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 a 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 Time Average SAR with a pre-defined antenna group (AG0) for WLAN. Below analysis demonstrates the compliance between AG0 and BT.

Qualcomm FastConnect TAS algorithm directly adds the time-averaged RF exposure of all simultaneous transmissions of WLAN radios within an antenna group and controls the total RF exposure from all WLAN radios to not exceed FCC limit. Therefore, simultaneous transmission compliance between WLAN operations is demonstrated in the RF Exposure Part 2 Test Report during algorithm validation.

E.3 Antenna Groups

Qualcomm's FastConnect WLAN TAS operates based on pre-defined antenna groups (AG). 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 AGs and the RF exposure from radios outside TAS is less than regulatory limits. This condition must be demonstrated for all antenna combinations of AGs.

(or)

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

This device supports one AG: AG0, with AG0 having 2 Antennas (R and L) and two BT antennas outside of FastConnect. The conditions are verified through the following criteria:

a) (SAR1 + SAR2 criteria): If SPLSR criteria is not used, then the highest reported SAR at Plimit (or Pmax when Plimit > Pmax) 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 AGs and the sum of RF exposure from all supported radios outside of TAS should be less than the regulatory limit as given below for each DSI.

- 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), denoted as max.SAR.AG0, and obtain the worst-case RF exposure for each external radio, and demonstrate that the SAR sum of these RF exposures meets: { [max.SAR.AG0] + BT Ant 1 + BT Ant 2} ≤ 1.6W/kg.

b) (SPLSR criteria): For each antenna, obtain the highest reported SAR value at Plimit out of all supported technologies for each frequency band. Using these values, demonstrate for a given DSI that

every antenna from one AG meets SPLSR criteria with every antenna in another AG for all frequency bands. These criteria must be demonstrated for all antenna pair combinations irrespective of supported simultaneous transmission scenarios as given below for each DSI:

E.4 Body (DSI =0) (Plastic) Antenna Group and Simultaneous Analysis

Table E-1
DSI = 0 Body Highest Reported SAR per AG (Bottom Edge at 0mm)

AG0 SAR (W/kg)					
Body	Configuration	R	L	MIMO	Max
	Bottom	1.061	0.814	1.198	1.198

Table E-2
Simultaneous Conditions with Bluetooth

Configuration	2.4 GHz Bluetooth Ant R at 12 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant L at 12.75 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant R at 12 dBm +2.4 GHz Bluetooth Ant L at 12.75 dBm SAR (W/kg)	BT Worst-Case Combination SAR (W/kg)
Bottom	0.164	0.127	0.291	0.291

Table E-3
Body Simultaneous Analysis

Body SAR	Configuration	AG0 SAR (W/kg)	BT Worst-case Combinaton SAR (W/kg)	AG0 + BT SAR (W/kg)
	Bottom	1.198	0.291	1.489

1. For all combinations where the sum of AG0 + BT is less than 1.6 W/kg, there's no further analysis required for compliance demonstration.

Table E-4
Simultaneous Analysis when WLAN is inactive

Configuration	2.4 GHz Bluetooth Ant R at 18.5 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant L at 18.5 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant R at 18.5 dBm + 2.4 GHz Bluetooth Ant L at 18.5 dBm SAR (W/kg)	BT Worst-Case Combination SAR (W/kg)
Bottom	0.651	0.478	1.129	1.129

1. For all combinations where the sum of AG0 + BT is less than 1.6 W/kg, there's no further analysis required for compliance demonstration.

E.5 Body (DSI =0) (Metal) Antenna Group and Simultaneous Analysis

Table E-5
DSI = 0 Body Highest Reported SAR per AG (Bottom Edge at 0mm)

AG0 SAR (W/kg)					
Body	Configuration	R	L	MIMO	Max
	Bottom	0.596	0.900	0.911	0.911

Table E-6
Simultaneous Conditions with Bluetooth

Configuration	2.4 GHz Bluetooth Ant R at 12 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant L at 12.75 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant R at 12 dBm +2.4 GHz Bluetooth Ant L at 12.75 dBm SAR (W/kg)	BT Worst- Case Combination SAR (W/kg)
Bottom	0.125	0.136	0.261	0.261

Table E-7
Body Simultaneous Analysis

Body SAR	Configuration	AG0 SAR (W/kg)	BT Worst-case Combinaton SAR (W/kg)	AG0 + BT SAR (W/kg)
	Bottom	0.911	0.261	1.172

1. For all combinations where the sum of AG0 + BT is less than 1.6 W/kg, there's no further analysis required for compliance demonstration.

Table E-8
Simultaneous Analysis when WLAN is inactive

Configuration	2.4 GHz Bluetooth Ant R at 18.5 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant L at 18.5 dBm SAR (W/kg)	2.4 GHz Bluetooth Ant R at 18.5 dBm + 2.4 GHz Bluetooth Ant L at 18.5 dBm SAR (W/kg)	BT Worst-Case Combination SAR (W/kg)
Bottom	0.622	0.476	1.098	1.098

1. For all combinations where the sum of AG0 + BT is less than 1.6 W/kg, there's no further analysis required for compliance demonstration.

E.6 Conclusion

The above numerical summed SAR results for all the combinations of antenna groups and external radios are sufficient to show 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