APPENDIX C: TOTAL EXPOSURE RATIO

The Total Exposure Ratio (TER) is calculated by combining all SAR measurements and power density measurements after normalizing to their respective limits. The general expression is below.

$$TER = \sum_{a=1}^{A} \frac{SAR_a}{SAR_a, limit} + \sum_{b=1}^{B} \frac{psPD_b}{psPD_b, limit} < 1$$

The TER shall be less than unity to ensure compliance with the limits.

$$\sum_{n=1}^{N} \frac{4G\ SAR_n}{4G\ SAR_n, limit} + \sum_{m=1}^{M} \frac{5G\ mmW\ NR\ psPD_m}{5G\ mmW\ NR\ psPD_m, limit} + \sum_{p=1}^{P} \frac{WLAN\ SAR_p}{WLAN\ SAR_p, limit} < 1$$

Qualcomm® Smart Transmit algorithm for WWAN adds directly the time-averaged RF exposure from 4G and time-averaged RFexposure from 5G mmW NR. Smart Transmit algorithm controls the total RF exposure from both 4G and 5G mmW NR to not exceed FCC limit. Therefore, per FCC guidance, TER does not need to be evaluated directly for the 4G and 5G simultaneous compliance via summation. The following equations are derived later in Appendix C. The validation of the time-averaging algorithm and compliance under the Tx varying transmission scenario for WWAN technologies are reported in Part 2 report. The report SN could be found in Bibliography section.

$$\sum_{n=1}^{N} \frac{4G\ SAR_n}{4G\ SAR_n, limit} + \sum_{p=1}^{P} \frac{WLAN\ SAR_p}{WLAN\ SAR_p, limit} < 1$$

$$\sum_{m=1}^{M} \frac{5G\ mmW\ NR\ psPD_m}{5G\ mmW\ NR\ psPD_m, limit} + \sum_{p=1}^{P} \frac{WLAN\ SAR_p}{WLAN\ SAR_p, limit} < 1$$

For 5G mmW NR, since there is total design-related uncertainty arising from TxAGC and device-to-device variation, the worst-case RF exposure should be determined by accounting for device uncertainty. For this device, the manufacturer has added an additional permanent back-off (indicated below as WWAN backoff) for every beam in the calculations for input.power.limits used in the EFS file. The back-off levels can be found in the Part 0 Test report. Therefore, 5G mmW NR RF exposure for this DUT is evaluated by reported psPD calculated as:

$$reported\_psPD = (PD\_design\_target + PD\_uncertainty) \times 10^{(-WWAN\ backoff\ in\ dB)/10}$$

Note that since not all the beams supported by this EUT are measured, *reported_psPD* cannot be computed based on limited *measured psPD* data. Alternatively, since *measured psPD* for all the beams will be ≤ *PD_design_target* + *PD_uncertainty* uncertainty, *reported_psPD* is computed based on this worst-case psPD as shown above.

The compliance analysis for simultaneous transmission scenarios of WWAN (4G LTE & 5G mmW NR) with Smart Transmit and 4G & WLAN can be found in two reports indicated in the table below. This appendix demonstrates compliance for the 5G + WLAN scenarios. The report SNs can be found in Bibliography section.

	Simultaneous Scenario	**Evaluation Report**
1.	4G LTE WWAN + WLAN	FCC SAR Evaluation Report (Part 1)
2.	4G LTE WWAN + 5G mmW NR WWAN	RF Exposure Part 2 Test Report

RF exposure compliance with 5G mmW NR WWAN+WLAN simultaneous transmission scenarios is demonstrated for various radio configurations below.

Note that the above *reported psPD* applies to the worst-case surfaces of the DUT at 2mm evaluation distance.

Worst-case PD on other surfaces of the DUT are calculated from simulated PD data (see Power Density Simulation Report), by multiplying reported psPD with the highest proportion out of all beams and out of all three channels in each band, where the adjustment for each beam/channel is computed as the proportion of “simulated PD on desired surface” to “simulated PD on worst-surface”. For example, to determine worst-case PD on front surface (needed for Head RF Exposure evaluation during simultaneous transmission), highest proportion of (simulated PD on front surface)/(simulated PD on worst surface) was determined out of all supported beams and out of all three channels by the DUT in each band.

In some cases, the simulation vs measurement for some surfaces can exceed the device's total uncertainty. In those cases, if the measured psPD > simulated adjusted psPD (assuming a linear congruency of the psPD across surfaces), then measured psPD should be used towards the simultaneous TX analysis. Table C-1 lists the relevant worst-case reported psPD values based on the additional surfaces and evaluation distances needed to perform the TER analysis. The highest of the adjusted Reported_psPD and Measured Total psPD was chosen for TER analysis and the chosen values are indicated by bolded psPD values.

Table C-1
5G mmW NR psPD - Closed

NR Band	Antenna	Surface	Evaluation Distance (mm)	Adjustment Factor due to Simulation	Adjusted Reported psPD (mW/cm²)	Measured Total psPD (mW/cm²)	Final Reported psPD (mW/cm²)
n261	K	Back	2	0.338	0.269	0.131	**0.269**
n261	K	Front	2	1.000	0.794	0.160	**0.794**
n261	K	Top	2	0.168	0.133	0.144	**0.144**
n261	K	Bottom	2	0.118	0.094	-	**0.094**
n261	K	Right	2	0.057	0.045	-	**0.045**
n261	K	Left	2	1.000	0.794	0.388	**0.794**
n260	K	Back	2	0.327	0.260	0.187	**0.260**
n260	K	Front	2	0.619	0.492	-	**0.492**
n260	K	Top	2	0.143	0.113	0.078	**0.113**
n260	K	Bottom	2	0.081	0.064	-	**0.064**
n260	K	Right	2	0.032	0.026	-	**0.026**
n260	K	Left	2	1.000	0.794	0.592	**0.794**
n261	L	Back	2	0.022	0.018	0.046	**0.046**
n261	L	Front	2	1.000	0.794	0.548	**0.794**
n261	L	Top	2	0.461	0.367	0.280	**0.367**
n261	L	Bottom	2	0.019	0.015	-	**0.015**
n261	L	Right	2	0.161	0.128	0.110	**0.128**
n261	L	Left	2	0.136	0.108	-	**0.108**
n260	L	Back	2	0.017	0.013	0.028	**0.028**
n260	L	Front	2	1.000	0.794	0.511	**0.794**
n260	L	Top	2	0.452	0.359	0.128	**0.359**
n260	L	Bottom	2	0.071	0.057	-	**0.057**
n260	L	Right	2	0.176	0.140	0.077	**0.140**
n260	L	Left	2	0.156	0.124	-	**0.124**
n261	K	Front	5	0.662	0.526	0.131	**0.526**
n261	K	Left	5	0.793	0.630	0.348	**0.630**
n260	K	Front	5	0.424	0.337	0.094	**0.337**
n260	K	Left	5	0.797	0.633	0.122	**0.633**
n261	L	Front	5	0.812	0.645	0.362	**0.645**
n261	L	Left	5	0.108	0.086	0.060	**0.086**
n260	L	Front	5	0.736	0.585	0.335	**0.585**
n260	L	Left	5	0.121	0.096	0.013	**0.096**

Note: Adjusted factor is (simulated PD on desired exposure plane)/(PD on worst-surface at 2mm evaluation distance) out of all beams and out of all channels. See Power Density Simulation Report.

Table C-2
5G mmW NR psPD - Open

NR Band	Antenna	Surface	Evaluation Distance (mm)	Adjustment Factor due to Simulation	Adjusted Reported psPD (mW/cm²)	Measured Total psPD (mW/cm²)	Final Reported psPD (mW/cm²)
n261	K	Back	2	0.666	0.529	-	**0.529**
n261	K	Front	2	0.660	0.524	-	**0.524**
n261	K	Top	2	0.077	0.061	-	**0.061**
n261	K	Bottom	2	0.041	0.033	-	**0.033**
n261	K	Right	2	0.036	0.029	-	**0.029**
n261	K	Left	2	1.000	0.794	0.176	**0.794**
n260	K	Back	2	0.792	0.629	0.159	**0.629**
n260	K	Front	2	0.707	0.562	0.246	**0.562**
n260	K	Top	2	0.091	0.073	-	**0.073**
n260	K	Bottom	2	0.022	0.017	-	**0.017**
n260	K	Right	2	0.030	0.024	-	**0.024**
n260	K	Left	2	1.000	0.794	0.538	**0.794**
n261	L	Back	2	1.000	0.794	0.491	**0.794**
n261	L	Front	2	0.026	0.021	0.030	**0.030**
n261	L	Top	2	0.019	0.015	-	**0.015**
n261	L	Bottom	2	0.023	0.018	-	**0.018**
n261	L	Right	2	0.133	0.106	0.079	**0.106**
n261	L	Left	2	0.136	0.108	-	**0.108**
n260	L	Back	2	1.000	0.794	0.318	**0.794**
n260	L	Front	2	0.042	0.033	0.028	**0.033**
n260	L	Top	2	0.057	0.046	-	**0.046**
n260	L	Bottom	2	0.053	0.042	-	**0.042**
n260	L	Right	2	0.171	0.136	0.034	**0.136**
n260	L	Left	2	0.197	0.156	-	**0.156**

Note: Adjusted factor is (simulated PD on desired exposure plane)/(PD on worst-surface at 2mm evaluation distance) out of all beams and out of all channels. See Power Density Simulation Report.

Note: Additional beams with highest adjustment factors for n260 Antenna K were evaluated at 2mm front side to show that measured psPD is lower than adjusted reported psPD for those specific beams. The worst case adjustment factor due to simulation of the non-selected beams was used in the above table for n260 Antenna K (Front).

Table C-3
5G mmW NR Head Total Exposure Ratio - Open

		psPD	2.4 GHz WLAN Ant 2 Reported SAR	2.4 GHz WLAN MIMO Reported SAR	Bluetooth Ant 1 Reported SAR	Bluetooth Ant 2 Reported SAR	5 GHz WLAN Ant 1 Reported SAR	5 GHz WLAN MIMO Reported SAR	psPD + 2.4 GHz WLAN MIMO	psPD + BT Ant 1	psPD + BT Ant 2	psPD + 5 GHz WLAN Ant 1	psPD + 5 GHz WLAN MIMO	psPD + 2.4 GHz WLAN MIMO + 5 GHz WLAN MIMO	psPD + 2.4 GHz WLAN Ant 2 + BT Ant 1	psPD + 2.4 GHz WLAN Ant 2 + BT Ant 1 + 5 GHz WLAN Ant 1	psPD + 2.4 GHz WLAN Ant 2 + BT Ant 1 + 5 GHz WLAN MIMO	psPD + BT Ant 1 + 5GHz WLAN Ant 1	psPD + BT Ant 2 + 5GHz WLAN Ant 1	psPD + BT Ant 1 + 5GHz WLAN MIMO	psPD + BT Ant 2 + 5 GHz WLAN MIMO
			10.0 dBm	13.0 dBm	9.0 dBm	9.0 dBm	10.0 dBm	13.0 dBm													
		mW/cm²	W/kg	W/kg	W/kg	W/kg	W/kg	W/kg													
		1	3	4	5	6	7	8	1 + 4	1 + 5	1 + 6	1 + 7	1 + 8	1 + 4 + 8	1 + 3 + 5	1 + 3 + 5 + 7	1 + 3 + 5 + 8	1 + 5 + 7	1 + 6 + 7	1 + 5 + 8	1 + 6 + 8
Applicable Limit		1.0	1.6	1.6	1.6	1.6	1.6	1.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Front Side	Reported Value	0.562	0.308	0.310	0.125	0.207	0.147	0.266													
	Ratio to Limit	0.562	0.193	0.194	0.078	0.129	0.092	0.166	0.756	0.640	0.691	0.654	0.728	0.922	0.833	0.925	**0.999**	0.732	0.783	0.806	0.858

Table C-4
5G mmW NR Body-Worn Total Exposure Ratio - Closed

		psPD	2.4 GHz WLAN Ant2 Reported SAR	2.4 GHz WLAN MIMO Reported SAR	Bluetooth Ant 1 Reported SAR	Bluetooth Ant 2 Reported SAR	5 GHz WLAN Ant 1 Reported SAR	5 GHz WLAN MIMO Reported SAR	psPD + 2.4 GHz WLAN MIMO	psPD + BT Ant 1	psPD + BT Ant 2	psPD + 5 GHz WLAN Ant 1	psPD + 5 GHz WLAN MIMO	psPD + 2.4 GHz WLAN MIMO + 5 GHz WLAN MIMO	psPD + 2.4 GHz WLAN Ant 2 + BT Ant 1	psPD + 2.4 GHz WLAN Ant 2 + BT Ant 1 + 5 GHz WLAN Ant 1	psPD + 2.4 GHz WLAN Ant 2 + BT Ant 1 + 5 GHz WLAN MIMO	psPD + BT Ant 1 + 5GHz WLAN Ant 1	psPD + BT Ant 2 + 5GHz WLAN Ant 1	psPD + BT Ant 1 + 5GHz WLAN MIMO	psPD + BT Ant 2 + 5 GHz WLAN MIMO
			18.0 dBm	21.0 dBm	15.0 dBm	16.0 dBm	17.0 dBm	20.0 dBm													
		mW/cm²	W/kg	W/kg	W/kg	W/kg	W/kg	W/kg													
		1	3	4	5	6	7	8	1 + 4	1 + 5	1 + 6	1 + 7	1 + 8	1 + 4 + 8	1 + 3 + 5	1 + 3 + 5 + 7	1 + 3 + 5 + 8	1 + 5 + 7	1 + 6 + 7	1 + 5 + 8	1 + 6 + 8
Applicable Limit		1.0	1.6	1.6	1.6	1.6	1.6	1.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Back Side	Reported Value	0.269	0.019	0.072	0.018	0.013	0.001	0.013													
	Ratio to Limit	0.269	0.012	0.045	0.011	0.008	0.001	0.008	0.314	0.280	0.277	0.270	0.277	**0.322**	0.292	0.293	0.300	0.281	0.278	0.288	0.285

Table C-5
5G mmW NR Body-Worn Total Exposure Ratio - Open

		psPD	2.4 GHz WLAN Ant2 Reported SAR	2.4 GHz WLAN MIMO Reported SAR	Bluetooth Ant 1 Reported SAR	Bluetooth Ant 2 Reported SAR	5 GHz WLAN Ant 1 Reported SAR	5 GHz WLAN MIMO Reported SAR	psPD + 2.4 GHz WLAN MIMO	psPD + BT Ant 1	psPD + BT Ant 2	psPD + 5 GHz WLAN Ant 1	psPD + 5 GHz WLAN MIMO	psPD + 2.4 GHz WLAN MIMO + 5 GHz WLAN MIMO	psPD + 2.4 GHz WLAN Ant 2 + BT Ant 1	psPD + 2.4 GHz WLAN Ant 2 + BT Ant 1 + 5 GHz WLAN Ant 1	psPD + 2.4 GHz WLAN Ant 2 + BT Ant 1 + 5 GHz WLAN MIMO	psPD + BT Ant 1 + 5GHz WLAN Ant 1	psPD + BT Ant 2 + 5GHz WLAN Ant 1	psPD + BT Ant 1 + 5GHz WLAN MIMO	psPD + BT Ant 2 + 5 GHz WLAN MIMO
			18.0 dBm	17.0 dBm	15.0 dBm	16.0 dBm	17.0 dBm	20.0 dBm													
		mW/cm²	W/kg	W/kg	W/kg	W/kg	W/kg	W/kg													
		1	3	4	5	6	7	8	1 + 4	1 + 5	1 + 6	1 + 7	1 + 8	1 + 4 + 8	1 + 3 + 5	1 + 3 + 5 + 7	1 + 3 + 5 + 8	1 + 5 + 7	1 + 6 + 7	1 + 5 + 8	1 + 6 + 8
Applicable Limit		1.0	1.6	1.6	1.6	1.6	1.6	1.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Back Side	Reported Value	0.794	0.051	0.043	0.071	0.059	0.128	0.148													
	Ratio to Limit	0.794	0.032	0.027	0.044	0.037	0.080	0.093	0.821	0.838	0.831	0.874	0.887	0.913	0.870	0.950	**0.963**	0.918	0.911	0.931	0.923

Table C-6
5G mmW NR Hotspot Total Exposure Ratio - Closed

		psPD	2.4 GHz WLAN Ant 2 Reported SAR	2.4 GHz WLAN MIMO Reported SAR	Bluetooth Ant 1 Reported SAR	Bluetooth Ant 2 Reported SAR	5 GHz WLAN Ant 1 Reported SAR	5 GHz WLAN MIMO Reported SAR	psPD + 2.4 GHz WLAN MIMO	psPD + BT Ant 1	psPD + BT Ant 2	psPD + 5 GHz WLAN Ant 1	psPD + 5 GHz WLAN MIMO	psPD + 2.4 GHz WLAN MIMO + 5 GHz WLAN MIMO	psPD + 2.4 GHz WLAN Ant 2 + BT Ant 1	psPD + 2.4 GHz WLAN Ant 2 + BT Ant 1 + 5 GHz WLAN Ant 1	psPD + 2.4 GHz WLAN Ant 2 + BT Ant 1 + 5 GHz WLAN MIMO	psPD + BT Ant 1 + 5GHz WLAN Ant 1	psPD + BT Ant 2 + 5GHz WLAN Ant 1	psPD + BT Ant 1 + 5GHz WLAN MIMO	psPD + BT Ant 2 + 5 GHz WLAN MIMO
			14.0 dBm	17.0 dBm	13.0 dBm	13.0 dBm	14.0 dBm	17.0 dBm													
		mW/cm²	W/kg	W/kg	W/kg	W/kg	W/kg	W/kg													
		1	3	4	5	6	7	8	1 + 4	1 + 5	1 + 6	1 + 7	1 + 8	1 + 4 + 8	1 + 3 + 5	1 + 3 + 5 + 7	1 + 3 + 5 + 8	1 + 5 + 7	1 + 6 + 7	1 + 5 + 8	1 + 6 + 8
Applicable Limit		1.0	1.6	1.6	1.6	1.6	1.6	1.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Back Side	Reported Value	0.269	0.149	0.182	0.029	0.035	0.062	0.273													
	Ratio to Limit	0.269	0.093	0.114	0.018	0.022	0.039	0.171	0.383	0.287	0.291	0.308	0.440	0.553	0.380	0.419	0.551	0.326	0.330	0.458	0.462
Front Side	Reported Value	0.645	0.087	0.132	0.112	0.112	0.054	0.263													
	Ratio to Limit	0.645	0.054	0.083	0.070	0.070	0.034	0.164	0.728	0.715	0.715	0.679	0.809	0.892	0.769	0.803	**0.934**	0.749	0.749	0.879	0.879
Top Edge	Reported Value	0.367	0.000	0.000	0.000	0.000	0.000	0.000													
	Ratio to Limit	0.367	0.000	0.000	0.000	0.000	0.000	0.000	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367	0.367
Bottom Edge	Reported Value	0.094	0.149	0.182	0.056	0.089	0.062	0.140													
	Ratio to Limit	0.094	0.093	0.114	0.035	0.056	0.039	0.088	0.208	0.129	0.150	0.133	0.182	0.295	0.222	0.261	0.310	0.168	0.188	0.217	0.237
Right Edge	Reported Value	0.140	0.000	0.182	0.032	0.000	0.062	0.019													
	Ratio to Limit	0.140	0.000	0.114	0.020	0.000	0.039	0.012	0.254	0.160	0.140	0.179	0.152	0.266	0.160	0.199	0.172	0.199	0.179	0.172	0.152
Left Edge	Reported Value	0.633	0.149	0.182	0.000	0.110	0.000	0.273													
	Ratio to Limit	0.633	0.093	0.114	0.000	0.069	0.000	0.171	0.747	0.633	0.702	0.633	0.804	0.917	0.726	0.726	0.897	0.633	0.702	0.804	0.872

Table C-7
5G mmW NR Hotspot Total Exposure Ratio - Open

		psPD	2.4 GHz WLAN Ant 2 Reported SAR	2.4 GHz WLAN MIMO Reported SAR	Bluetooth Ant 1 Reported SAR	Bluetooth Ant 2 Reported SAR	5 GHz WLAN Ant 1 Reported SAR	5 GHz WLAN MIMO Reported SAR	psPD + 2.4 GHz WLAN MIMO	psPD + BT Ant 1	psPD + BT Ant 2	psPD + 5 GHz WLAN Ant 1	psPD + 5 GHz WLAN MIMO	psPD + 2.4 GHz WLAN MIMO + 5 GHz WLAN MIMO	psPD + 2.4 GHz WLAN Ant 2 + BT Ant 1	psPD + 2.4 GHz WLAN Ant 2 + BT Ant 1 + 5 GHz WLAN Ant 1	psPD + 2.4 GHz WLAN Ant 2 + BT Ant 1 + 5 GHz WLAN MIMO	psPD + BT Ant 1 + 5GHz WLAN Ant 1	psPD + BT Ant 2 + 5GHz WLAN Ant 1	psPD + BT Ant 1 + 5GHz WLAN MIMO	psPD + BT Ant 2 + 5 GHz WLAN MIMO
			14.0 dBm	17.0 dBm	15.0 dBm	16.0 dBm	14.0 dBm	17.0 dBm													
		mW/cm²	W/kg	W/kg	W/kg	W/kg	W/kg	W/kg													
		1	3	4	5	6	7	8	1 + 4	1 + 5	1 + 6	1 + 7	1 + 8	1 + 4 + 8	1 + 3 + 5	1 + 3 + 5 + 7	1 + 3 + 5 + 8	1 + 5 + 7	1 + 6 + 7	1 + 5 + 8	1 + 6 + 8
Applicable Limit		1.0	1.6	1.6	1.6	1.6	1.6	1.6	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
Back Side	Reported Value	0.794	0.058	0.089	0.153	0.133	0.000	0.067													
	Ratio to Limit	0.794	0.036	0.056	0.096	0.083	0.000	0.042	0.850	0.890	0.877	0.794	0.836	0.892	0.926	0.926	**0.968**	0.890	0.877	0.932	0.919
Front Side	Reported Value	0.562	0.069	0.079	0.101	0.157	0.000	0.068													
	Ratio to Limit	0.562	0.043	0.049	0.063	0.098	0.000	0.043	0.611	0.625	0.660	0.562	0.605	0.654	0.668	0.668	0.711	0.625	0.660	0.668	0.703
Top Edge	Reported Value	0.073	0.086	0.067	0.065	0.098	0.022	0.055													
	Ratio to Limit	0.073	0.054	0.042	0.041	0.061	0.014	0.034	0.115	0.114	0.134	0.087	0.107	0.149	0.167	0.181	0.202	0.127	0.148	0.148	0.169
Bottom Edge	Reported Value	0.042	0.000	0.000	0.000	0.000	0.000	0.000													
	Ratio to Limit	0.042	0.000	0.000	0.000	0.000	0.000	0.000	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042	0.042
Right Edge	Reported Value	0.136	0.000	0.023	0.033	0.000	0.002	0.007													
	Ratio to Limit	0.136	0.000	0.014	0.021	0.000	0.001	0.004	0.150	0.157	0.136	0.137	0.140	0.155	0.157	0.158	0.161	0.158	0.137	0.161	0.140
Left Edge	Reported Value	0.794	0.074	0.079	0.000	0.166	0.000	0.078													
	Ratio to Limit	0.794	0.046	0.049	0.000	0.104	0.000	0.049	0.843	0.794	0.898	0.794	0.843	0.892	0.840	0.840	0.889	0.794	0.898	0.843	0.947

Table C-8
5G mmW NR Phablet Total Exposure Ratio - Open

		psPD	5 GHz WLAN Ant 1 Reported SAR	5 GHz WLAN MIMO Reported SAR	psPD + 5 GHz WLAN Ant 1	psPD + 5 GHz WLAN MIMO
			14.0 dBm	17.0 dBm		
		mW/cm²	W/kg	W/kg		
		1	2	3	1 + 2	1 + 3
Applicable Limit		1.0	4.0	4.0	1.0	1.0
Back Side	Reported Value	0.794	0.196	0.419		
	Ratio to Limit	0.794	0.049	0.105	0.843	0.899
Front Side	Reported Value	0.562	0.196	0.662		
	Ratio to Limit	0.562	0.049	0.166	0.611	0.728
Top Edge	Reported Value	0.073	0.166	0.662		
	Ratio to Limit	0.073	0.042	0.166	0.115	0.239
Bottom Edge	Reported Value	0.042	0.000	0.000		
	Ratio to Limit	0.042	0.000	0.000	0.042	0.042
Right Edge	Reported Value	0.136	0.196	0.662		
	Ratio to Limit	0.136	0.049	0.166	0.185	0.302
Left Edge	Reported Value	0.794	0.000	0.662		
	Ratio to Limit	0.794	0.000	0.166	0.794	**0.960**

Notes:

1. Worst-case power density results for each test configuration among all antenna arrays and among all supported bands were considered for TER analysis.
2. If test positions were not required to be evaluated for WLAN SAR per FCC KDB publication 248227, the worst-case WLAN SAR result for the applicable exposure conditions was used for simultaneous transmission analysis. Any such values are indicated in the above tables in blue.
3. If Part 1 SAR report does not include standalone WLAN MIMO results, then per KDB Publication 248227 D01v02r02, SAR for MIMO was evaluated by following the simultaneous SAR provisions from KDB Publication 447498 D01v06 by evaluating the sum of the 1g SAR values of each antenna transmitting independently. Any such values are indicated in the above tables in green.
4. When additional sides were tested at a distance greater than 2mm for hotspot and body-worn configurations, those power density results were used for TER. Otherwise, power density results at 2mm were considered as a more conservative evaluation.
5. Per FCC guidance, the bands/modes that are not required to be evaluated for Phablet SAR are not considered for TER analysis.
6. Per FCC guidance, for power density measurements, a test separation distance of 2 mm was used for phablet configuration due to probe restraints.
7. Beams with highest adjustment factor were evaluated at 2mm front side to demonstrate that measured psPD for front side was low and head exposure conditions would not exceed FCC TER limit. Front side with worst case psPD adjustment factor of the remaining beams was used for head TER analysis.
8. The worst-case between Adjusted Reported_psPD and Measured Total psPD was chosen for TER analysis. The bolded psPD values in Table C-1 indicate the worst-case Reported psPD used in TER analysis.
9. In WLAN MIMO operations, each antenna transmits at target powers to achieve the MIMO target powers as indicated above.

The above numerical summed PD and SAR for all the worst-case simultaneous transmission conditions were below the Total Exposure Ratio. Therefore, the above analysis is sufficient to determine no further test cases are required and that simultaneous transmission is compliant to the FCC RF Exposure Limit.

Mathematical Derivation of TER Compliance

$$Total\ Normalized\ RFx\ =\ Normalized\ RFx_{\ Time\ Averaged\ WWAN} + Normalized\ RFx_{\ WLAN}\ \leq\ 1.0 \quad (1)$$

Since WWAN Smart Transmit algorithm adds directly the time-averaged RF exposure from 4G and time-averaged RF exposure from 5G mmW NR, per chipset manufacturer's guidance, Normalized RF exposure from 4G and from 5G mmW NR could be assumed as

$$Normalized\ RFx_{\ Time\ Averaged\ WWAN} = \frac{4G\ SAR}{4G\ SAR\ Limit} + \frac{5G\ mmW\ NR\ psPD}{5G\ mmW\ NR\ psPD\ Limit} \leq 1.0 \quad (2)$$

Smart Transmit algorithm assumes that 4G and 5G mmW NR hotspots are co-located and therefore:

$$Time\ Averaged\ WWAN = [\ x(t) \times A] + [(1\text{-}x(t)) \times B] \leq 1.0\ Normalized\ Limit \quad (3)$$

A = Max normalized time-averaged SAR exposure from 4G
B = Max normalized time-averaged PD exposure from 5G mmW NR

x(t) = Ranges between [0,1]
x(t)× A = Percentage of normalized time-averaged RF exposure from 4G
(1-x(t))× B = Remaining percentage of RF exposure contribution from 5G mmW NR

Smart Transmit controls "*x*" in real time such that the sum of these exposures never exceeds 1.0 Normalized Limit. If the equations below (4a, 4b) are proven, then, mathematically equation (5) would be proven.

$$A\ +\ norm.\ SAR\ from\ WLAN \leq 1.0\ normalized\ limit \quad (4a)$$

$$B\ +\ norm.\ SAR\ from\ WLAN \leq 1.0\ normalized\ limit \quad (4b)$$

$$[x(t)\times A] + [(1-x(t))\times B] +\ norm.\ SAR\ from\ WLAN \leq 1.0\ normalized\ limit \quad (5)$$

Without 5G mmW NR, Smart Transmit limits the maximum RF exposure contributed from 4G to 100% normalized exposure. For this device, the manufacturer has added an additional permanent back-off (indicated below as WWAN backoff) for every beam in the calculations for input.power.limits used in the EFS file. Therefore,

$$Smart\ Tx\ WWAN:\ A = max\ (normalized\ SAR\ exposure\ from\ 4G) \leq 1.0\ normalized\ limit \quad (6a)$$

$$Smart\ Tx\ WWAN:\ B = max\ (normalized\ PD\ exposure\ from\ 5G\ mmW\ NR) x 10^{(-WWAN\ backoff\ in\ dB)/10} \leq 1.0\ normalized\ limit \quad (6b)$$

To demonstrate simultaneous transmission compliance in equation (1), below equations (7a & 7b) obtained by combining equations (4a & 4b) and (6a & 6b), should be proven for simultaneous transmission compliance:

$$Total\ Normalized\ RFx\ =\ Normalized\ SAR_{\ 4G\ WWAN} + Normalized\ SAR_{\ WLAN} < 1.0 \quad (7a)$$

$$Total\ Normalized\ RFx\ =\ 10^{(-WWAN\ backoff\ in\ dB)/10} x\ Normalized\ psPD_{\ 5G\ mmW\ NR\ WWAN} + Normalized\ SAR_{\ WLAN} < 1.0 \quad (7b)$$

which are re-written as:

$$Total\ Normalized\ RFx\ =\ \frac{4G\ SAR}{4G\ SAR\ Limit} + \frac{WLAN\ SAR}{WLAN\ SAR\ Limit} < 1 \quad (8a)$$

$$Total\ Normalized\ RFx\ =\ 10^{(-WWAN\ backoff\ in\ dB)/10} * \frac{5G\ mmW\ NR\ psPD}{5G\ mmW\ NR\ psPD\ Limit} + \frac{WLAN\ SAR}{WLAN\ SAR\ Limit} < 1 \quad (8b)$$

Analysis for equation (8a) is performed in Section 12 of FCC SAR Evaluation Report (Part 1). Analysis for equation (8b) is performed in this appendix.