

APPENDIX E: MULTI-TX AND ANTENNA SAR CONSIDERATIONS

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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 IEC/IEEE 62209-1528:2020 Section 7.4.4, 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. Alternatively, simultaneous transmission SAR test exclusion may be evaluated using Total Exposure Ratio (TER). 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 pre-defined antenna groups (AG0 and AG1) for WLAN. Simultaneous transmission analysis is performed per antenna groups. Below analysis demonstrates the mutually exclusive operation of AG0 and AG1 and the compliance between each antenna group and BT/NFC.

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 Part 2 Report during algorithm validation.

Note: Please see the original filing for the standalone reported SAR for modes and bands that were not evaluated in this permissive change.

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 Smart Transmit 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 two AGs: AG0 and AG1, with AG0 having 1 antenna (R) and AG1 having 1 antenna (L), and two BT antennas and 1 NFC antenna outside of FastConnect. The conditions are verified through the following criteria

i) (SAR1 + SAR2 criteria): If SPLSR criteria is not used, then the highest reported ER 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.

1. Obtain the worst-case reported ER for each antenna group (i.e., maximum reported SAR at Plimit (or Pmax when Plimit > Pmax) out of all supported

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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 for each external radio, and demonstrate that the TER sum of these RF exposures meets: $\{ [\text{max.SAR.AG0} + \text{max.SAR.AG1}] + \text{BT Ant R} + \text{BT Ant L} + \text{NFC} \} \leq 1..$

ii) (SPLSR criteria): For each antenna, obtain the highest reported ER 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:

- SPLSR criteria should be met for all antenna pair combinations of AG0 and AG1: {antenna (R) in AG0; antenna (L) in AG1. As it can be seen, these include all combinations of antenna groups, antennas, and frequency bands.}

E.4 Body with Motion (DSI = 1) Antenna Group and Simultaneous Analysis

Table 1
DSI=1 Body with Motion Highest Reported ER per AG (at 0mm)

AG0 Ratio to Limit			
	Configuration	R	Max
Body	Back	0.049	0.049
	Top	0.385	0.385
	Bottom	0.005	0.005
	Right	0.026	0.026
	Left	0.004	0.004
AG1 Ratio to Limit			
	Configuration	L	Max
Body	Back	0.063	0.063
	Top	0.408	0.408
	Bottom	0.009	0.009
	Right	0.003	0.003
	Left	0.088	0.088

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Table 2
DSI=1 Body with Motion AG Verification (at 0mm)

Body	Configuration	AG0 Ratio to Limit	AG1 Ratio to Limit	Bluetooth Ant R at 12 dBm Ratio to Limit	Bluetooth Ant L at 12 dBm Ratio to Limit	NFC Ratio to Limit	AG0 + AG1 + BT Ant R + BT Ant L + NFC Ratio to Limit
	Back	0.049	0.063	0.006	0.014	0.000	0.132
	Top	0.385	0.408	0.043	0.079	0.000	0.915
	Bottom	0.005	0.009	0.003	0.009	0.000	0.026
	Right	0.026	0.003	0.003	0.000	0.000	0.032
	Left	0.004	0.088	0.000	0.003	0.000	0.095

Notes:

- For all combinations where the TER sum of AG0+AG1+BT Ant R + BT Ant L + NFC is less than 1, there's no further analysis required for compliance demonstration.

Table 3
DSI=1 Body with Motion Bluetooth Simultaneous Transmission when WLAN is Inactive

Body	Configuration	Bluetooth Ant R at 17.25 dBm Ratio to Limit	Bluetooth Ant L at 17.25 dBm Ratio to Limit	NFC Ratio to Limit	BT Ant R + BT Ant L + NFC Ratio to Limit
	Back	0.049	0.076	0.000	0.125
	Top	0.356	0.385	0.000	0.741
	Bottom	0.003	0.009	0.000	0.012
	Right	0.003	0.000	0.000	0.003
	Left	0.000	0.003	0.000	0.003

Notes:

- For all combinations where the TER sum of BT Ant R + BT Ant L + NFC is less than 1, there's no further analysis required for compliance demonstration.

E.5 Conclusion

The above numerical summed SAR 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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