

APPENDIX H: LTE DOWNLINK CA RF CONDUCTED POWERS

LTE Downlink Only Carrier Aggregation Test Reduction Methodology

Per October 2024 TCBC Workshop Notes, the use of Carrier Aggregation (CA, hereafter) requires ensuring that the applicable rules are met in each portion of the spectrum that is used by each component carrier. CA can be applied to both transmissions, or uplink (UL) from the device under test perspective and reception, or downlink (DL). For FCC compliance, only UL operations are relevant. It is possible that in some cases the DL impacts the available options for UL. Therefore, spot-check conducted power measurements will be evaluated.

SAR test exclusion for LTE downlink Carrier Aggregation is determined by power measurements according to the number of component carriers (CCs) supported by the product implementation. Per April 2018 TCBC Workshop Notes, the following test reduction methodology was applied to determine the combinations required for conducted power measurements.

LTE DLCA Test Reduction Methodology:

- The supported combinations were arranged by the number of component carriers in columns.
- Any limitations on the PCC or SCC for each combination were identified alongside the combination (e.g. CA_2A-2A-4A-12A, but B12 can only be configured as a SCC).
- Power measurements were performed for "supersets" (LTE CA combinations with multiple components carriers) and any "subsets" (LTE CA combinations with fewer component carriers) that were not completely covered by the supersets.
- Only subsets that have the exact same components as a superset were excluded for measurement.
- When there were certain restrictions on component carriers that existed in the superset that were not applied for the subset, the subset configuration was additionally evaluated.
- Both inter-band and intra-band downlink carrier aggregation scenarios were considered.
- Downlink CA combinations for 4x4 Downlink MIMO operations were measured and represent the worst-case to cover all SISO configurations with the same bands and component carriers.
- Evaluate MIMO combinations with the maximum number of frequency bands, component carriers, and largest aggregated bandwidth to represent worst-case scenarios for spot-check measurements.

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Table H-1 – Exclusion Table for MIMO Configurations for Spot-check Measurements

[illegible]

Note: [CC] indicates component carrier with 4x4 DL MIMO antenna configuration

H.1 LTE Downlink Only Carrier Aggregation Test Selection and Setup

SAR test exclusion for LTE downlink Carrier Aggregation is determined by power measurements according to the number component carriers (CCs) supported by the product implementation. For those configurations required by April 2018 TCBC Workshop Notes, conducted power measurements with LTE Carrier Aggregation (CA) (downlink only) active are made in accordance to KDB Publication 941225 D05Av01r02. The RRC connection is only handled by one cell, the primary component carrier (PCC) for downlink and uplink communications. After making a data connection to the PCC, the UE device adds secondary component carrier(s) (SCC) on the downlink only. All uplink communications and acknowledgements remain identical to specifications when downlink carrier aggregation is inactive on the PCC. Additional conducted output powers are measured with the downlink carrier aggregation active for the configuration with highest measured maximum conducted power with downlink carrier aggregation inactive measured among the channel bandwidth, modulation, and RB combinations in each frequency band.

Per FCC KDB Publication 941225 D05Av01r02, no SAR measurements are required for carrier aggregation configurations when the maximum average output power with downlink only carrier aggregation active is not more than 0.25 dB higher than the average output power with downlink only carrier aggregation inactive. All bands required for SAR testing per FCC KDB procedures were considered. Based on the measured maximum powers below, no additional SAR tests were required for DLCA SAR configurations.

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General PCC and SCC configuration selection procedure

- PCC uplink channel, channel bandwidth, modulation and RB configurations were selected based on section C)3)b)ii) of KDB 941225 D05 V01r02. All LTE bandwidth conducted powers needed for PCC uplink configuration selection can be found in the RF Conducted Powers Section and LTE/NR Lower Bandwidth RF Conducted Power Appendix. The downlink PCC channel was paired with the selected PCC uplink channel according to normal configurations without carrier aggregation.
- To maximize aggregated bandwidth, the highest channel bandwidth available for that CA combination was selected for SCC. For inter-band CA, the SCC downlink channels were selected near the middle of their transmission bands. For contiguous intra-band CA, the downlink channel spacing between the component carriers was set to multiple of 300 kHz less than the nominal channel spacing defined in section 5.4.1A of 3GPP TS 36.521. For non-contiguous intra-band CA, the downlink channel spacing between the component carriers was set to be larger than the nominal channel spacing and provided maximum separation between the component carriers.
- All selected PCC and SCC(s) remained fully within the uplink/downlink transmission band of the respective component carrier.

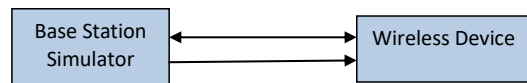


Figure H-1
DL CA Power Measurement Setup

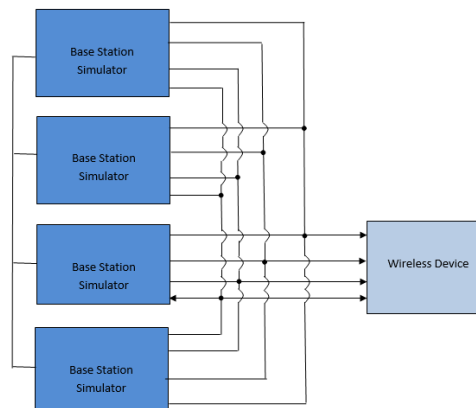


Figure H-2
DL CA with DL 4x4 MIMO Power Measurement Setup

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H.2 Downlink Carrier Aggregation RF Conducted Powers

H.2.1 LTE Band 71 as PCC

Table H-2
Maximum Output Powers

Combination	PCC										SCC 1				SCC 2				SCC 3				SCC 4				Power					
	PCC Band	PCC BW [MHz]	PCC (UL) Ch.	PCC (UL) Freq. [MHz]	Mod.	PCC UL RB	PCC UL RB Offset	PCC (DL) Ch.	PCC (DL) Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC (DL) Ch.	SCC (DL) Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC (DL) Ch.	SCC (DL) Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC (DL) Ch.	SCC (DL) Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC (DL) Ch.	SCC (DL) Freq. [MHz]	DL Ant. Config.	LTE Tx Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA [2A] [2A] [7A] [66A] 71A	LTE B71	5	1313147	665.5	16QAM	1	12	68611	619.5	2x2	LTE B2	20	900	1960	4x4	LTE B2	20	700	1940	4x4	LTE B7	20	3100	2655	4x4	LTE B66	20	66786	2145	4x4	19.24	19.73

H.2.2 LTE Band 12 as PCC

Table H-3
Maximum Output Powers

Combination	PCC										SCC 1				SCC 2				SCC 3				SCC 4				Power					
	PCC Band	PCC BW [MHz]	PCC (UL) Ch.	PCC (UL) Freq [MHz]	Mod.	PCC UL# RB	PCC UL RB Offset	PCC (DL) Ch.	PCC (DL) Freq [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC (DL) Ch.	SCC (DL) Freq [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC (DL) Ch.	SCC (DL) Freq [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC (DL) Ch.	SCC (DL) Freq [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC (DL) Ch.	SCC (DL) Freq [MHz]	DL Ant. Config.	LTE Tx Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA [2A] [2A] [7A] [12A] [66A]	LTE B12	5	23155	713.5	256QAM	1	12	5155	743.5	2x2	LTE B2	20	900	1960	4x4	LTE B2	20	700	1940	4x4	LTE B7	20	1100	2655	4x4	LTE B66	20	66786	2145	4x4	18.85	17.14
CA [2A] [2A] [12A] [30A] [66A]	LTE B12	5	23155	713.5	256QAM	1	12	5155	743.5	2x2	LTE B2	20	900	1960	4x4	LTE B2	20	700	1940	4x4	LTE B30	10	9820	2355	4x4	LTE B66	20	66786	2145	4x4	18.50	19.14
CA [2A] [2A] [12A] [12A] [66A]	LTE B12	5	23155	713.5	256QAM	1	12	5155	743.5	2x2	LTE B2	20	900	1960	4x4	LTE B2	20	700	1940	4x4	LTE B66	20	66786	2145	4x4	LTE B66	20	67236	2190	4x4	18.53	19.14
CA [2A] [12A] [30A] [66A] [66A]	LTE B12	5	23155	713.5	256QAM	1	12	5155	743.5	2x2	LTE B2	20	900	1960	4x4	LTE B30	10	9820	2355	4x4	LTE B66	20	66786	2145	4x4	LTE B66	20	67236	2190	4x4	18.59	19.14

H.2.3 LTE Band 13 as PCC

Table H-4
Maximum Output Powers

Combination	PCC										SCC 1				SCC 2				SCC 3				SCC 4				Power					
	PCC Band	PCC BW [MHz]	PCC [UL] Freq [MHz]	Mod.	PCC UL RB	PCC UL RB Offset	PCC [DL] Ch.	PCC [DL] Freq [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC [DL] Ch.	SCC [DL] Freq [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC [DL] Ch.	SCC [DL] Freq [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC [DL] Ch.	SCC [DL] Freq [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC [DL] Ch.	SCC [DL] Freq [MHz]	DL Ant. Config.	LTE Tx Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)	
CA [2A] [2A] [13A] [66A]	LTE B13	5	23230	782	16QAM	1	12	5230	751	2x2	LTE B2	20	900	1960	4x4	LTE B2	20	700	1940	4x4	LTE B66	20	66786	2145	4x4	LTE B66	20	67236	2190	4x4	19.89	19.69
CA [2A] [2A] [7A] [13A] [66A]	LTE B13	5	23230	782	16QAM	1	12	5230	751	2x2	LTE B2	20	900	1960	4x4	LTE B7	20	2850	3630	4x4	LTE B7	20	3100	2650	4x4	LTE B66	20	66636	2120	4x4	19.19	19.69
CA [13A] [480] [66A]	LTE B13	5	23230	782	16QAM	1	12	5230	751	2x2	LTE B48	20	55990	3625	4x4	LTE B48	20	56188	3644.8	4x4	LTE B48	20	56386	3664.6	4x4	LTE B66	20	66786	2145	4x4	19.19	19.69
CA [13A] [480]	LTE B13	5	23230	782	16QAM	1	12	5230	751	2x2	LTE B48	20	55990	3625	4x4	LTE B48	20	56188	3644.8	4x4	LTE B48	20	56386	3664.6	4x4	LTE B48	20	56584	3684.4	4x4	19.71	19.69

H.2.4 LTE Band 14 as PCC

Table H-5
Maximum Output Powers

Combination	PCC										SCC 1				SCC 2				SCC 3				SCC 4				Power					
	PCC Band	PCC BW [MHz]	PCC (UL) Freq. [MHz]	Mod.	PCC UL# RB	PCC UL RB Offset	PCC (DL) Ch.	PCC (DL) Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC (DL) Ch.	SCC (DL) Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC (DL) Ch.	SCC (DL) Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC (DL) Ch.	SCC (DL) Freq. [MHz]	DL Ant. Config.	SCC Band	SCC BW [MHz]	SCC (DL) Ch.	SCC (DL) Freq. [MHz]	DL Ant. Config.	LTE Tx Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)	
CA [2A] [2A] [14A] [30A] [66A]	LTE B14	5	23330	793	16QAM	1	12	5330	763	2x2	LTE B2	20	900	1960	4x4	LTE B2	20	700	1940	4x4	LTE B30	10	9820	2355	4x4	LTE B66	20	66786	2145	4x4	19.06	19.09
CA [2A] [2A] [14A] [66A]	LTE B14	5	23330	793	16QAM	1	12	5330	763	2x2	LTE B2	20	900	1960	4x4	LTE B2	20	700	1940	4x4	LTE B66	20	66786	2145	4x4	LTE B66	20	66786	2145	4x4	19.09	19.09
CA [2A] [14A] [30A] [66A]	LTE B14	5	23330	793	16QAM	1	12	5330	763	2x2	LTE B2	20	900	1960	4x4	LTE B30	10	9820	2355	4x4	LTE B66	20	66786	2145	4x4	LTE B66	20	66786	2145	4x4	19.07	19.09

H.2.5 LTE Band 5 as PCC

Table H-6
Maximum Output Powers

Combination	PCC										SCC 1				SCC 2				SCC 3				SCC 4				Power					
	PCC Band	PCC BW [MHz]	PCC (UL) Ch.	PCC (UL) Freq. [MHz]	Mod.	PCC UL# RB	PCC UL RB Offset	PCC (DL) Ch.	PCC (DL) Freq. [MHz]	DL-Ant. Config.	SCC Band	SCC BW [MHz]	SCC (DL) Ch.	SCC (DL) Freq. [MHz]	DL-Ant. Config.	SCC Band	SCC BW [MHz]	SCC (DL) Ch.	SCC (DL) Freq. [MHz]	DL-Ant. Config.	SCC Band	SCC BW [MHz]	SCC (DL) Ch.	SCC (DL) Freq. [MHz]	DL-Ant. Config.	SCC Band	SCC BW [MHz]	SCC (DL) Ch.	SCC (DL) Freq. [MHz]	DL-Ant. Config.	LTE Tx Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA [2A] [2A] [5A] [30A] [66A]	LTE B5	5	20625	846.5	16QAM	1	12	2625	891.5	2x2	LTE B2	20	900	1960	4x4	LTE B2	20	700	1940	4x4	LTE B30	10	9820	2355	4x4	LTE B66	20	66786	2145	4x4	17.59	18.55
CA [2A] [2A] [5A] [66A] [66A]	LTE B5	5	20625	846.5	16QAM	1	12	2625	891.5	2x2	LTE B2	20	900	1960	4x4	LTE B2	20	700	1940	4x4	LTE B66	20	66786	2145	4x4	LTE B66	20	66786	2145	4x4	17.59	18.55
CA [2A] [2A] [5A] [66B]	LTE B5	5	20625	846.5	16QAM	1	12	2625	891.5	2x2	LTE B2	20	900	1960	4x4	LTE B2	20	700	1940	4x4	LTE B66	20	66786	2145	4x4	LTE B66	5	66878	2154.3	4x4	17.58	18.55
CA [2A] [2A] [5A] [66C]	LTE B5	5	20625	846.5	16QAM	1	12	2625	891.5	2x2	LTE B2	20	900	1960	4x4	LTE B2	20	700	1940	4x4	LTE B66	20	66786	2145	4x4	LTE B66	20	66984	2164.8	4x4	17.70	18.55
CA [2A] [5A] [7A] [12A] [66A]	LTE B5	5	20625	846.5	16QAM	1	12	2625	891.5	2x2	LTE B7	20	2950	2630	4x4	LTE B7	20	3152	2660.2	4x4	LTE B66	20	66786	2145	4x4	LTE B66	20	66536	2120	4x4	17.69	18.55
CA [2A] [5A] [30A] [66A]	LTE B5	5	20625	846.5	16QAM	1	12	2625	891.5	2x2	LTE B2	20	900	1960	4x4	LTE B30	10	9820	2355	4x4	LTE B66	20	66786	2145	4x4	LTE B66	20	66786	2145	4x4	17.67	18.55
CA [2A] [5A] [48A] [66A] [66A]	LTE B5	5	20625	846.5	16QAM	1	12	2625	891.5	2x2	LTE B2	20	900	1960	4x4	LTE B48	20	55990	3625	4x4	LTE B66	20	66786	2145	4x4	LTE B66	20	66786	2145	4x4	17.82	18.55
CA [5A] [7A] [66A]	LTE B5	5	20625	846.5	16QAM	1	12	2625	891.5	2x2	LTE B7	20	2950	2630	4x4	LTE B7	20	2902	2652.2	4x4	LTE B66	20	66786	2145	4x4	LTE B66	20	66786	2145	4x4	17.68	18.55
CA [5A] [48C] [66A]	LTE B5	5	20625	846.5	16QAM	1	12	2625	891.5	2x2	LTE B48	20	55990	3625	4x4	LTE B48	20	56188	3644.8	4x4	LTE B66	20	66786	2145	4x4	LTE B66	20	66786	2145	4x4	17.73	18.55

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