APPENDIX E: MULTI-TX AND ANTENNA SAR CONSIDERATIONS

E.1 Introduction

The following procedures adopted from FCC KDB Publication 447498 D01v06 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 D01v06 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.

Per FCC KDB Publication 941225 D06v02r01, the devices edges with antennas more than 2.5 cm from edge are not required to be evaluated for SAR ("-").

In 5G + LTE + WLAN + BT simultaneous transmission, 5G NR, and LTE transmission are managed and controlled by MediaTeK WWAN TA-SAR and WLAN transmission is managed and controlled by MediaTeK CONNSYS TA-SAR.

Since BT does not employ time-averaging, 1g SAR and 10g SAR measurements for BT need to be conducted at their corresponding rated ower following current FCC test procedures to determine reported SAR values.

TA-SAR current implementation assumes hotspots from 5G NR and LTE are collocated. Therefore, for a total of 100% exposure margin, if LTE uses x, then the exposure margin left for 5G NR is capped to y. Thus, the compliance equation for 5G + LTE + WLAN + BT is

$$x * A + y * B + m \leq 1$$
$$x + y = g \leq 1$$
$$g + m \leq 1$$

Where, A is normalized reported time-averaged SAR exposure ratio from LTE, and A ≤ 1.0; B is normalized reported time-averaged exposure ratio from 5G NR, and B ≤ 1.0. Let m = normalized reported time-averaged SAR exposure ratio from WLAN + BT, then for compliance

$$x * A + y * B + m \leq 1 \ (1)$$
$$x * A + y * B \leq x * \max(A, B) + (g - x) * \max(A, B) \leq \max(A, B)$$
$$x * A + (g - x) * B + m \leq \max(A, B) + m \leq 1.0 \ (2)$$

If A + m ≤ 1.0 and B + m ≤ 1.0 can be proven, then "x * A + y * B + m ≤ 1.0". Therefore simultaneous transmission analysis for 5G NR + LTE + WLAN + BT can be performed in two steps.

Step 1: Prove total exposure ratio (TER) of LTE + WLAN + BT < 1

Step 2: Prove total exposure ratio (TER) of 5G NR + WLAN + BT < 1

Else, if A + m > 1.0 and/or B + m >1.0, then the following need to hold true for compliance:

i. A and m need to be checked if decoupled based on SPLSR criteria
ii. $y * B + m \leq 1.0$ (or B and m need to be checked if decoupled based on SPLSR, and
iii. $x * A + y * B \leq 1.0$

Note iii is covered in Part 2 report; I, and ii are covered in the Part 1 report.
Above analysis is also apply to LTE/NR inter band uplink, LTE(NR)1 + LTE(NR)2 + WLAN + BT simultaneous
transmission, So inter-band uplink CA no need to do additional simultaneously analysis again. Only required comply with total exposure ratio (TER) of LTE/NR + WLAN + BT < 1.
Above analysis is also apply to NR band UL MIMO, NR(SISO1) + NR(SISO2) + WLAN + BT simultaneous
transmission, So UL MIMO no need to do additional simultaneously analysis again. Only required comply with total exposure ratio (TER) of NR + WLAN + BT < 1.

E.3 Head (ECI = 1) SAR Analysis

Table E-1
ECI = 1 Held-to-ear Verification

Head SAR	WWAN Design Target + unc (W/kg)	WLAN Design Target + unc (W/kg)	2.4 GHz Bluetooth SAR W/kg	WWAN Design Target + unc + WLAN Design Target + unc + 2.4 GHz Bluetooth SAR W/kg
	0.818	0.692	0.065	1.575

Notes:

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

E.4 Body-worn (ECI = 4) SAR Analysis

Table E-2
ECI = 4 Body-worn Verification

Bodyworn SAR	WWAN Design Target + unc (W/kg)	WLAN Design Target + unc (W/kg)	2.4 GHz Bluetooth SAR W/kg	WWAN Design Target + unc + WLAN Design Target + unc + 2.4 GHz Bluetooth SAR W/kg
	0.818	0.692	0.016	1.526

Notes:

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

E.5 Hotspot (ECI = 2) SAR Antenna Group Analysis

Table E-3
ECI = 2 Hotspot Verification

Hotspot SAR	WWAN Design Target + unc (W/kg)	WLAN Design Target + unc (W/kg)	2.4 GHz Bluetooth SAR W/kg	WWAN Design Target + unc + WLAN Design Target + unc + 2.4 GHz Bluetooth SAR W/kg
	0.818	0.692	0.016	1.526

Notes:

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

E.6 Phablet (ECI = 4) SAR Analysis

Per FCC KDB Publication 648474 D04 Handset SAR, Phablet SAR tests were not required if wireless router 1g SAR (scaled to the maximum output power, including tolerance) < 1.2 W/kg. Therefore no further analysis beyond the tables included in this section was required to determine that possible simultaneous transmission scenarios would not exceed the SAR limit.

Table E-4
ECI = 4 Phablet Verification

Phablet SAR	WWAN Design Target + unc (W/kg)	WLAN Design Target + unc (W/kg)	NFC SAR W/kg	WWAN Design Target + unc + WLAN Design Target + unc + NFC + SAR W/kg
	2.046	1.731	0.025	3.802

Notes:

1. For all combinations where the sum of WWAN+WLAN+NFC is less than 4W/kg, there's no further analysis required for compliance demonstration.

E.7 Conclusion

The above numerical summed SAR results 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