APPENDIX G: POWER REDUCTION VERIFICATION

Per the May 2017 TCBC Workshop Notes, demonstration of proper functioning of the power reduction mechanisms is required to support the corresponding SAR configurations. The verification process was divided into two parts: (1) evaluation of output power levels for individual or multiple triggering mechanisms and (2) evaluation of the triggering distances for proximity-based sensors.

G.1 Power Verification Procedure

The power verification was performed according to the following procedure:

1. A base station simulator was used to establish a conducted RF connection and the output power was monitored. The power measurements were confirmed to be within expected tolerances for all states before and after a power reduction mechanism was triggered.

2. Step 1 was repeated for all relevant modes and frequency bands for the mechanism being investigated.

3. Steps 1 and 2 were repeated for all individual power reduction mechanisms and combinations thereof. For the combination cases, one mechanism was switched to a 'triggered' state at a time; powers were confirmed to be within tolerances after each additional mechanism was activated.

4. For licensed modes, the device state index as displayed on the device UI was recorded before and after the mechanism was triggered.

G.2 Distance Verification Procedure

The distance verification procedure was performed according to the following procedure:

1. A base station simulator was used to establish an RF connection and to monitor the power levels. The device being tested was placed below the relevant section of the phantom with the relevant side or edge of the device facing toward the phantom.

2. The device was moved toward and away from the phantom to determine the distance at which the mechanism triggers and the output power is reduced, per KDB Publication 616217 D04v01r02 and FCC Guidance. Each applicable test position was evaluated. The distances were confirmed to be the same or larger (more conservative) than the minimum distances provided by the manufacturer.

3. Steps 1 and 2 were repeated for low, mid, and high bands, as appropriate (see note below for more details).

4. Steps 1 through 3 were repeated for all distance-based power reduction mechanisms.

5. For licensed modes, the device state index on the device UI was monitored to determine the triggering state.

G.3 Main Antenna Verification Summary

Table G-1
Power Measurement Verification for Licensed Modes Folder Closed

Mechanism(s)			Mode/Band	Device State Index (DSI)			
1st	2nd	3rd		Free Space	Mechanism #1	Mechanism #2	Mechanism #3
Hotspot On	Grip		GPRS 1900 1 Tx Slot	1	7	3	
Grip	Hotspot On		GPRS 1900 1 Tx Slot	1	3	3	
Hotspot On	Grip		UMTS 1750	1	7	3	
Grip	Hotspot On		UMTS 1750	1	3	3	
Hotspot On	Grip		UMTS 1900	1	7	3	
Grip	Hotspot On		UMTS 1900	1	3	3	
Hotspot On	Grip		LTE Band 66 Ant B	1	7	3	
Grip	Hotspot On		LTE Band 66 Ant B	1	3	3	
Hotspot On	Grip		LTE Band 4 Ant B	1	7	3	
Grip	Hotspot On		LTE Band 4 Ant B	1	3	3	
Hotspot On	Grip		LTE Band 25 Ant B	1	7	3	
Grip	Hotspot On		LTE Band 25 Ant B	1	3	3	
Hotspot On	Grip		LTE Band 2 Ant B	1	7	3	
Grip	Hotspot On		LTE Band 2 Ant B	1	3	3	
Hotspot On	Grip		LTE Band 41 Ant B	1	7	3	
Grip	Hotspot On		LTE Band 41 Ant B	1	3	3	
Hotspot On	Grip		LTE Band 41 PC2 Ant B	1	7	3	
Grip	Hotspot On		LTE Band 41 PC2 Ant B	1	3	3	
Hotspot On	Grip	Held-to-Ear	LTE Band 66 Ant F	1	7	3	5
Hotspot On	Held-to-Ear	Grip	LTE Band 66 Ant F	1	7	5	5
Grip	Hotspot On	Held-to-Ear	LTE Band 66 Ant F	1	3	3	5
Grip	Held-to-Ear	Hotspot On	LTE Band 66 Ant F	1	3	5	5
Held-to-Ear	Hotspot On	Grip	LTE Band 66 Ant F	1	5	5	5
Held-to-Ear	Grip	Hotspot On	LTE Band 66 Ant F	1	5	5	5
Hotspot On	Grip	Held-to-Ear	LTE Band 4 Ant F	1	7	3	5
Hotspot On	Held-to-Ear	Grip	LTE Band 4 Ant F	1	7	5	5
Grip	Hotspot On	Held-to-Ear	LTE Band 4 Ant F	1	3	3	5
Grip	Held-to-Ear	Hotspot On	LTE Band 4 Ant F	1	3	5	5
Held-to-Ear	Hotspot On	Grip	LTE Band 4 Ant F	1	5	5	5
Held-to-Ear	Grip	Hotspot On	LTE Band 4 Ant F	1	5	5	5
Hotspot On	Grip		NR FDD Band n66 Ant B	1	7	3	
Grip	Hotspot On		NR FDD Band n66 Ant B	1	3	3	
Hotspot On	Grip		NR FDD Band n25 Ant B	1	7	3	
Grip	Hotspot On		NR FDD Band n25 Ant B	1	3	3	
Hotspot On	Grip		NR FDD Band n2 Ant B	1	7	3	
Grip	Hotspot On		NR FDD Band n2 Ant B	1	3	3	
Hotspot On	Grip	Held-to-Ear	NR FDD Band n66 Ant F	1	7	3	5
Hotspot On	Held-to-Ear	Grip	NR FDD Band n66 Ant F	1	7	5	5
Grip	Hotspot On	Held-to-Ear	NR FDD Band n66 Ant F	1	3	3	5
Grip	Held-to-Ear	Hotspot On	NR FDD Band n66 Ant F	1	3	5	5
Held-to-Ear	Hotspot On	Grip	NR FDD Band n66 Ant F	1	5	5	5
Held-to-Ear	Grip	Hotspot On	NR FDD Band n66 Ant F	1	5	5	5

*Note: This device uses different Device State Indices (DSI) to configure different time averaged power levels based on certain exposure scenarios. For this device in the closed configuration, DSI = 3 represents the case when the grip sensor is active, DSI = 5 represents the case where the device is held to ear, and DSI = 7 represents the case when hotspot mode is active. DSI = 1 is configured when the device cannot detect the use condition.

Table G-2
Power Measurement Verification for Licensed Modes Folder Open

Mechanism(s)			Mode/Band	Device State Index (DSI)			
1st	2nd	3rd		Free Space	Mechanism #1	Mechanism #2	Mechanism #3
Hotspot On	Grip		GPRS 1900 1 Tx Slot	0	6	2	
Grip	Hotspot On		GPRS 1900 1 Tx Slot	0	2	2	
Hotspot On	Grip		UMTS 1750	0	6	2	
Grip	Hotspot On		UMTS 1750	0	2	2	
Hotspot On	Grip		UMTS 1900	0	6	2	
Grip	Hotspot On		UMTS 1900	0	2	2	
Hotspot On	Grip		LTE Band 66 Ant B	0	6	2	
Grip	Hotspot On		LTE Band 66 Ant B	0	2	2	
Hotspot On	Grip		LTE Band 4 Ant B	0	6	2	
Grip	Hotspot On		LTE Band 4 Ant B	0	2	2	
Hotspot On	Grip		LTE Band 25 Ant B	0	6	2	
Grip	Hotspot On		LTE Band 25 Ant B	0	2	2	
Hotspot On	Grip		LTE Band 2 Ant B	0	6	2	
Grip	Hotspot On		LTE Band 2 Ant B	0	2	2	
Hotspot On	Grip		LTE Band 41 Ant B	0	6	2	
Grip	Hotspot On		LTE Band 41 Ant B	0	2	2	
Hotspot On	Grip		LTE Band 41 PC2 Ant B	0	6	2	
Grip	Hotspot On		LTE Band 41 PC2 Ant B	0	2	2	
Hotspot On	Grip	Held-to-Ear	LTE Band 4 Ant F	0	6	2	4
Hotspot On	Held-to-Ear	Grip	LTE Band 4 Ant F	0	6	4	4
Grip	Hotspot On	Held-to-Ear	LTE Band 4 Ant F	0	2	2	4
Grip	Held-to-Ear	Hotspot On	LTE Band 4 Ant F	0	2	4	4
Held-to-Ear	Hotspot On	Grip	LTE Band 4 Ant F	0	4	4	4
Held-to-Ear	Grip	Hotspot On	LTE Band 4 Ant F	0	4	4	4
Hotspot On	Grip		NR FDD Band n66 Ant B	0	6	2	
Grip	Hotspot On		NR FDD Band n66 Ant B	0	2	2	
Hotspot On	Grip		NR FDD Band n25 Ant B	0	6	2	
Grip	Hotspot On		NR FDD Band n25 Ant B	0	2	2	
Hotspot On	Grip		NR FDD Band n2 Ant B	0	6	2	
Grip	Hotspot On		NR FDD Band n2 Ant B	0	2	2	
Hotspot On	Grip	Held-to-Ear	NR FDD Band n66 Ant F	0	6	2	4
Hotspot On	Held-to-Ear	Grip	NR FDD Band n66 Ant F	0	6	4	4
Grip	Hotspot On	Held-to-Ear	NR FDD Band n66 Ant F	0	2	2	4
Grip	Held-to-Ear	Hotspot On	NR FDD Band n66 Ant F	0	2	4	4
Held-to-Ear	Hotspot On	Grip	NR FDD Band n66 Ant F	0	4	4	4
Held-to-Ear	Grip	Hotspot On	NR FDD Band n66 Ant F	0	4	4	4

*Note: This device uses different Device State Indices (DSI) to configure different time averaged power levels based on certain exposure scenarios. For this device in the open configuration, DSI = 2 represents the case when the grip sensor is active, DSI = 4 represents the case where the device is held to ear, and DSI = 6 represents the case when hotspot mode is active. DSI = 0 is configured when the device cannot detect the use condition.

Table G-3
Distance Measurement Verification for Main Antenna Folder Closed

Mechanism(s)	Test Condition	Band	Distance Measurements (mm)		Minimum Distance per Manufacturer (mm)
			Moving Toward	Moving Away	
Grip	Phablet - Back Side	Mid	14	19	13
Grip	Phablet - Back Side	High	13	19	13
Grip	Phablet - Bottom Edge	Mid	15	20	15
Grip	Phablet - Bottom Edge	High	15	19	15

Table G-4
Distance Measurement Verification for Main Antenna Folder Open

Mechanism(s)	Test Condition	Band	Distance Measurements (mm)		Minimum Distance per Manufacturer (mm)
			Moving Toward	Moving Away	
Grip	UMPC - Back Side	Mid	16	18	15
Grip	UMPC - Back Side	High	16	19	15
Grip	UMPC - Front Side	Mid	13	17	13
Grip	UMPC - Front Side	High	14	19	13
Grip	UMPC - Bottom Edge	Mid	20	22	19
Grip	UMPC - Bottom Edge	High	19	21	19

*Note: Mid band refers to: GSM1900, UMTS B2/4, LTE Antenna B B2/4/25/66, NR Antenna B Band n66/25/2; High band refers to: LTE Antenna B B41.

G.4 WIFI Verification Summary

Table G-5
Power Measurement Verification WIFI Antenna 1 Held to Ear

Mechanism(s)	Mode/Band	Conducted Power (dBm)	
1st		Un-triggered (Max)	Mechanism #1 (Reduced)
Held-to-Ear	802.11b	18.83	12.85
Held-to-Ear	802.11g	17.66	12.71
Held-to-Ear	802.11n (2.4GHz)	17.60	12.69
Held-to-Ear	802.11a	17.22	11.67
Held-to-Ear	802.11n (5GHz, 20MHz BW)	17.15	11.58
Held-to-Ear	802.11ac (20MHz BW)	17.11	11.65
Held-to-Ear	802.11n (5GHz, 40MHz BW)	17.00	11.73
Held-to-Ear	802.11ac (40MHz BW)	16.26	11.93
Held-to-Ear	802.11ac (80MHz BW)	15.04	11.45
Held-to-Ear	802.11ac (160MHz BW)	14.79	11.23

*Note: IEEE 802.11ax and MIMO WIFI modes were not evaluated due to equipment limitations. 802.11a, 802.11n, and 802.11ac 5 GHz WIFI only operate in MIMO, and these SISO powers were taken during MIMO Conditions.

Table G-6
Power Measurement Verification WIFI Antenna 2 Held to Ear

Mechanism(s)	Mode/Band	Conducted Power (dBm)	
1st		Un-triggered (Max)	Mechanism #1 (Reduced)
Held-to-Ear	802.11b	18.59	12.95
Held-to-Ear	802.11g	17.87	12.98
Held-to-Ear	802.11n (2.4GHz)	17.86	12.99
Held-to-Ear	802.11a	16.85	11.04
Held-to-Ear	802.11n (5GHz, 20MHz BW)	17.02	11.01
Held-to-Ear	802.11ac (20MHz BW)	16.91	11.13
Held-to-Ear	802.11n (5GHz, 40MHz BW)	16.83	11.45
Held-to-Ear	802.11ac (40MHz BW)	16.91	11.34
Held-to-Ear	802.11ac (80MHz BW)	15.14	10.98
Held-to-Ear	802.11ac (160MHz BW)	14.91	11.01

*Note: IEEE 802.11ax and MIMO WIFI modes were not evaluated due to equipment limitations. 802.11a, 802.11n, and 802.11ac 5 GHz WIFI only operate in MIMO, and these SISO powers were taken during MIMO Conditions.

Table G-7
Power Measurement Verification 2.4 GHz WIFI Antenna 1 with NR Active

Mode/Band	Conducted Power (dBm)		
	Un-triggered (Max)	Mechanism #1 NR Active (Reduced)	Mechanism #2 RCV and NR FR1 Active (Reduced)
802.11b	18.30	14.02	11.81
802.11g	17.20	13.69	11.47
802.11n (2.4GHz)	17.15	13.67	11.44

*Note: IEEE 802.11ax and MIMO WIFI modes were not evaluated due to equipment limitations.

Table G-8
Power Measurement Verification 5GHz WIFI Antenna 1 with NR Active

Mode/Band	Conducted Power (dBm)		
	Un-triggered (Max)	Mechanism #1 NR Active (Reduced)	Mechanism #2 RCV and NR Active (Reduced)
802.11a	17.23	14.53	11.30
802.11n (5GHz, 20MHz BW)	17.16	14.47	11.25
802.11ac (20MHz BW)	17.15	14.47	11.24
802.11n (5GHz, 40MHz BW)	15.59	13.69	10.52
802.11ac (40MHz BW)	15.48	13.73	10.58
802.11ac (80MHz BW)	14.65	13.60	10.83
802.11ac (160MHz BW)	14.79	13.99	10.95

*Note: IEEE 802.11ax and MIMO WIFI modes were not evaluated due to equipment limitations. 802.11a, 802.11n, and 802.11ac 5 GHz WIFI only operate in MIMO, and these SISO powers were taken during MIMO Conditions.

Table G-9
Power Measurement Verification 2.4 GHz WIFI Antenna 2 with NR Active

Mode/Band	Conducted Power (dBm)		
	Un-triggered (Max)	Mechanism #1 NR Active (Reduced)	Mechanism #2 RCV and NR FR1 Active (Reduced)
802.11b	18.12	13.68	11.50
802.11g	16.83	13.38	11.56
802.11n (2.4GHz)	16.75	13.36	11.19

*Note: IEEE 802.11ax and MIMO WIFI modes were not evaluated due to equipment limitations.

Table G-10
Power Measurement Verification 5 GHz WIFI Antenna 2 with NR Active

Mode/Band	Conducted Power (dBm)		
	Un-triggered (Max)	Mechanism #1 NR Active (Reduced)	Mechanism #2 RCV and NR Active (Reduced)
802.11a	17.47	14.43	11.49
802.11n (5GHz, 20MHz BW)	17.37	14.77	11.27
802.11ac (20MHz BW)	17.47	14.75	11.38
802.11n (5GHz, 40MHz BW)	15.92	14.01	10.89
802.11ac (40MHz BW)	16.02	13.98	10.83
802.11ac (80MHz BW)	14.97	14.10	10.85
802.11ac (160MHz BW)	15.47	14.57	11.51

*Note: IEEE 802.11ax and MIMO WIFI modes were not evaluated due to equipment limitations. 802.11a, 802.11n, and 802.11ac 5 GHz WIFI only operate in MIMO, and these SISO powers were taken during MIMO Conditions.

G.5 Bluetooth Verification Summary

Table G-11
Power Measurement Verification Bluetooth Antenna 1

Mechanism(s)	Mode/Band	Conducted Power (dBm)	
1st		Un-triggered (Max)	Mechanism #1 (Reduced)
Held-to-Ear	Bluetooth	18.84	11.30
NR Active	Bluetooth		14.20
5/6 GHz WLAN Active	Bluetooth		14.73

Table G-12
Power Measurement Verification Bluetooth Antenna 2

Mechanism(s)	Mode/Band	Conducted Power (dBm)	
1st		Un-triggered (Max)	Mechanism #1 (Reduced)
Held-to-Ear	Bluetooth	15.35	9.14
NR Active	Bluetooth		12.06
5/6 GHz WLAN Active	Bluetooth		11.92