

Appendix E: Simultaneous Transmission Analysis

E.1. Introduction

According to FCC KDB Publication 447498 D04v01, transmitters are considered to be operating simultaneously when there is overlapping transmission, with the exception of transmissions during network hand-offs with maximum hand-off duration less than 30 seconds.

Table E-1 - Supported Simultaneous Transmission Scenarios

#	Scenario	Body
1	2.4 GHz WIFI_SISO + 5 GHz WIFI_SISO	Yes
2	2.4 GHz WIFI_SISO + 6 GHz WIFI_SISO	Yes
3	2.4 GHz WIFI_SISO + 5 GHz WIFI_MIMO	Yes
4	2.4 GHz WIFI_SISO + 6 GHz WIFI_MIMO	Yes
5	2.4 GHz WIFI_MIMO + 5 GHz WIFI_SISO	Yes
6	2.4 GHz WIFI_MIMO + 6 GHz WIFI_SISO	Yes
7	2.4 GHz WIFI_MIMO + 5 GHz WIFI_MIMO	Yes
8	2.4 GHz WIFI_MIMO + 6 GHz WIFI_MIMO	Yes
9	5 GHz WIFI_SISO + 2.4 GHz Bluetooth_SISO	Yes
10	6 GHz WIFI_SISO + 2.4 GHz Bluetooth_SISO	Yes
11	5 GHz WIFI_SISO + 2.4 GHz Bluetooth_MIMO	Yes
12	6 GHz WIFI_SISO + 2.4 GHz Bluetooth_MIMO	Yes
13	5 GHz WIFI_MIMO + 2.4 GHz Bluetooth_SISO	Yes
14	6 GHz WIFI_MIMO + 2.4 GHz Bluetooth_SISO	Yes
15	5 GHz WIFI_MIMO + 2.4 GHz Bluetooth_MIMO	Yes
16	6 GHz WIFI_MIMO + 2.4 GHz Bluetooth_MIMO	Yes
17	2.4 GHz WIFI_Chain 2 + 2.4 GHz Bluetooth_Chain 1	Yes
18	5 GHz WIFI_SISO + 2.4 GHz WIFI_Chain 2 + 2.4 GHz Bluetooth_Chain 1	Yes
19	6 GHz WIFI_SISO + 2.4 GHz WIFI_Chain 2 + 2.4 GHz Bluetooth_Chain 1	Yes
20	5 GHz WIFI_MIMO + 2.4 GHz WIFI_Chain 2 + 2.4 GHz Bluetooth_Chain 1	Yes
21	6 GHz WIFI_MIMO + 2.4 GHz WIFI_Chain 2 + 2.4 GHz Bluetooth_Chain 1	Yes

Note: NFC Reader/NFC WPT can simultaneously transmit with all the above combinations

E.2. 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 SAR.

This device is enabled with Qualcomm® FastConnect with pre-defined sub6 antenna groups (AG0 and AG1). Simultaneous transmission analysis is performed per antenna group. Below analysis demonstrates the mutually exclusive operation of AG0 and AG1 and the compliance between each antenna group with non-

FastConnect Radios. For this model, WLAN Radios are managed under FastConnect. Non-FastConnect Radios include BT/NFC Reader/NFC WPT.

When operating in the same antenna group, simultaneous transmission compliance between radio operations within an antenna group is demonstrated in the Part 2 Report during algorithm validation. Therefore, no further simultaneous analysis is needed within an antenna group.

E.3. FastConnect Antenna Grouping

The 2nd generation of FastConnect operates based on pre-defined sub6 antenna groups (AG). WLAN 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 the conditions below for all exposure scenarios:

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

(or)

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

This device supports two AGs: AG0 and AG1, with AG0 having 1 antenna (Chain 1) and AG1 having 1 antenna (Chain 2). The conditions are verified through the following criteria for a given exposure position:

i) Summation criteria:

1. Obtain the adjusted SAR for all supported WLAN frequency bands from all antennas supported in each antenna group. *Adjusted SAR* is SAR at reported P_{limit} . If $EFS P_{limit} \leq P_{max}$, reported $P_{limit} = EFS P_{limit} + unc$; otherwise reported $P_{limit} = \max\{EFS P_{limit}, P_{max} + unc\}$.
2. Determine the overall maximum adjusted SAR from all WLAN radios for each antenna on each antenna group, denoted as $max.exp.ant_{AG0}(i)$ and $max.exp.ant_{AG1}(j)$
3. Obtain reported SAR for each external radio, denoted as *reported.exp.NFC Reader*, *reported.exp.NFC WPT*, *reported.exp.BT1*, *reported.exp.BT2*
4. Demonstrate that the sum of these exposures meets: $max.exp.ant_{AG0}(i) + max.exp.ant_{AG1}(j) + reported.exp.NFC Reader + reported.exp.NFC WPT + reported.exp.BT1 + reported.exp.BT2 \leq 1.6$

ii) SPLSR or composite exposure distribution criteria: When SAR summation of an antenna pair is over the limit for an exposure position, SPLSR or composite exposure distribution can be done to demonstrate simultaneous transmission compliance:

1. SPLSR analysis:

- For Top edge, due to Antenna location, BT Chain 2 is grouped with AG1 as Left Group, BT Chain 1/NFC Reader/NFC WPT are grouped with AG0 as Right Group.
- On an exposure position for each antenna group, obtain the highest adjusted SAR from all supported frequency bands on all antennas irrespective of supported simultaneous transmission scenarios for each DSI, along with the peak SAR locations.
- Per Qualcomm guidance, only Y-axis coordinates are used in the analysis for calculation simplicity. For Left group, Y_max coordinate represents the worst-case hotspot location that is closest to the Right group. Similarly, for Right group, Y_min coordinate represents the worst-case hotspot location that is closest to the Left group.
- Using the above values, demonstrate for a given DSI that every antenna from group meets SPLSR criteria with every antenna in another group for all frequency bands. The following formula is used to calculate the SPLSR between Left Group and Right Group for each exposure configuration:

$$SPLSR = \frac{(\max SAR \text{ Left Group} + \max SAR \text{ Right Group})^{1.5}}{|Y_{\text{Left Group}} - Y_{\text{Right Group}}|}$$

- When $SPLSR \leq 0.04$ (rounded to 2 decimal places) for 1g SAR, or 0.1 for 10g SAR, the antenna pair qualifies for test exemption.

E.4. Simultaneous Transmission Analysis

Table E-2 – AG0 + AG1 + BT + NFC Reader + NFC WPT Simultaneous Transmission Analysis for all edges but Top Edge

Exposure Condition	Position	SAR (W/kg)						
		AG0	AG1	Bluetooth1	Bluetooth 2	NFC Reader	NFC WPT	Sum
Body	Back	0.618	0.206	0.000	0.008	0.000	0.000	0.832
Body	Bottom	0.400	0.400	0.400	0.400	0.000	0.000	1.600
Body	Right	0.400	0.400	0.400	0.400	0.000	0.000	1.600
Body	Left	0.400	0.400	0.400	0.400	0.000	0.000	1.600

Note: Estimated SAR was used for Bottom/Right/Left for WLAN/BT per section 4 in Part1 SAR report.

Table E-3 – Left Group Maximum SAR Values for Top Edge

Exposure Condition	Position	Left Group SAR (W/kg)		
		AG1	Bluetooth Chain 2	Sum
Body	Top	0.963	0.109	1.072

Table E-4 – Right Group Maximum SAR Values for Top Edge

Exposure Condition	Position	Right Group SAR (W/kg)				
		AG0	Bluetooth Chain 1	NFC Reader	NFC WPT	Sum
Body	Top	0.924	0.043	0.000	0.000	0.967

Table E-5 – Left Group and Right Group SPLSR Analysis for Top Edge

Exposure Condition	Position	Right Group		Left Group		Sum SAR (W/kg)	SPLSR
		SAR (W/kg)	Y coordinate	SAR (W/kg)	Y coordinate		
Body	Top	0.967	37.4	1.072	-33.2	2.039	0.04

Notes:

- For all combinations where the SAR sum of AG0+AG1 +NFC reader+NFC WPT+BT or Left Group+Right Group is not greater than regulatory limits or SPLRS is under the limit, there's no further analysis required for compliance demonstration
- See section E.5 for coordinates details for all bands/modes

E.5. Coordinates

Table E-6

Left Group coordinates [mm]		
Exposure condition	Body	
Position	Top	
Band	Antenna	
	AG1	Chain 2
2.4 GHz WIFI	-59	-
5 GHz WIFI	-33.2	-
6 GHz WIFI	-35.6	-
2.4 GHz Bluetooth	-	-60
Ant Combination	AG1+BT2	
Overall Coordinate	-33.2	

Table E-7

Right Group Coordinates [mm]				
Exposure condition	Body			
Position	Top			
Band	Antenna			
	AG0	Chain 1	NFC	WPT
2.4 GHz WIFI	57.5	-	-	-
5 GHz WIFI	37.4	-	-	-
6 GHz WIFI	46.3	-	-	-
2.4 GHz Bluetooth	-	64	-	-
NFC Reader	-	-	39	-
NFC WPT	-	-	-	39.5
Ant Combination	AG0+BT1+ NFC Reader + NFC WPT			
Overall Coordinate	37.4			

E.6. Conclusion

The above numerical summed results and SPLSR for all the combinations of antenna groups are sufficient to show that AG0/Right Group is mutually exclusive from AG1/Left Group and that simultaneous transmission cases will not exceed the SAR limit. Therefore, no measured volumetric simultaneous SAR summation is required per FCC KDB Publication 447498 D04v01 and IEEE 1528- 2013 Section 6.3.4.1.