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 or 10g SAR.

This device is enabled with Qualcomm® FastConnect with pre-defined sub6 antenna groups (AG0 and AG1) for WLAN and Qualcomm® Smart Transmit Gen2 with 1 Antenna Group for WWAN. 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, WWAN, and BT.

When operating in the same antenna group, Qualcomm Smart Transmit algorithm in WWAN directly adds the time-averaged RF exposure from 4G and time-averaged RF exposure from 5G NR. Smart Transmit algorithm controls the total RF exposure from both 4G and 5G NR to not exceed FCC limit and FastConnect algorithm controls the total RF exposure from WLAN to not exceed FCC limit. Therefore, simultaneous transmission compliance between 4G+5G operations and WLAN operations within an antenna group is demonstrated in the Part 2 Report during algorithm validation.

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.

(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 using Qualcomm's Smart Transmit, two WLAN AG: AG0 and AG1, with AG0 having 1 antenna (6) and AG1 having 1 antenna (7) using Qualcomm's FastConnect, and two BT antennas outside of TAS. The conditions are verified through the following criteria:

i) (SAR1 + SAR2 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 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 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: { [max.SAR.AG0 + max.SAR.AG1] + max.SAR.WWAN + BT Ant 1 + BT Ant 2} ≤ 1.6 (for 1g).

ii) (SPLSR criteria): For each antenna, obtain the highest reported SAR 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: {antenna 6 in AG0; antenna 7 in AG1. As it can be seen, these include all combinations of antenna groups, antennas, and frequency bands.

iii) (combination of SPLSR & SAR1+SAR2 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: {max.SAR.AG0 + max.SAR.WWAN + BT Ant 1 + BT Ant 2} ≤ 1.6 and {max.SAR.AG1 + max.SAR.WWAN + BT Ant 1 + BT Ant 2} ≤ 1.6 for compliance demonstration (for 1g).

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 coordinate locations are documented in the Highest Report SAR and Hotspot Location Section of the "FCC Proprietary Analysis for Multi-Tx and Antenna SAR considerations" document.

Table E-1
Worst Case Per Exposure Condition

SAR (W/kg)	
Laptop	Tablet
1.40	1.58

E.4 Conclusion

Detailed numerical summed SAR and SPLSR results for all the combinations of sub6 antenna groups are demonstrated in the “FCC Proprietary Analysis for Multi-Tx and Antenna SAR considerations” document and worst-case Simultaneous Tx reported SAR for each exposure condition are reported on SAR summary table on page 1 of SAR RF Exposure Part 1 Test Report (Report SN: 1M2312040120-01.C3K). All results 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 more measured volumetric simultaneous SAR summation is required per FCC KDB Publication 447498 D01v06 and IEEE 1528- 2013 Section 6.3.4.1