

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.

Alternatively, simultaneous transmission SAR test exclusion may be evaluated using Total Exposure Ratio (TER).

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 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.

In sub6 + WLAN/BT/802.15.4 ab-NB/NFC/NTN simultaneous transmission, WWAN transmission is managed and controlled by MediaTek TAS (TA-SAR) feature.

Since WLAN/BT/802.15.4 ab-NB/NFC/NTN does not employ time-averaging, 1g SAR measurements for WLAN/BT/802.15.4 ab-NB/NFC/NTN need to be conducted at their corresponding rated power following current FCC test procedures to determine reported SAR values.

Mediatek TER implementation is to prove $x*A + y*B + m \leq 1$ (x & y adjusted dynamically and be defined by OEM) where, A is normalized reported time-averaged SAR exposure ratio from sub6 radio, B is normalized reported time-averaged FR2 exposure ratio, and m is normalized reported time-averaged SAR exposure ratio for WiFi/unlicensed mode/bands (i.e. BT, 802.15.4 ab-NB, NFC).

$$x * A + y * B + m \leq 1 \quad (1)$$

$$x + y = g \leq 1 \quad (2)$$

$$y = g - x$$

If $A \geq B$,

$$x*A + y*B + m \leq x*A + (g-x)*A + m = g*A + m \quad (3)$$

If $A < B$,

$$x*A + y*B + m < x*B + (g-x)*B + m = g*B + m \quad (4)$$

If $x*A + y*B + m \leq g*\text{Max}(A,B) + m$

Then,

$$g*\text{Max}(A) + m \leq 1 \quad (5)$$

$$g*\text{Max}(B) + m \leq 1 \quad (6)$$

$$x*A + y*B + m \leq g*\text{Max}(A,B) + m \leq 1 \quad (7)$$

Since FR2 is not supported for this device, if $g*\text{Max}(A) + m \leq 1$, then $\text{TER} \leq 1$. In addition, $x*A \leq 1$ will be approved in Part 2 report.

Note: In cases where simultaneous transmission scenarios overlap with the same power level (for example, cellular band + 2.4 GHz WIFI and cellular band + 2.4 GHz WIFI + 802.15.4 ab-NB), the most conservative SAR summation scenario was evaluated.

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E.3 Exposure Ratios

Exposure ratio (ER) for different transmitters is calculated as following:

$$ER_{SAR,n} = \frac{SAR_n}{SAR_{limit,n}}$$

Where:

- SAR_n is the SAR value for the n-th transmitter/test frequency
- $SAR_{limit,n}$ is the basic restriction limit that is applicable to the n-th transmitter/test frequency

E.4 Head SAR Simultaneous Transmission Analysis

For SAR summation, the highest reported SAR across all housing and wristband types was used as a conservative evaluation for simultaneous transmission analysis.

In some cases, SAR evaluations at the maximum output power level were used as the most conservative evaluation for simultaneous transmission analysis.

Note: NFC and NTN Band 254 were evaluated for extremity only based on expected usage conditions.

Table E-1

Simultaneous Transmission Scenario with Cellular, 2.4 GHz WIFI and 802.15.4 ab-NB (Head at 1.0 cm)

ER (Ratio to Limit)					
Exposure Condition	Configuration	Cellular Band ER	2.4 GHz WIFI Reduced ER	802.15.4 ab-NB ER	Σ ER
		1	2	3	1+2+3
Head SAR	Front	0.722	0.116	0.001	0.839

Table E-2

Simultaneous Transmission Scenario with Cellular, 2.4 GHz Bluetooth and 5 GHz WIFI (Head at 1.0 cm)

ER (Ratio to Limit)					
Exposure Condition	Configuration	Cellular Band ER	2.4 GHz Bluetooth Reduced ER	5 GHz WIFI Reduced ER	Σ ER
		1	2	3	1+2+3
Head SAR	Front	0.722	0.082	0.015	0.819

Table E-3

Simultaneous Transmission Scenario with Cellular, 2.4 GHz Bluetooth and 802.15.4 ab-NB (Head at 1.0 cm)

ER (Ratio to Limit)					
Exposure Condition	Configuration	Cellular Band ER	2.4 GHz Bluetooth Reduced ER	802.15.4 ab-NB ER	Σ ER
		1	2	3	1+2+3
Head SAR	Front	0.722	0.082	0.001	0.805

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Table E-4
Simultaneous Transmission Scenario with 2.4 GHz WIFI and 802.15.4 ab-NB (Head at 1.0 cm)

ER (Ratio to Limit)				
Exposure Condition	Configuration	2.4 GHz WIFI ER	802.15.4 ab-NB ER	Σ ER
		1	2	1+2
Head SAR	Front	0.365	0.001	0.366

Table E-5
Simultaneous Transmission Scenario with 2.4 GHz Bluetooth and 5 GHz WIFI (Head at 1.0 cm)

ER (Ratio to Limit)				
Exposure Condition	Configuration	2.4 GHz Bluetooth ER	5 GHz WIFI ER	Σ ER
		1	2	1+2
Head SAR	Front	0.284	0.059	0.343

Table E-6
Simultaneous Transmission Scenario with 2.4 GHz Bluetooth and 802.15.4 ab-NB (Head at 1.0 cm)

ER (Ratio to Limit)				
Exposure Condition	Configuration	2.4 GHz Bluetooth ER	802.15.4 ab-NB ER	Σ ER
		1	2	1+2
Head SAR	Front	0.284	0.001	0.285

E.5 Extremity SAR Simultaneous Transmission Analysis

For SAR summation, the highest reported SAR across all housing and wristband types was used as a conservative evaluation for simultaneous transmission analysis.

Table E-7
Simultaneous Transmission Scenario with Cellular, 2.4 GHz WIFI, 802.15.4 ab-NB and NFC (Extremity at 0.0 cm)

ER (Ratio to Limit)						
Exposure Condition	Configuration	Cellular Band ER	2.4 GHz WIFI ER	802.15.4 ab-NB ER	NFC ER	Σ ER
		1	2	3	4	1+2+3+4
Extremity SAR	Back	0.202	0.015	0.000	0.000	0.217

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Table E-8
Simultaneous Transmission Scenario with Cellular, 2.4 GHz Bluetooth, 5 GHz WIFI and NFC
(Extremity at 0.0 cm)

ER (Ratio to Limit)						
Exposure Condition	Configuration	Cellular Band ER	2.4 GHz Bluetooth ER	5 GHz WIFI ER	NFC ER	Σ ER
		1	2	3	4	1+2+3+4
Extremity SAR	Back	0.202	0.007	0.014	0.000	0.223

Table E-9
Simultaneous Transmission Scenario with Cellular, 2.4 GHz Bluetooth, 802.15.4 ab-NB and NFC
(Extremity at 0.0 cm)

ER (Ratio to Limit)						
Exposure Condition	Configuration	Cellular Band ER	2.4 GHz Bluetooth ER	802.15.4 ab-NB ER	NFC ER	Σ ER
		1	2	3	4	1+2+3+4
Extremity SAR	Back	0.202	0.007	0.000	0.000	0.209

Table E-10
Simultaneous Transmission Scenario with 802.15.4 ab-NB and NFC (Extremity at 0.0 cm)

ER (Ratio to Limit)					
Exposure Condition	Configuration	2.4 GHz WIFI ER	802.15.4 ab-NB ER	NFC ER	Σ ER
		1	2	3	1+2+3
Extremity SAR	Back	0.015	0.000	0.000	0.015

Table E-11
Simultaneous Transmission Scenario with 2.4 GHz Bluetooth, 5 GHz WIFI and NFC (Extremity at 0.0 cm)

ER (Ratio to Limit)					
Exposure Condition	Configuration	2.4 GHz Bluetooth ER	5 GHz WIFI ER	NFC ER	Σ ER
		1	2	3	1+2+3
Extremity SAR	Back	0.007	0.014	0.000	0.021

Table E-12
Simultaneous Transmission Scenario with 2.4 GHz Bluetooth, 802.15.4 ab-NB and NFC
(Extremity at 0.0 cm)

ER (Ratio to Limit)					
Exposure Condition	Configuration	2.4 GHz Bluetooth ER	802.15.4 ab-NB ER	NFC ER	Σ ER
		1	2	3	1+2+3
Extremity SAR	Back	0.007	0.000	0.000	0.007

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Table E-13
Simultaneous Transmission Scenario with NTN Band 254, 2.4 GHz Bluetooth and NFC
(Extremity at 0.0 cm)

ER (Ratio to Limit)					
Exposure Condition	Configuration	NTN Band 254 ER	2.4 GHz Bluetooth ER	NFC ER	Σ ER
		1	2	3	1+2+3
Extremity SAR	Back	0.050	0.007	0.000	0.057

Table E-14
Simultaneous Transmission Scenario with NRN Band 254, 802.15.4 ab-NB and NFC (Extremity at 0.0 cm)

ER (Ratio to Limit)					
Exposure Condition	Configuration	NTN Band 254 ER	802.15.4 ER	NFC ER	Σ ER
		1	2	3	1+2+3
Extremity SAR	Back	0.050	0.000	0.000	0.050

E.6 Simultaneous Transmission Conclusion

The above numerical summed SAR results for all the worst-case simultaneous transmission conditions were below the SAR limit. Therefore, the above analysis is sufficient to determine 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.

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