

APPENDIX I: LTE DOWNLINK ONLY CARRIER AGGREGATION TEST REDUCTION METHODOLOGY

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 SISO and 4x4 Downlink MIMO operations were measured independently, per May 2017 TCBC Workshop notes.

Table I-1 – Example of Exclusion Table for SISO Configurations

Index	BCC	Supported Channel Bandwidth (MHz)				Restriction	Completely Covered by Measurement Superset	Index	BCC	Supported Channel Bandwidth (MHz)				Restriction	Completely Covered by Measurement Superset	Index	BCC	Supported Channel Bandwidth (MHz)				Restriction	Completely Covered by Measurement Superset				
		CC1	CC2	CC3	CC4					CC1	CC2	CC3	CC4					CC1	CC2	CC3	CC4						
CC101	CA_12A	5, 10, 15, 20					No	CC102	CA_2A	5, 10, 15, 20					No	CC103	CA_12A	5, 10, 15, 20					No				
CC104	CA_2A-5A	5, 10, 15, 20	5, 10, 15, 20				Yes	CC105	CA_2A-5A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			Yes	CC106	CA_2A-5A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			Yes				
CC107	CA_2A-5A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			Yes	CC108	CA_2A-5A-12A-5A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			Yes	CC109	CA_2A-5A-12A-5A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			Yes		
CC110	CA_2A-5A-12A-5A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		Yes	CC111	CA_2A-5A-12A-5A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			Yes	CC112	CA_2A-5A-12A-5A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			Yes

Table I-2 – Example of Exclusion Table for 4x4 Downlink MIMO Configurations

Index	BCC	Supported Channel Bandwidth (MHz)				Restriction	Completely Covered by Measurement Superset	Index	BCC	Supported Channel Bandwidth (MHz)				Restriction	Completely Covered by Measurement Superset	Index	BCC	Supported Channel Bandwidth (MHz)				Restriction	Completely Covered by Measurement Superset	
		CC1	CC2	CC3	CC4					CC1	CC2	CC3	CC4					CC1	CC2	CC3	CC4			
CC1M1	CA_12C1	5, 10, 15, 20					No	CC1M2	CA_12A-2A-4A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M3	CA_12A-2A-4A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No		
CC1M4	CA_12A-2A	5, 10, 15, 20	5, 10, 15, 20				No	CC1M5	CA_12A-2A-5A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10		CC1M6	CA_12A-2A-5A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10		No		
CC1M7	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20				No	CC1M8	CA_12A-2A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10		CC1M9	CA_12A-2A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10		No		
CC1M10	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No	CC1M11	CA_12A-2A-12A-5A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10		CC1M12	CA_12A-2A-12A-5A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10		No		
CC1M13	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M14	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M15	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No		
CC1M16	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M17	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M18	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M19	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M20	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M21	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M22	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M23	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M24	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M25	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M26	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M27	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M28	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M29	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M30	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M31	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M32	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M33	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M34	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M35	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M36	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M37	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M38	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M39	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M40	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M41	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M42	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M43	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M44	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M45	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M46	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M47	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M48	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M49	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M50	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M51	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M52	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M53	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M54	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M55	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M56	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M57	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M58	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M59	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M60	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M61	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M62	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M63	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M64	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M65	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M66	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M67	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M68	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M69	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M70	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M71	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M72	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M73	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M74	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M75	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M76	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M77	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M78	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M79	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M80	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M81	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M82	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20		No	CC1M83	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			CC1M84	CA_12C1-66A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20	5, 10, 15, 20			No
CC1M85	CA_12A-12A-12A	5, 10, 15, 20	5, 10, 15, 20	5, 10, 1																				

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 active 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.

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, 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.

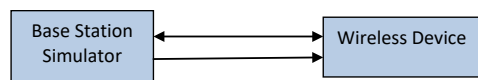


Figure I-1
DL CA Power Measurement Setup

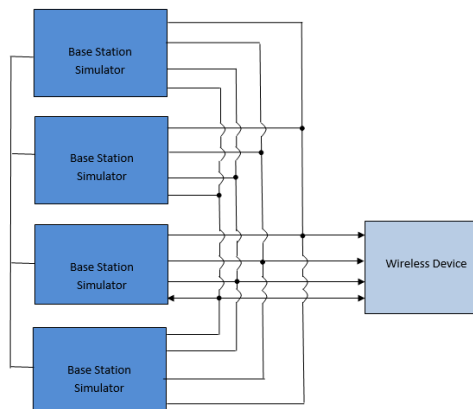


Figure I-2
DL CA with DL 4x4 MIMO Power Measurement Setup

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I.2 Downlink Carrier Aggregation RF Conducted Powers

I.2.1 LTE Band 41 as PCC

Table I-3
Maximum Output Powers

Combination	PCC									SCC 1				Power	
	PCC Band	PCC BW [MHz]	PCC (UL) Ch.	PCC (UL) Freq. [MHz]	Mod.	PCC UL# RB	PCC UL RB Offset	PCC (DL) Channel	PCC (DL) Freq. [MHz]	SCC Band	SCC BW [MHz]	SCC (DL) Channel	SCC (DL) Freq. [MHz]	LTE Tx.Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA 41C (1)	LTE B41	10	40620	2593	QPSK	1	25	40620	2593	LTE B41	20	40764	2607.4	24.05	24.06

I.3 DL CA with DL 4x4 MIMO RF Conduction Powers

This device supports downlink 4x4 MIMO operations for some LTE bands. Uplink transmission is limited to a single output stream. When carrier aggregation was applicable, the general test selection and setup procedures described in Section I.1 were applied.

Per May 2017 TCB Workshop Notes, SAR for 4x4 DL MIMO was not needed since the maximum average output power in 4x4 DL MIMO mode was not more than 0.25 dB higher than the maximum output power with 4x4 DL MIMO inactive. Additionally, SAR for 4x4 MIMO Downlink Carrier Aggregation was not needed since the maximum average output power in 4x4 MIMO Downlink Carrier Aggregation mode was not more than 0.25 dB higher than the maximum output power with 4x4 MIMO Downlink and downlink carrier aggregation inactive.

I.3.1 LTE 4x4 MIMO DL Standalone Powers

Table I-4
Maximum Output Powers

LTE Band	Bandwidth [MHz]	Channel	Frequency [MHz]	Modulation	RB Size	RB Offset	4x4 DL MIMO Tx. Power [dBm]	Single Antenna Tx. Power [dBm]	Target Power [dBm]
41	10	40620	2593	QPSK	1	25	24.06	24.06	24.0

I.3.2 LTE Band 41 as PCC

Table I-5
Maximum Output Powers

Combination	PCC										SCC 1				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.	LTE Tx.Power with DL CA Enabled (dBm)	LTE Single Carrier Tx Power (dBm)
CA 41C (1)	LTE B41	10	40620	2593	QPSK	1	25	40620	2593	4x4	LTE B41	20	40764	2607.4	4x4	24.03	24.06

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I.4 Additional Downlink Carrier Aggregation with Uplink Carrier Aggregation Enabled

This device supports uplink carrier aggregation (ULCA) with additional Carrier Aggregation configurations active in the downlink. Power measurements were performed with ULCA active and additional CA configurations active in the downlink for the configuration per Fall 2017 TCB Workshop Notes.

Per FCC Guidance, additional SAR measurements for these configurations were not required since their maximum output power was not more than 0.25 dB higher than the maximum output power for with only CA_41C ULCA active.

I.4.1 Additional 4x4 MIMO DL Carrier Aggregation RF Conducted Powers with Uplink Carrier Aggregation Enabled

Note: 4x4 DL MIMO is only operating in the downlink. Uplink transmission is limited to a single output stream for each component carrier of ULCA.

Table I-6
Maximum Output Powers

Combination	PCC										SCC 1							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 [UL] Ch.	SCC [UL] Freq. [MHz]	Mod.	SCC UL# RB	SCC UL RB Offset	SCC [DL] Ch.	SCC [DL] Freq. [MHz]	DL Ant. Config.	ULCA Tx Power with add'l CA config. active (dBm)	ULCA Tx Power (dBm)
CA_41C	LTE B41	20	40620	2593	QPSK	1	99	40620	2593	4x4	LTE B41	20	40818	2612.8	QPSK	1	0	40818	2612.8	4x4	23.74	23.59

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