

APPENDIX F: 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.

F.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.

F.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 Table F-2 for more details).
4. Steps 1 through 3 were repeated for all distance-based power reduction mechanisms.

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F.3 Main Antenna Verification Summary

Table F-1
Power Measurement Verification for Main Antenna

Mechanism(s)		Mode/Band	Device State index (DSI)		
1st	2nd		Free Space	Mechanism #1	Mechanism #2
Hotspot On		GPRS 1900 1 Tx Slot	0	3	
Hotspot On		UMTS 1750	0	3	
Grip		UMTS 1750	0	1	
Hotspot On	Grip	UMTS 1750	0	3	3
Grip	Hotspot On	UMTS 1750	0	1	3
Hotspot On		UMTS 1900	0	3	
Grip		UMTS 1900	0	1	
Hotspot On	Grip	UMTS 1900	0	3	3
Grip	Hotspot On	UMTS 1900	0	1	3
Hotspot On		LTE Band 66 Ant A	0	3	
Grip		LTE Band 66 Ant A	0	1	
Hotspot On	Grip	LTE Band 66 Ant A	0	3	3
Grip	Hotspot On	LTE Band 66 Ant A	0	1	3
Held-to-Ear		LTE Band 66 Ant F	0	2	
Hotspot On		LTE Band 4 Ant A	0	3	
Grip		LTE Band 4 Ant A	0	1	
Hotspot On	Grip	LTE Band 4 Ant A	0	3	3
Grip	Hotspot On	LTE Band 4 Ant A	0	1	3
Held-to-Ear		LTE Band 4 Ant F	0	2	
Hotspot On		LTE Band 25 Ant A	0	3	
Grip		LTE Band 25 Ant A	0	1	
Hotspot On	Grip	LTE Band 25 Ant A	0	3	3
Grip	Hotspot On	LTE Band 25 Ant A	0	1	3
Held-to-Ear		LTE Band 25 Ant F	0	2	
Hotspot On		LTE Band 2 Ant A	0	3	
Grip		LTE Band 2 Ant A	0	1	
Hotspot On	Grip	LTE Band 2 Ant A	0	3	3
Grip	Hotspot On	LTE Band 2 Ant A	0	1	3
Held-to-Ear		LTE Band 2 Ant F	0	2	
Hotspot On		LTE Band 30 Ant A	0	3	
Grip		LTE Band 30 Ant A	0	1	
Hotspot On	Grip	LTE Band 30 Ant A	0	3	3
Grip	Hotspot On	LTE Band 30 Ant A	0	1	3
Held-to-Ear		LTE Band 30 Ant F	0	2	
Hotspot On		LTE Band 7 Ant B	0	3	
Grip		LTE Band 7 Ant B	0	1	
Hotspot On	Grip	LTE Band 7 Ant B	0	3	3
Grip	Hotspot On	LTE Band 7 Ant B	0	1	3
Held-to-Ear		LTE Band 7 Ant F	0	2	
Hotspot On		LTE Band 41 PC3 Ant B	0	3	
Grip		LTE Band 41 PC3 Ant B	0	1	
Hotspot On	Grip	LTE Band 41 PC3 Ant B	0	3	3
Grip	Hotspot On	LTE Band 41 PC3 Ant B	0	1	3
Hotspot On		LTE Band 41 PC2 Ant B	0	3	
Grip		LTE Band 41 PC2 Ant B	0	1	
Hotspot On	Grip	LTE Band 41 PC2 Ant B	0	3	3
Grip	Hotspot On	LTE Band 41 PC2 Ant B	0	1	3
Held-to-Ear		LTE Band 41 PC3 Ant F	0	2	
Held-to-Ear		LTE Band 41 PC2 Ant F	0	2	
Hotspot On		LTE Band 38 Ant B	0	3	
Grip		LTE Band 38 Ant B	0	1	
Hotspot On	Grip	LTE Band 38 Ant B	0	3	3
Grip	Hotspot On	LTE Band 38 Ant B	0	1	3
Held-to-Ear		LTE Band 38 Ant F	0	2	
Held-to-Ear		LTE Band 48	0	2	
Hotspot On		NR FDD Band n66 Ant A	0	3	
Grip		NR FDD Band n66 Ant A	0	1	
Hotspot On	Grip	NR FDD Band n66 Ant A	0	3	3
Grip	Hotspot On	NR FDD Band n66 Ant A	0	1	3
Hotspot On		NR FDD Band n25 Ant A	0	3	
Grip		NR FDD Band n25 Ant A	0	1	
Hotspot On	Grip	NR FDD Band n25 Ant A	0	3	3
Grip	Hotspot On	NR FDD Band n25 Ant A	0	1	3
Hotspot On		NR FDD Band n2 Ant A	0	3	
Grip		NR FDD Band n2 Ant A	0	1	
Hotspot On	Grip	NR FDD Band n2 Ant A	0	3	3
Grip	Hotspot On	NR FDD Band n2 Ant A	0	1	3
Hotspot On		NR FDD Band n7 Ant B	0	3	
Grip		NR FDD Band n7 Ant B	0	1	
Hotspot On	Grip	NR FDD Band n7 Ant B	0	3	3
Grip	Hotspot On	NR FDD Band n7 Ant B	0	1	3
Hotspot On		NR FDD Band n30 Ant A	0	3	
Grip		NR FDD Band n30 Ant A	0	1	
Hotspot On	Grip	NR FDD Band n30 Ant A	0	3	3
Grip	Hotspot On	NR FDD Band n30 Ant A	0	1	3

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Mechanism(s)	Mode/Band	Device State index (DSI)	
1st		Free Space	Mechanism #1
Held-to-Ear	NR FDD Band n26 Ant A	0	2
Held-to-Ear	NR FDD Band n5 Ant A	0	2
Held-to-Ear	NR FDD Band n66 Ant F	0	2
Held-to-Ear	NR FDD Band n2 Ant F	0	2
Held-to-Ear	NR FDD Band n25 Ant F	0	2
Held-to-Ear	NR FDD Band n30 Ant F	0	2
Held-to-Ear	NR FDD Band n7 Ant F	0	2
Held-to-Ear	NR TDD Band n38 Ant F	0	2
Held-to-Ear	NR TDD Band n41 (PC2) Ant F Path 1	0	2
Held-to-Ear	NR TDD Band n41 (PC2) Ant E Path 1	0	2
Held-to-Ear	NR TDD Band n41 (PC2) Ant F Path 2	0	2
Held-to-Ear	NR TDD Band n41 (PC2) Ant E Path 2	0	2
Held-to-Ear	NR TDD Band n48 Ant F	0	2
Held-to-Ear	NR TDD Band n48 Ant I	0	2
Held-to-Ear	NR TDD Band n77 (PC2) C Band Ant F	0	2
Held-to-Ear	NR TDD Band n77 (PC2) DoD Band Ant F	0	2

*Note: This device uses different Device State Indices (DSI) to configure different time averaged power levels based on certain exposure scenarios. For this device, DSI = 1 represents the case when the grip sensor is active, DSI = 2 represents the case where the device is held to ear, and DSI = 3 represents the case when hotspot mode is active. DSI = 0 is configured at max power when the device cannot detect the use condition.

Table F-2
Distance Measurement Verification for Main Antenna

Mechanism(s)	Test Condition	Band	Distance Measurements (mm)		Minimum Distance per Manufacturer (mm)
			Moving Toward	Moving Away	
Grip	Phablet - Back Side	Mid	9	14	9
Grip	Phablet - Back Side	High	9	14	9
Grip	Phablet - Front Side	Mid	8	14	7
Grip	Phablet - Front Side	High	8	14	7
Grip	Phablet - Bottom Edge	Mid	14	19	12
Grip	Phablet - Bottom Edge	High	14	19	12

*Note: Mid band refers to in AG0: UMTS B2/4, LTE B2/4/25/66, NR Band n2/25/66; High band refers to in AG0: LTE B7/30/38/41, NR Band n7/n30

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F.4 WIFI Verification Summary

Table F-3
Power Measurement Verification WIFI – Antenna 1

Mechanism(s)	Mode/Band	Conducted Power (dBm)	
1st		Un-triggered (Max)	Mechanism #1 (Reduced)
Held-to-Ear	802.11b	18.39	10.86
Held-to-Ear	802.11g	17.49	10.64
Held-to-Ear	802.11n (2.4GHz)	17.24	10.87
Held-to-Ear	802.11a	17.04	12.42
Held-to-Ear	802.11n (5GHz, 20MHz BW)	17.25	12.97
Held-to-Ear	802.11ac (20MHz BW)	17.46	12.70
Held-to-Ear	802.11n (5GHz, 40MHz BW)	16.24	13.04
Held-to-Ear	802.11ac (40MHz BW)	16.45	12.58
Held-to-Ear	802.11ac (80MHz BW)	15.24	12.65
Held-to-Ear	802.11ac (160MHz BW)	15.15	12.30

*Note: 802.11ax and MIMO WIFI modes were not evaluated due to equipment limitations. All SISO powers were taken during MIMO conditions.

Table F-4
Power Measurement Verification WIFI – Antenna 2

Mechanism(s)	Mode/Band	Conducted Power (dBm)	
1st		Un-triggered (Max)	Mechanism #1 (Reduced)
Held-to-Ear	802.11b	18.17	10.11
Held-to-Ear	802.11g	17.15	10.47
Held-to-Ear	802.11n (2.4GHz)	16.98	10.92
Held-to-Ear	802.11a	16.66	12.03
Held-to-Ear	802.11n (5GHz, 20MHz BW)	16.57	12.00
Held-to-Ear	802.11ac (20MHz BW)	16.75	12.13
Held-to-Ear	802.11n (5GHz, 40MHz BW)	15.95	12.50
Held-to-Ear	802.11ac (40MHz BW)	15.78	12.13
Held-to-Ear	802.11ac (80MHz BW)	14.54	12.27
Held-to-Ear	802.11ac (160MHz BW)	14.75	12.68

*Note: 802.11ax and MIMO WIFI modes were not evaluated due to equipment limitations. All SISO powers were taken during MIMO conditions.

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Table F-5
Power Measurement Verification WIFI with NR Active – Antenna 1

Mode/Band	Conducted Power (dBm)		
	Un-triggered (Max)	Mechanism #1 NR Active (Reduced)	Mechanism #2 RCV and NR Active (Reduced)
802.11b	18.39	16.48	9.38
802.11g	17.49	16.05	9.06
802.11n (2.4GHz)	17.24	15.94	8.86
802.11a	17.04	12.73	9.55
802.11n (5GHz, 20MHz BW)	17.25	12.47	9.21
802.11ac (20MHz BW)	17.46	12.84	9.38
802.11n (5GHz, 40MHz BW)	16.24	12.67	9.27
802.11ac (40MHz BW)	16.45	12.65	9.87
802.11ac (80MHz BW)	15.24	12.38	9.56
802.11ac (160MHz BW)	15.15	12.86	9.47

*Note: 802.11ax and MIMO WIFI modes were not evaluated due to equipment limitations. All SISO powers were taken during MIMO conditions.

Table F-6
Power Measurement Verification WIFI with NR Active – Antenna 2

Mode/Band	Conducted Power (dBm)		
	Un-triggered (Max)	Mechanism #1 NR Active (Reduced)	Mechanism #2 RCV and NR Active (Reduced)
802.11b	18.17	16.07	9.50
802.11g	17.15	16.56	9.26
802.11n (2.4GHz)	16.98	16.35	9.35
802.11a	16.66	13.12	9.57
802.11n (5GHz, 20MHz BW)	16.57	13.07	9.65
802.11ac (20MHz BW)	16.75	12.86	9.43
802.11n (5GHz, 40MHz BW)	15.95	12.98	9.68
802.11ac (40MHz BW)	15.78	12.85	9.34
802.11ac (80MHz BW)	14.54	13.09	9.81
802.11ac (160MHz BW)	14.75	13.13	9.65

*Note: 802.11ax and MIMO WIFI modes were not evaluated due to equipment limitations. All SISO powers were taken during MIMO conditions.

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Table F-7
Power Measurement Verification Bluetooth – Antenna 1

Mechanism(s)	Mode/Band	Conducted Power (dBm)	
1st		Un-triggered (Max)	Mechanism #1 RCV Active (Reduced)
Held-to-Ear	Bluetooth Ant 1	14.25	9.45

Table F-8
Power Measurement Verification Bluetooth – Antenna 2

Mechanism(s)	Mode/Band	Conducted Power (dBm)	
1st		Un-triggered (Max)	Mechanism #1 RCV Active (Reduced)
Held-to-Ear	Bluetooth Ant 2	13.76	8.95