BT1+NFC	AG0+AG1+BT2+NFC	
		Antenna		3+4	3+4	
			ER	0.476	0.495	
WWAN Ant 1	LTE Band 48	1	0.513	0.989	1.008	
	NR Band n41	1	0.551	1.027	1.046	
	NR Band n48	1	0.29	0.766	0.785	Max:
	NR Band n77	1	0.329	0.805	0.824	1.046
WWAN Ant 2	UMTS 850	2	0.488	0.964	0.983	
	LTE Band 71	2	0.258	0.734	0.753	
	LTE Band 12	2	0.272	0.748	0.767	
	LTE Band 13	2	0.272	0.748	0.767	
	LTE Band 14	2	0.284	0.760	0.779	
	LTE Band 5	2	0.341	0.817	0.836	
	LTE Band 26	2	0.324	0.800	0.819	
	NR Band n71	2	0.373	0.849	0.868	
	NR Band n12	2	0.359	0.835	0.854	
	NR Band n14	2	0.39	0.866	0.885	
	NR Band n5	2	0.491	0.967	0.986	Max:
	NR Band n26	2	0.432	0.908	0.927	0.986
WWAN Ant 6	UMTS 1750	6	0.321	0.797	0.816	
	UMTS 1900	6	0.361	0.837	0.856	
	LTE Band 66	6	0.354	0.830	0.849	
	LTE Band 25	6	0.25	0.726	0.745	
	LTE Band 2	6	0.258	0.734	0.753	
	LTE Band 30	6	0.426	0.902	0.921	
	LTE Band 41	6	0.286	0.762	0.781	
	LTE Band 48	6	0.163	0.639	0.658	
	NR Band n66	6	0.524	1.000	1.019	
	NR Band n25	6	0.448	0.924	0.943	
	NR Band n30	6	0.314	0.790	0.809	
	NR Band n41	6	0.368	0.844	0.863	
	NR Band n48	6	0.339	0.815	0.834	Max:
	NR Band n77	6	0.462	0.938	0.957	1.019
WWAN Ant 7	NR Band n48	7	0.033	0.509	0.528	Max:
	NR Band n77	7	0.046	0.522	0.541	0.541
WWAN Ant 8	NR Band n48	8	0.054	0.530	0.549	Max:
	NR Band n77	8	0.075	0.551	0.570	0.570

Notes:

1. Per KDB Workshop Notes, if the sum of two overlapping TER is <1.0, those antennas can be determined to be co-located.
2. Bluetooth MIMO is not supported for this power level.
3. For all combinations where the TER sum of WWAN + WLAN ant 3 + BT ant 3 + WLAN ant 4 + NFC or WWAN + WLAN ant 3 + WLAN ant 4 + BT ant 4 + NFC is less than 1, there is no further analysis required for compliance demonstration.

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Table 47
Back Side Minimum Separation Distance Between Sets

Distance Matrix														
					WLAN and BT and NFC Co-location									
Band	Antenna				2.4 GHz	5 GHz	6 GHz	BT	2.4 GHz	5 GHz	6 GHz	BT	NFC Reader	NFC Charger
		X			3	3	3	3	4	4	4	4	NFC	WPT
			Y		40	57.1	44.2	51.9	-38.4	-52.8	-51.8	-40.3	-46.3	-6.2
				Y	104.6	92.8	90	102.2	105.7	89	90.8	100	107.2	123.7
WWAN Ant 1	LTE Band 48	1	129	92.2	89.9	71.9	84.8	77.7	167.9	181.8	180.8	169.5	175.9	138.8
	NR Band n41	1	129.8	85.3	91.9	73.1	85.7	79.7	169.4	182.6	181.7	170.7	177.5	141.3
	NR Band n48	1	124.7	88.7	86.2	67.7	80.5	74.0	164.0	177.5	176.5	165.4	172.0	135.5
	NR Band n77	1	124.3	84	86.8	67.8	80.3	74.7	164.1	177.2	176.2	165.4	172.2	136.4
Min Distance (mm):														67.7
WWAN Ant 3	UMTS 1750	6	-142.3	87.7	183.1	199.5	186.5	194.7	105.4	89.5	90.6	102.7	98.0	140.8
	UMTS 1900	6	-141.3	88.2	182.0	198.5	185.5	193.7	104.4	88.5	89.5	101.7	96.9	139.7
	LTE Band 66	6	-141.1	89.5	181.7	198.2	185.3	193.4	104.0	88.3	89.3	101.3	96.4	139.2
	LTE Band 25	6	-135.8	91.6	176.3	192.9	180.0	188.0	98.4	83.0	84.0	95.9	90.8	133.5
	LTE Band 2	6	-144.4	82.9	185.7	201.7	188.7	197.2	108.4	91.8	92.9	105.5	101.1	144.1
	LTE Band 30	6	-129	92.2	169.5	186.1	173.2	181.2	91.6	76.3	77.2	89.0	84.0	126.8
	LTE Band 41	6	-104.2	93.3	144.6	161.3	148.4	156.4	67.0	51.6	52.5	64.3	59.5	102.6
	LTE Band 48	6	-127	77	169.3	184.8	171.7	180.7	93.1	75.2	76.5	89.7	86.2	129.5
	NR Band n66	6	-135.3	85.7	176.3	192.5	179.6	187.9	98.9	82.6	83.7	96.1	91.6	134.6
	NR Band n25	6	-133.8	83.4	175.1	191.1	178.1	186.6	98.0	81.2	82.3	95.0	90.7	133.8
	NR Band n30	6	-130.5	86.8	171.4	187.7	174.7	183.0	94.0	77.7	78.8	91.2	86.6	129.7
	NR Band n41	6	-131.1	88.4	171.9	188.3	175.3	183.5	94.3	78.3	79.3	91.5	86.9	129.8
	NR Band n48	6	-125.9	79.5	167.8	183.5	170.4	179.2	91.3	73.7	75.0	88.0	84.3	127.6
	NR Band n77	6	-124.9	80	166.7	182.4	169.4	178.2	90.2	72.7	73.9	86.9	83.2	126.5
Min Distance (mm):														51.6

Table 48
Back Side Sum and SPLSR

Back				
Set 1	Set 2	Min Distance [mm]	Maximum ER Sum	SPLSR
WLAN and BT and NFC co-located Set	WWAN Ant 1	67.7	1.046	0.02
Back				
Set 1	Set 2	Min Distance [mm]	Maximum ER Sum	SPLSR
WLAN and BT and NFC co-located Set	WWAN Ant 3	51.6	1.019	0.02

Note:

1. Per KDB Workshop Notes, if the sum of two overlapping TER is <1.0, those antennas can be determined to be co-located.
2. 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.

Conclusion

The above numerical summed TER and SPLSR results for all the combinations of antenna groups and external radios 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 D04v01 and IEEE 1528- 2013 Section 6.3.4.1.

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DUT Type: Portable Computing Device	This report is Blockchain Verified. To verify the report authenticity, please visit https://www.blockchain-verified.com or by clicking on the Blockchain logo 	APPENDIX E: Page 19 of 19