LTE Downlink Carrier Aggregation configurations

1. DL Intra Band(contiguous)

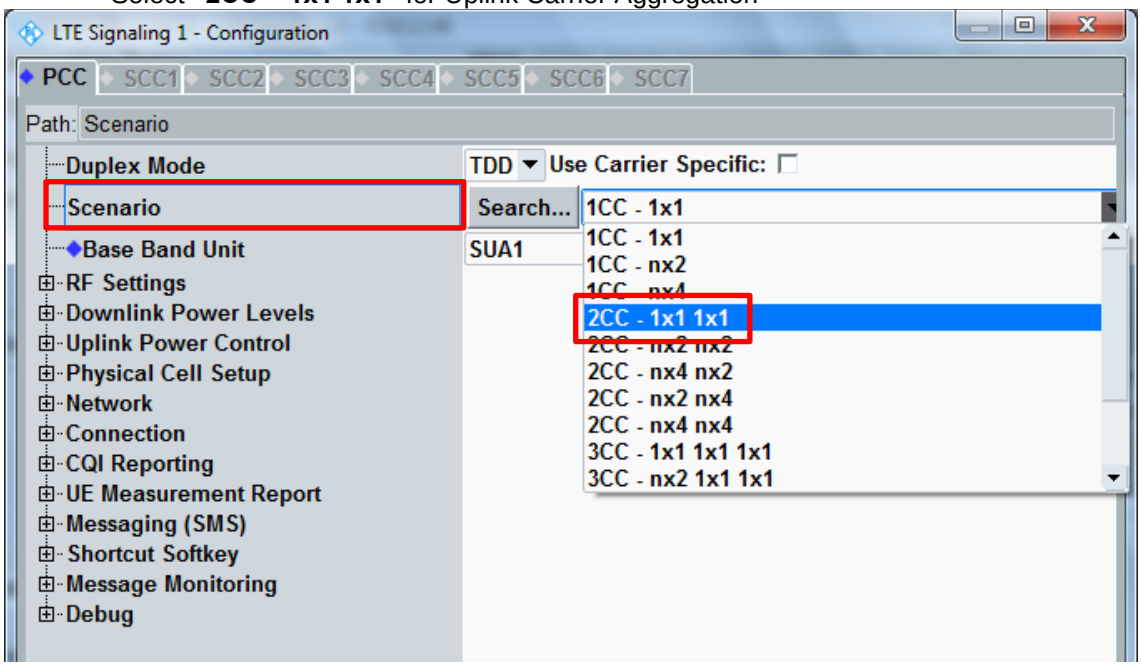
E-UTRA CA configuration	Bandwidth Combination Set	E-UTRA Band	Allowed Channel BW Per Carrier (MHz)					Max Aggregated BW
			1st Carrier	2nd Carrier	3rd Carrier	4th Carrier	5th Carrier	
41C	(0)	Band 41	10	20				40
			15	15, 20				
			20	10, 15, 20				
	(1)	Band 41	5, 10	20				40
			15	15, 20				
			20	5, 10, 15, 20				
	(2)	Band 41	10	15, 20				40
			15	10, 15, 20				
			20	10, 15, 20				
	(3)	Band 41	10	20				40
			20	20				
41D	(0)	Band 41	10	20	15			60
			10	15, 20	20			
			15	20	10, 15			
			15	10, 15, 20	20			
			20	15, 20	10			
			20	10, 15, 20	15, 20			

Note:

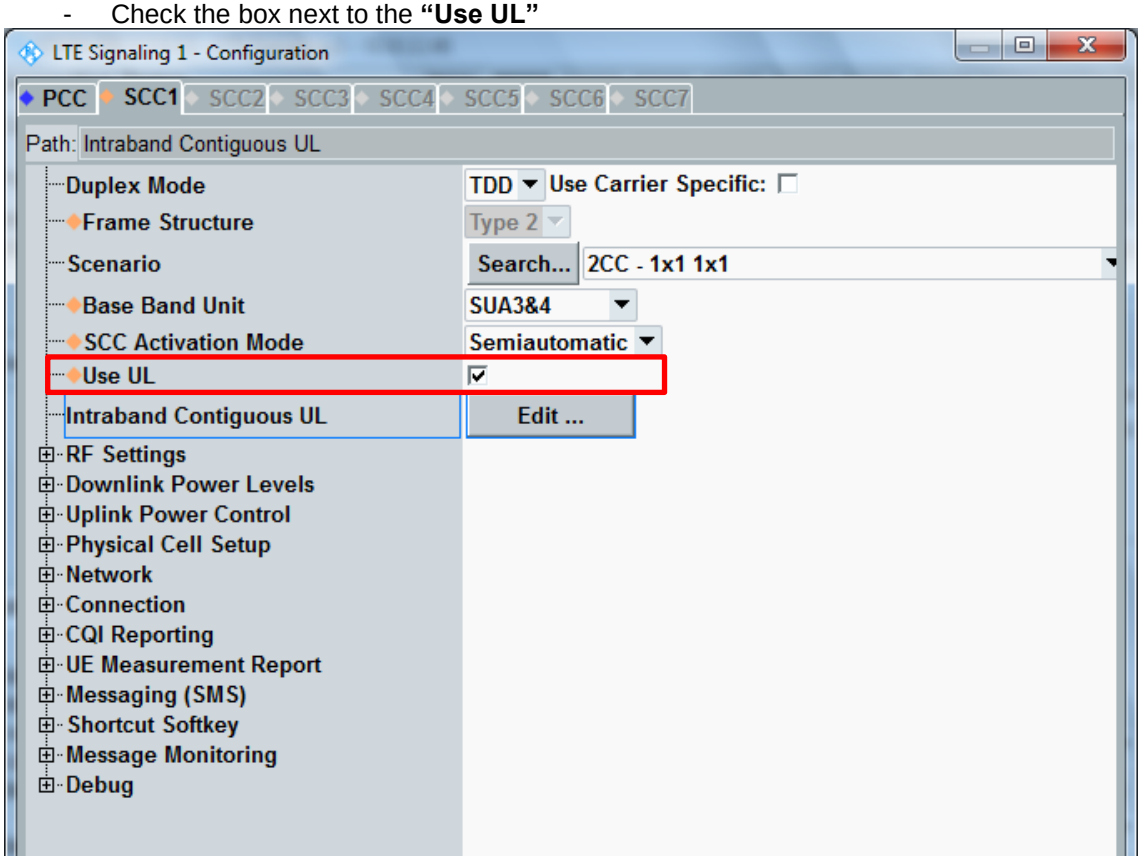
LTE CA_41C is supported in both Uplink and Downlink, other CA configurations are supported only Downlink

LTE Uplink Carrier Aggregation – Output Power measurement procedures

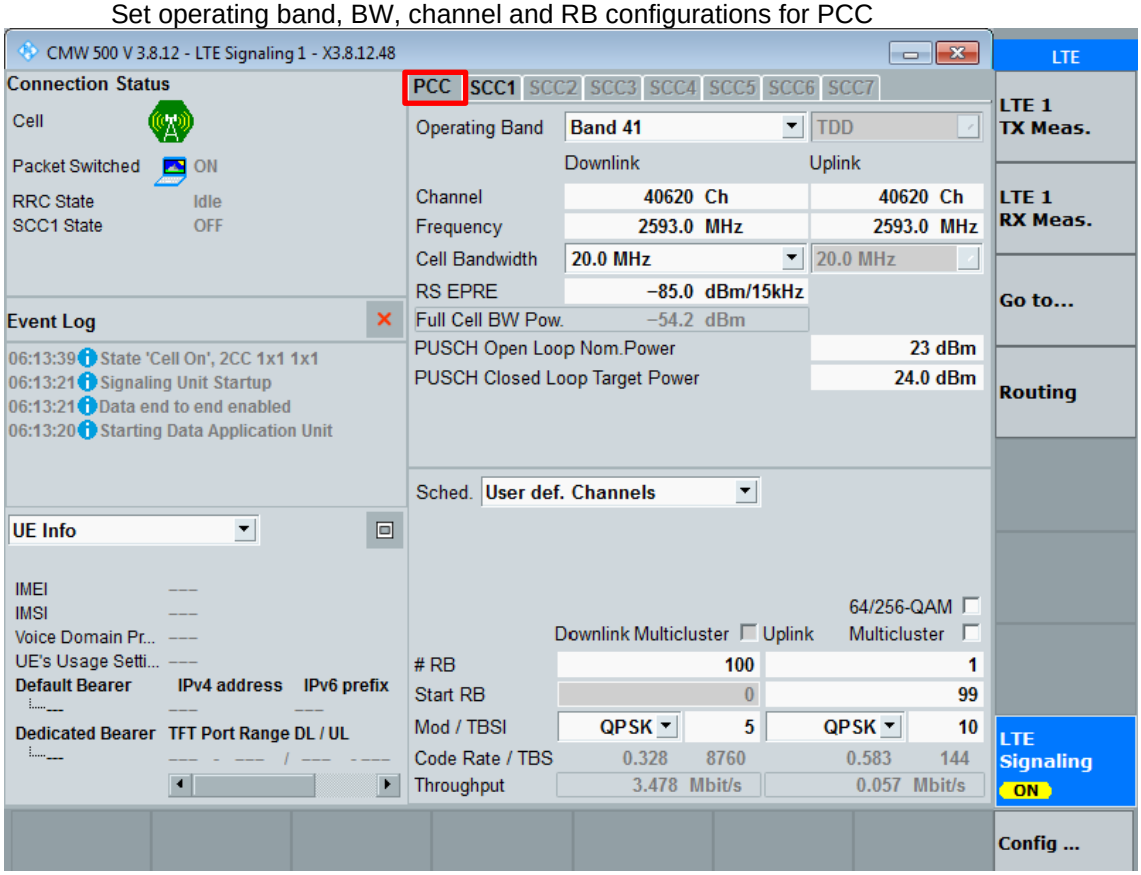
- Change the Scenario in the Configuration of LTE Signaling
  Select **"2CC – 1x1 1x1"** for Uplink Carrier Aggregation



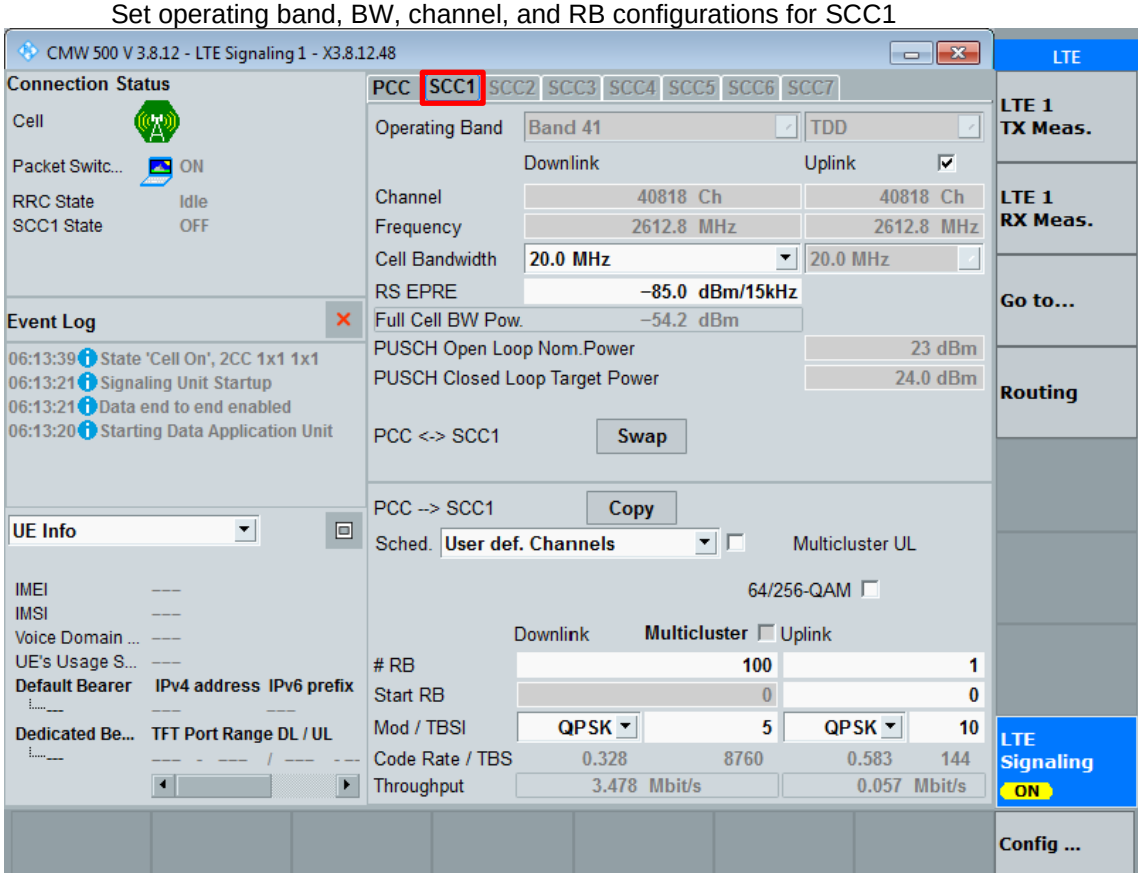
- Check the box next to the **"Use UL"**



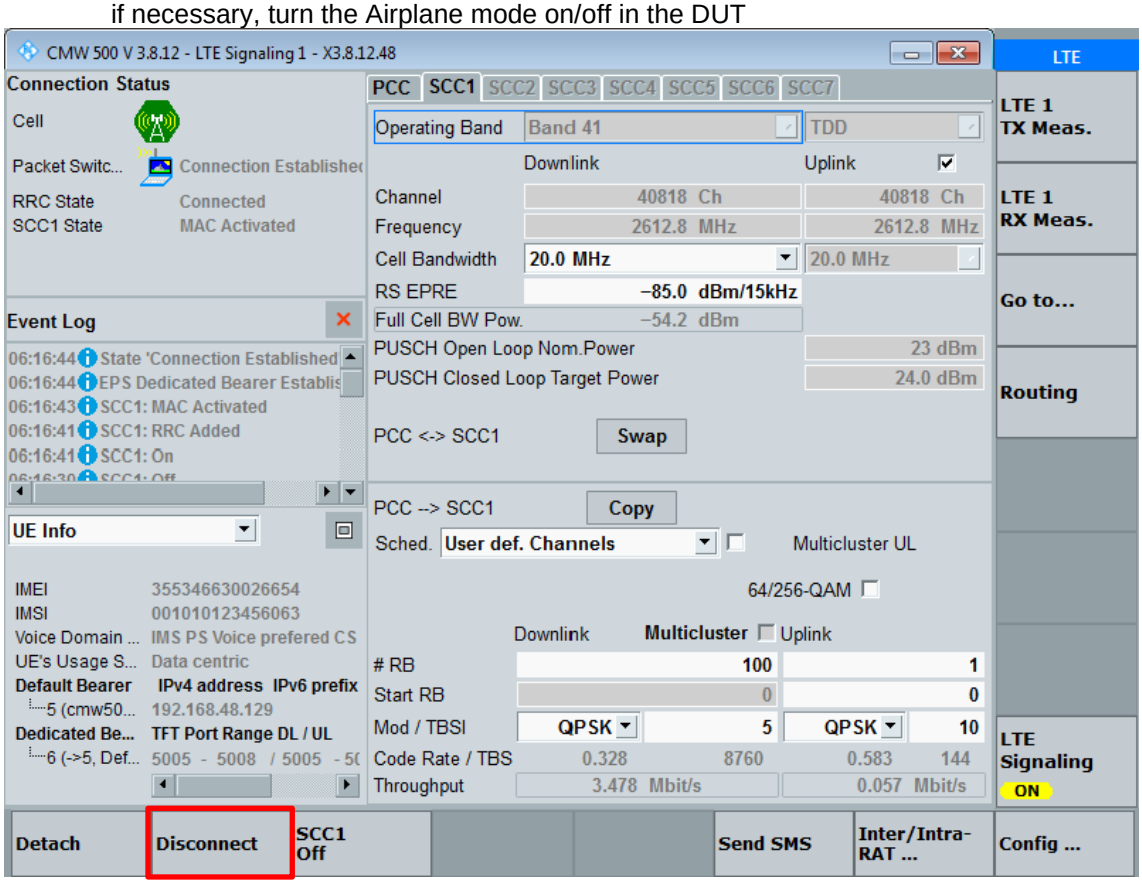
- Back to the LTE Signal screen, and then select the PCC tab,
  Set operating band, BW, channel and RB configurations for PCC



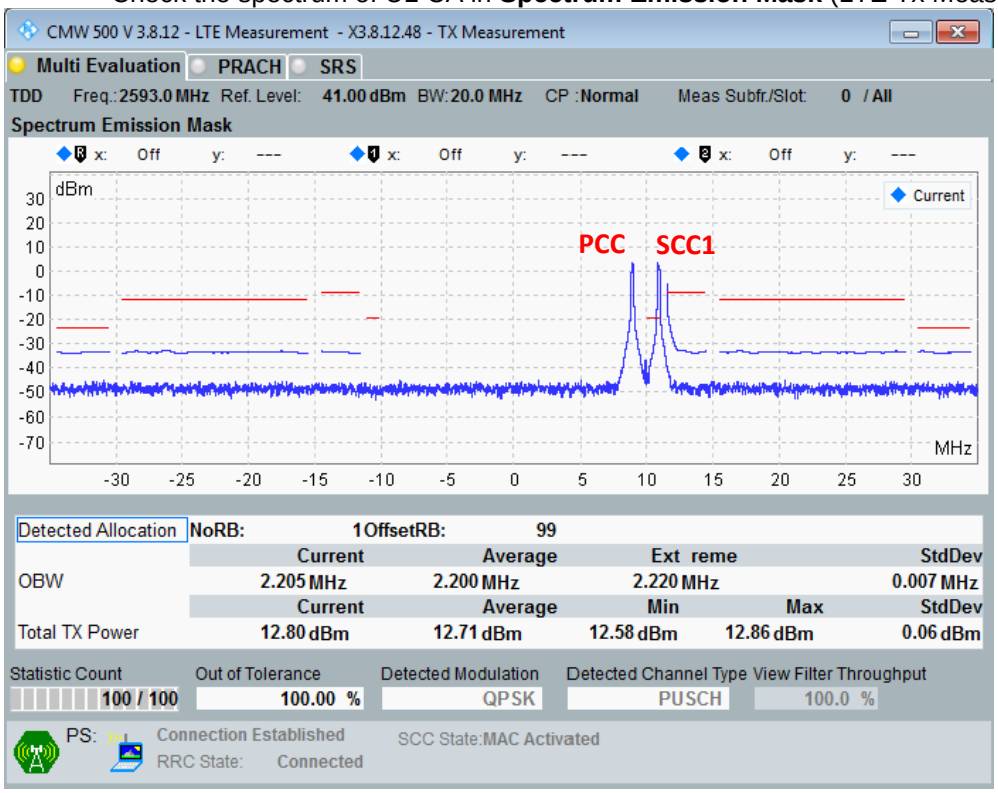
- Select the SCC1 tab,
  Set operating band, BW, channel, and RB configurations for SCC1



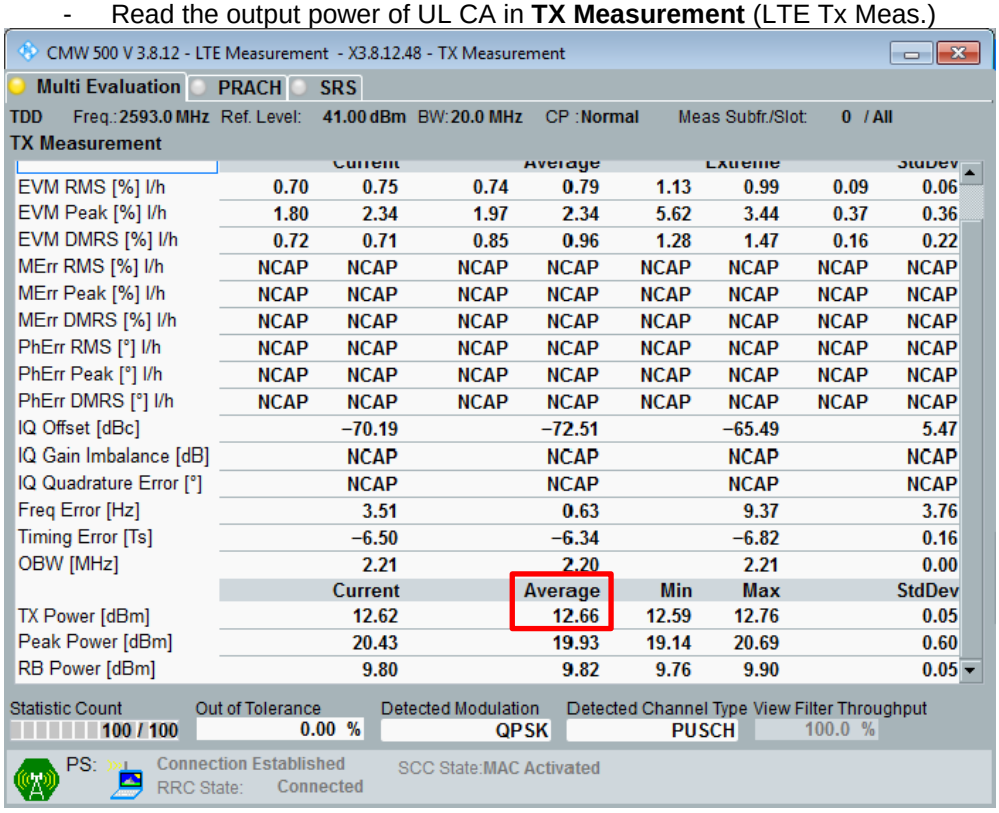
- Click the **"Connect"** button at the bottom of the screen, if necessary, turn the Airplane mode on/off in the DUT



- Check the spectrum of UL CA in **Spectrum Emission Mask** (LTE Tx Meas.)

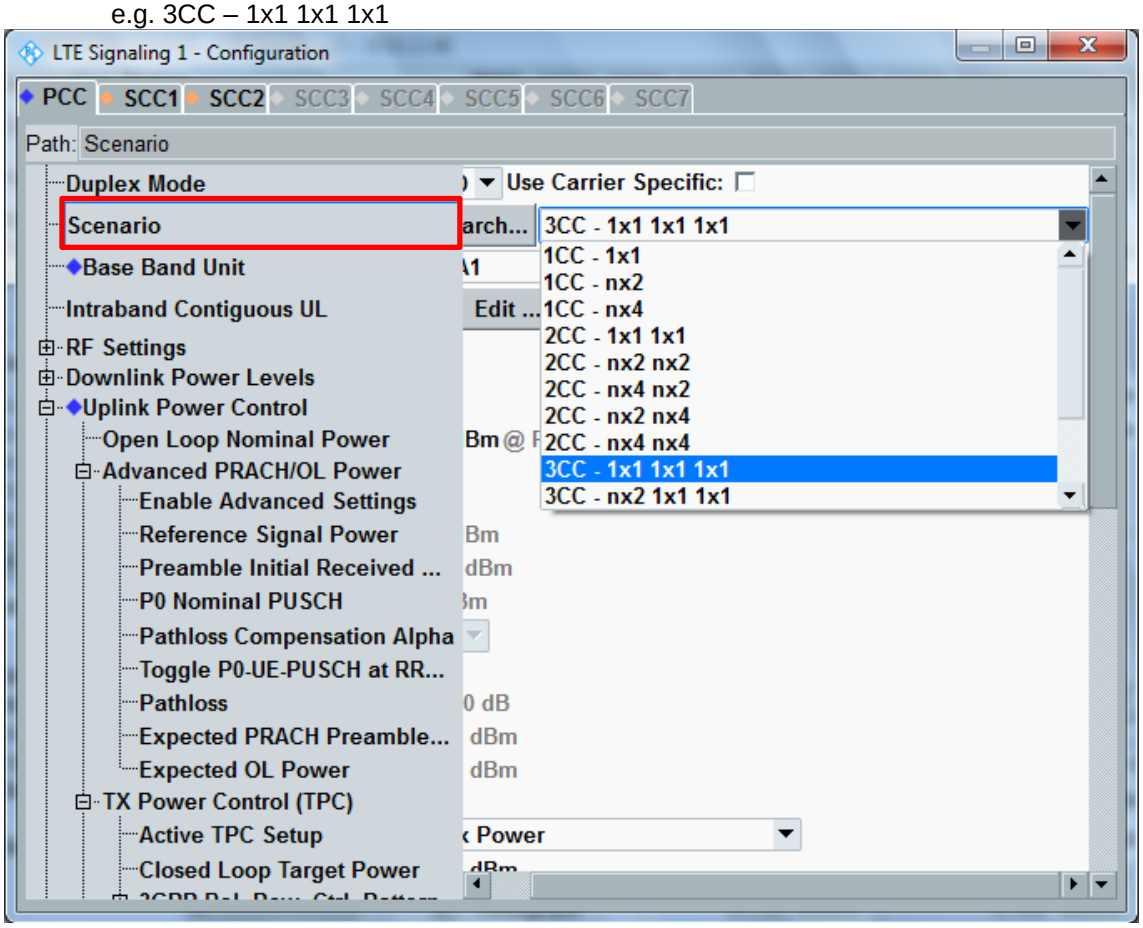


- Read the output power of UL CA in **TX Measurement** (LTE Tx Meas.)



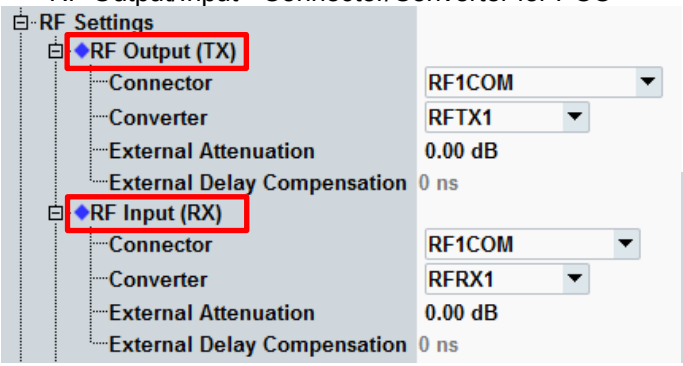
LTE Downlink Carrier Aggregation - Output Power measurement procedures

- Change the Scenario in the Configuration of LTE Signaling
  e.g. 3CC – 1x1 1x1 1x1

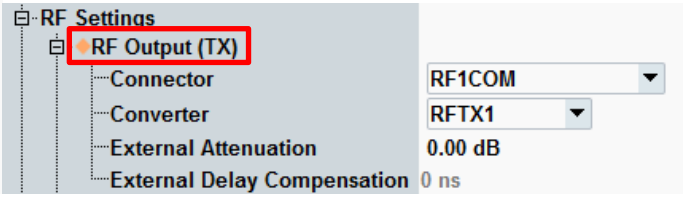


- Set the RF Output/Input Connector and Converter for PCC/SCC1/SCC2 in each tab.

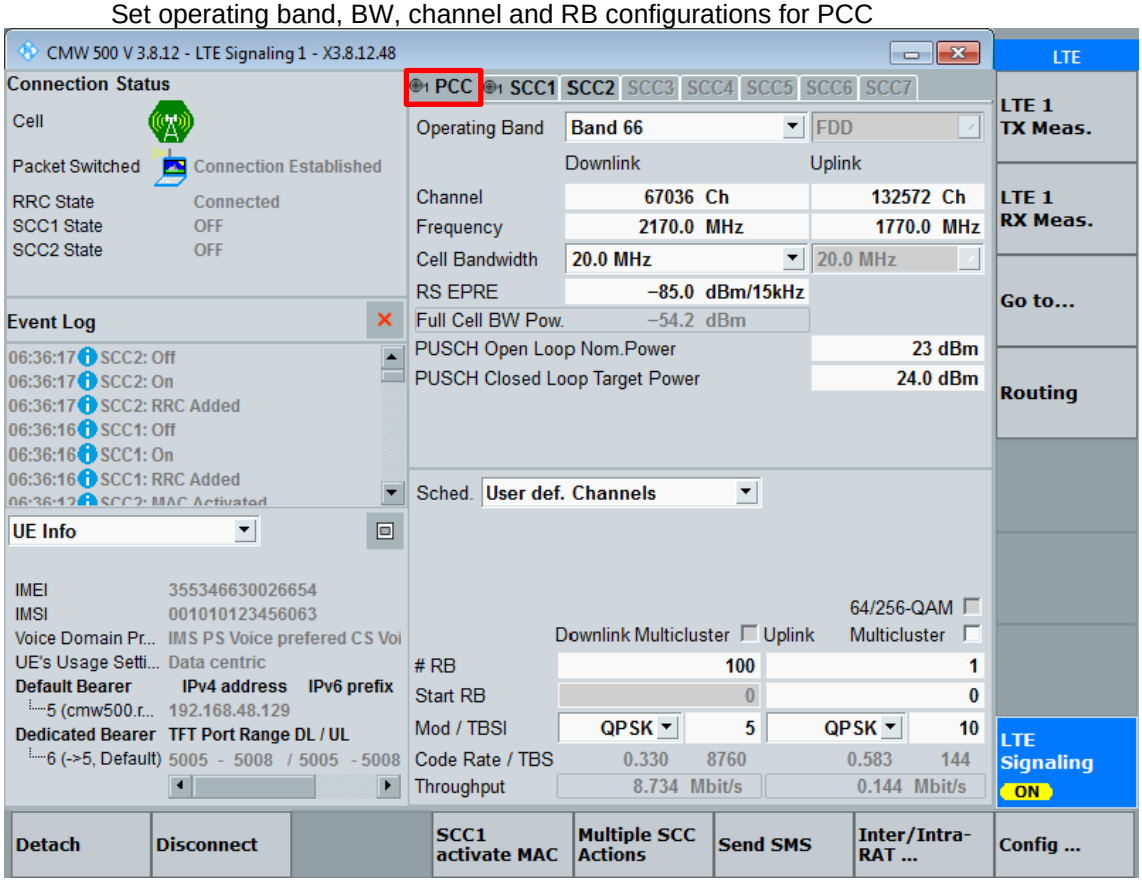
<RF Output/Input - Connector/Converter for PCC>



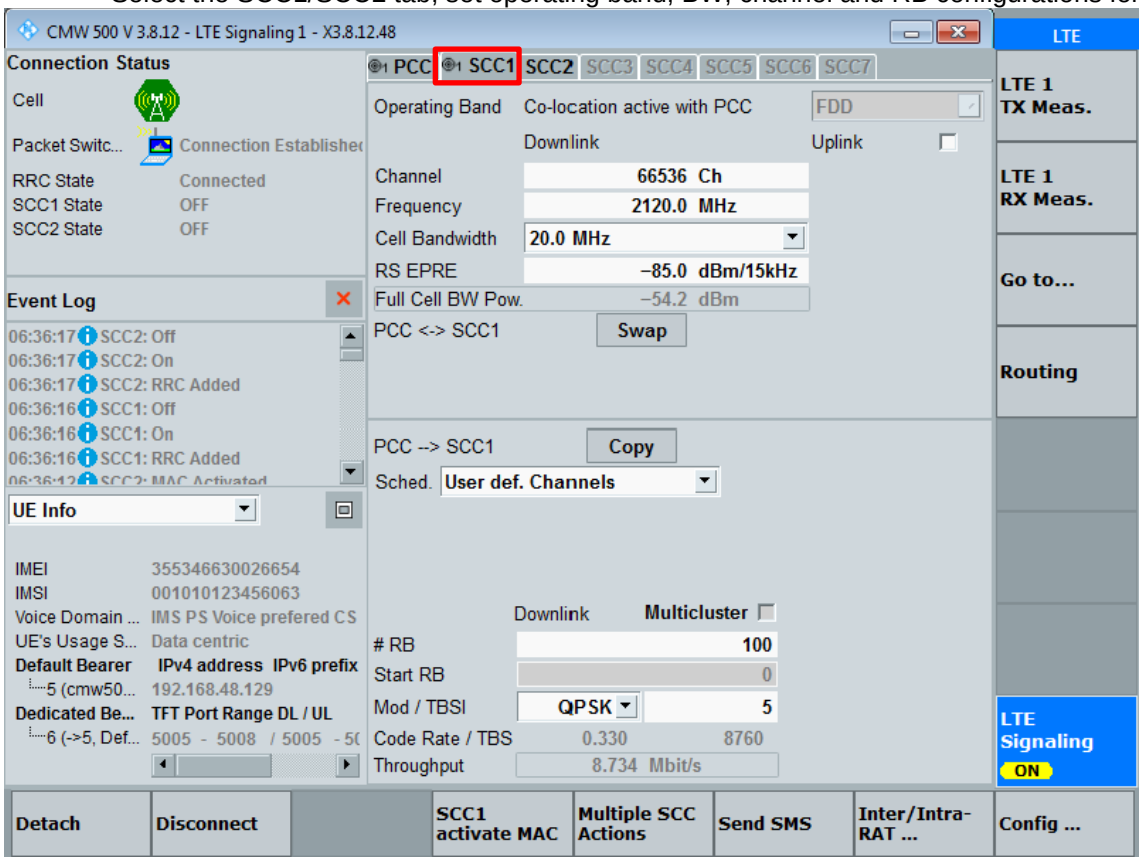
<RF Output – Connector/Converter for SCC1/SCC2>

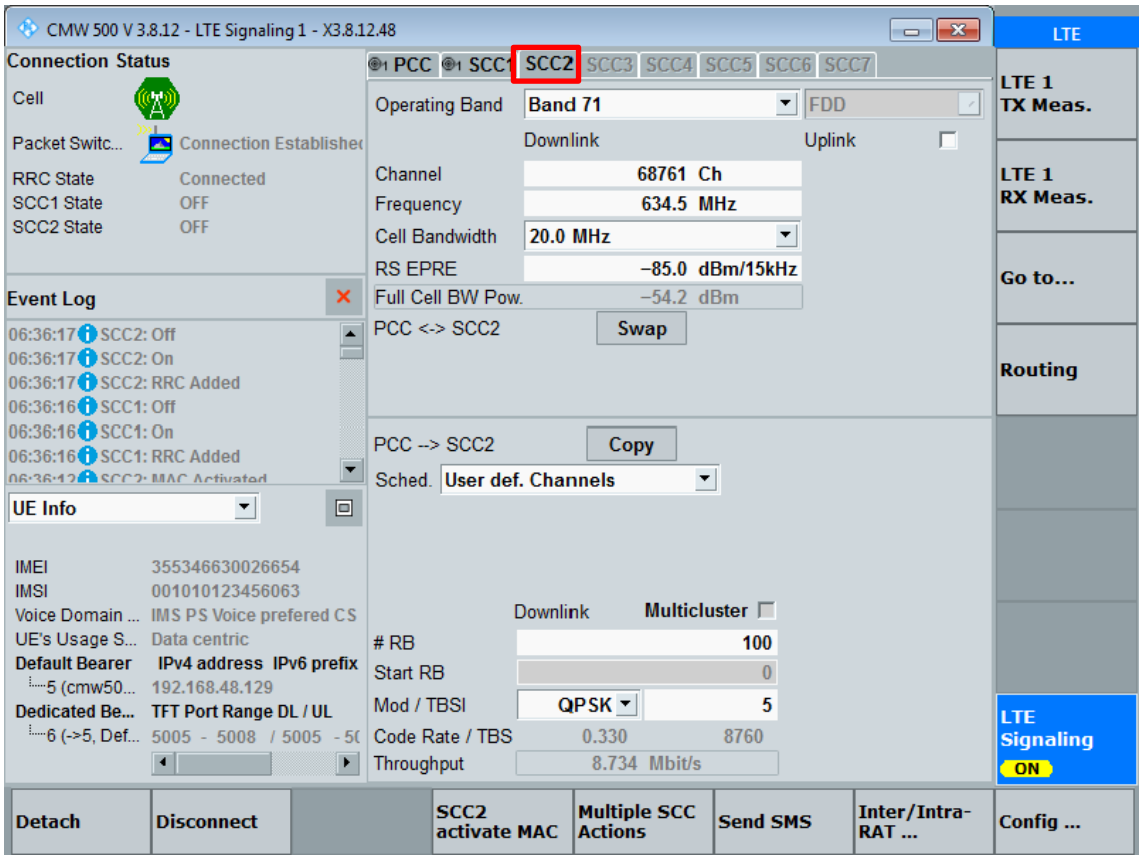


- Back to the LTE Signal screen, and then select the PCC tab,
  Set operating band, BW, channel and RB configurations for PCC

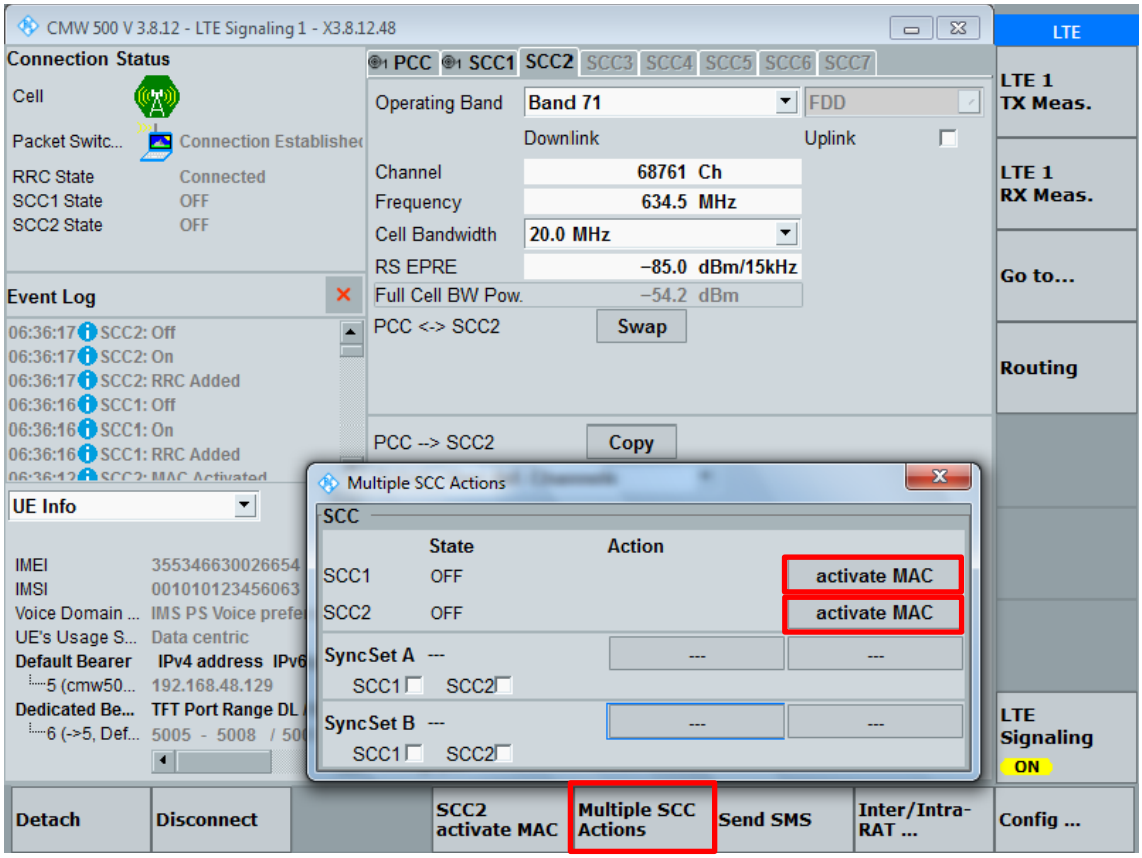


- Select the SCC1/SCC2 tab, set operating band, BW, channel and RB configurations for SCC1/SCC2

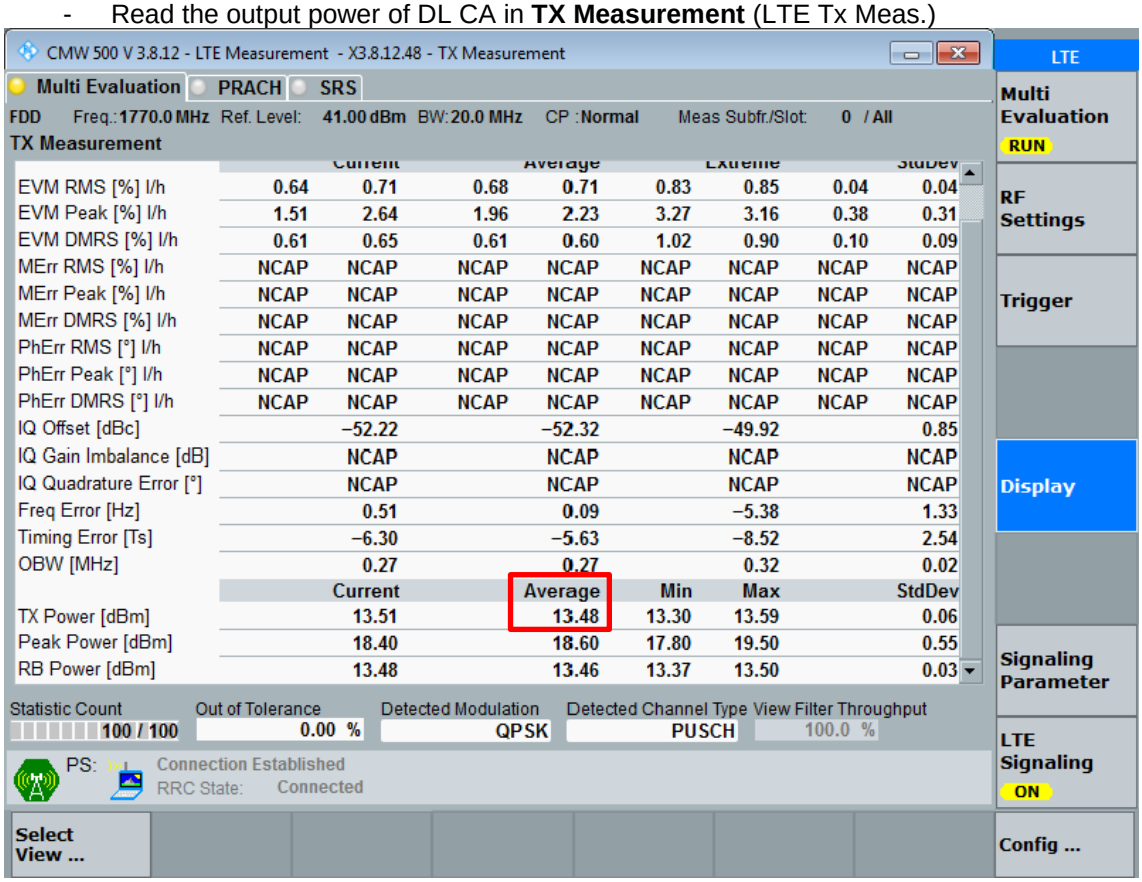




- Connect and Activate MAC for all SCCs

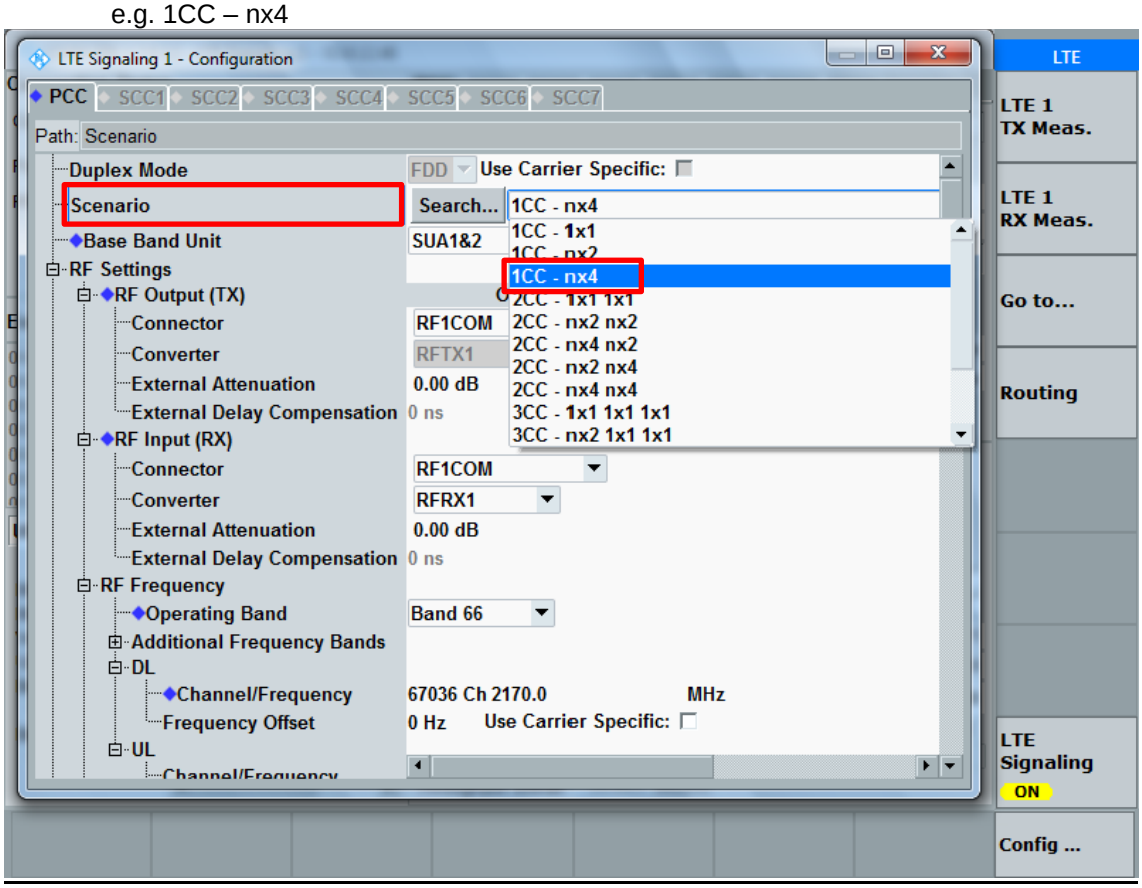


- Read the output power of DL CA in **TX Measurement** (LTE Tx Meas.)

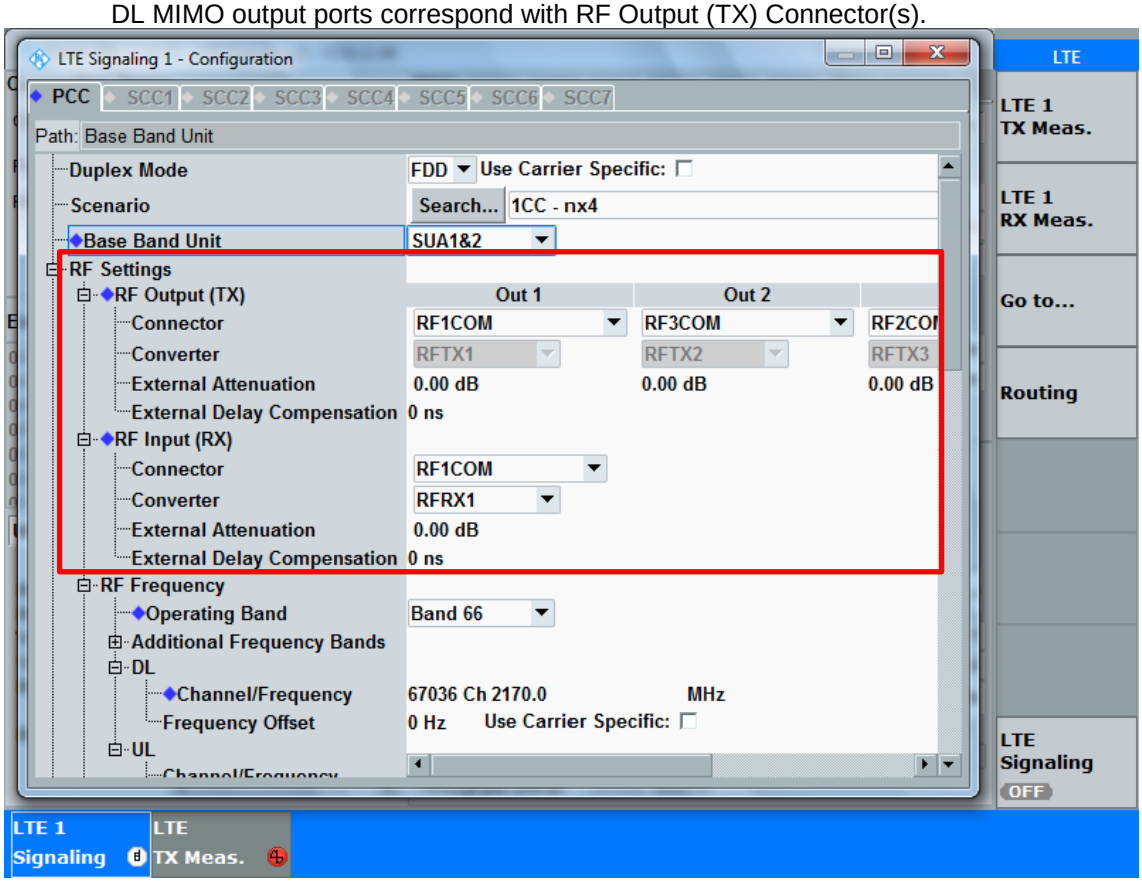


LTE Downlink 4x4 MIMO - Output Power measurement procedures

- Change the Scenario in the Configuration of LTE Signaling
  e.g. 1CC – nx4

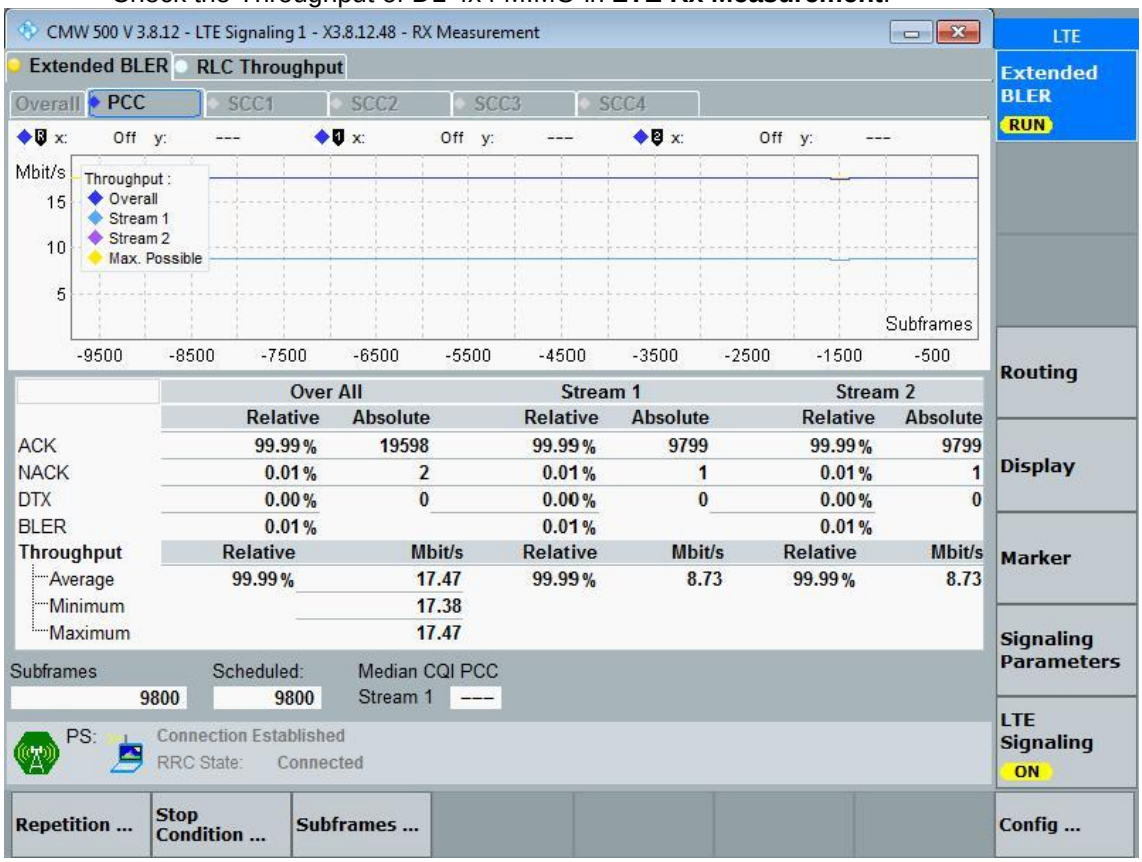


- Set the RF Output/Input Connector and Converter for PCC.
  DL MIMO output ports correspond with RF Output (TX) Connector(s).

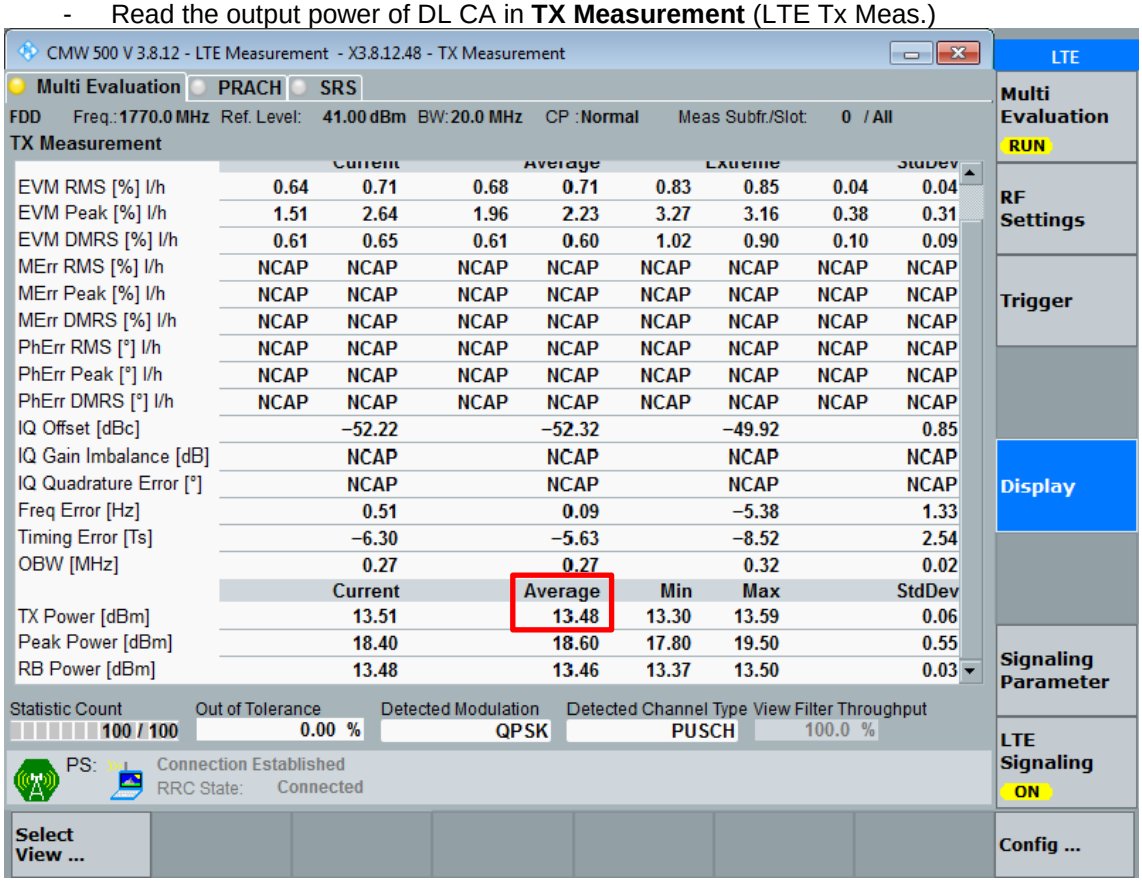


- Back to the LTE Signal screen, set operating band, BW, channel and RB configurations for PCC

- Check the Throughput of DL 4x4 MIMO in **LTE Rx Measurement**.



- Read the output power of DL CA in **TX Measurement** (LTE Tx Meas.)



LTE Uplink Carrier Aggregation Combinations

Maximum Output Power (Tune-up Limit) for LTE UL Carrier Aggregation

UL CA shall be tested based on the worst-case SAR configuration determined from non-CA SAR testing result. The channel BW, channel number, RB Allocation, etc. would be selected to allow contiguous CA of PCC and SCC. Uplink output power for UL CA is the total power measured across the PCC and SCC.

UL CA power measurements were performed with QPSK modulation based on the worst-case standalone SAR. The tune-up limits are provided in table below. The UL CA mode power measurements represent the total power across both carriers. Measurements were made for all supported PCC bandwidths using the channel/RB combination resulting in the highest standalone output power at the least MPR (0 dB). SCCs were set to use configurations similar to the PCC to establish conservative or worst case equivalent SAR test conditions (highest maximum power with MPR of 0 dB).

The standalone power measurement is the power for the PCC in the non-CA mode (i.e. single carrier power). In all cases the UL CA power is less than or equal to the standalone power, which is in accordance with the tune-up limits in table below.

According to November 2017 TCB workshop, Uplink CA SAR Test Guidance as follows;

a) When the maximum output for UL CA is ≤ standalone LTE mode (without CA)
   - PCC is configured according to the highest standalone SAR configuration tested
   - SCC and subsequent CCs are configured according to procedures used for power measurement and parameters (BW, RB etc.) similar to that used for the PCC.

b) When the Reported SAR for UL CA configuration, described above, is > 1.2 W/kg, UL CA SAR is also required for all required test channels (PCC based).

c) UL CA SAR is also required for standalone SAR configurations > 1.2 W/kg when they are scaled to the UL CA power level.

SAR measurement is not required for the 16QAM and 64QAM. When the highest maximum output power for 16QAM and 64QAM is ≤ 0.25 dB higher than the QPSK or when the reported SAR for the QPSK configuration is ≤ 1.45 W/kg.

E-UTRA CA configuration (BCS)	RF exposure conditions	Antenna	Bands		UL																		
			PCC	SCC	PCC						SCC						MPR	Standalone	PCC + SCC				
			1st	2nd	Modulation	RB	Offset	BW	Freq	ch	Modulation	RB	Offset	BW	Freq	ch		LTE Rel.8	Aggregated BW	MPR	Tune-Up Limit	CA power (total PCC+SCC)	Delta	3GPP Rel.
CA_41C(0)(1)(2)(3)	Head	Ant B	41C	41C	QPSK	1	0	20	2636.5	41055	QPSK	1	99	20	2616.7	40857	0	24.40	40	0	25.0	24.39	-0.01	16
CA_41C(0)(1)(2)(3)	Hotspot & Product specific 10-g SAR (Max)	Ant B	41C	41C	QPSK	50	0	20	2636.5	41055	QPSK	50	50	20	2616.7	40857	0	20.41	40	0	21.0	20.36	-0.05	16
CA_41C(0)(1)(2)(3)	Extremity	Ant B	41C	41C	QPSK	50	0	20	2636.5	41055	QPSK	50	50	20	2616.7	40857	0	17.82	40	0	18.5	17.81	-0.01	16
CA_41C(0)(1)(2)(3)	Body	Ant B	41C	41C	QPSK	50	50	20	2506.0	39750	QPSK	50	0	20	2525.8	39948	0	17.87	40	0	18.5	17.83	-0.04	16
CA_41C(0)(1)(2)(3)	Head	Ant E	41C	41C	QPSK	1	0	20	2680.0	41490	QPSK	1	99	20	2660.2	41292	0	23.72	40	0	25.0	23.71	-0.01	16
CA_41C(0)(1)(2)(3)	Hotspot	Ant E	41C	41C	QPSK	50	0	20	2680.0	41490	QPSK	50	50	20	2660.2	41292	0	20.87	40	0	22.0	20.85	-0.02	16
CA_41C(0)(1)(2)(3)	Extremity	Ant E	41C	41C	QPSK	50	50	20	2549.5	40185	QPSK	50	0	20	2569.3	40383	0	21.01	40	0	22.0	21.01	0.00	16
CA_41C(0)(1)(2)(3)	Body	Ant E	41C	41C	QPSK	50	0	20	2680.0	41490	QPSK	50	50	20	2660.2	41292	0	20.87	40	0	22.0	20.83	-0.04	16

Note:

Standalone output power values are referenced from Sec.9.3 in the SAR Part.1 Test Report.

LTE Downlink Carrier Aggregation Combinations

The DL CA power measurement conditions for various CC's combinations were determined according LTE DL CA SAR Test Exclusion guidance in TCB workshop note (April 2018). Only yellow highlighted cells need power measurement. The following power measurements were performed with a single carrier uplink; CA for this particular project only supports one (1) uplink and up to four (3) downlinks.

LTE Release 10 Carrier Aggregation

Index	2CC	Restriction	Completely Covered by Measurement Superset
2CC#1	41C		

Index	3CC	Restriction	Completely Covered by Measurement Superset
3CC#1	41D		

LTE Release 10 Carrier Aggregation with 4x4 MIMO

Index	2CC	Restriction	Completely Covered by Measurement Superset
2CC#1	[41C]		

Index	3CC	Restriction	Completely Covered by Measurement Superset
3CC#1	[41D]		

Note:

Only yellow highlight cells need power measurement according to LTE DL CA SAR test Exclusion in TCB workshop (April.2018).

Single Carrier Downlink 4x4 MIMO output power results

LTE Bands	Modulation	BW (MHz)	Channel	Freq. (MHz)	RB/Offset	LTE Rel 8 Tx. Power [dBm]	DL 4x4 MIMO Tx. Power [dBm]	Delta
41	QPSK	20	41055	2636.5	1/0	24.40	24.37	-0.03

Note:

According to LTE Test Conditions in TCB workshop (May, 2017), SAR is excluded for LTE downlink 4x4 MIMO operation when uplink output with DL MIMO does not exceed highest uplink output power configuration without DL MIMO by more than 1/4 dB. And for DL MIMO with carrier aggregation, the same SAR test exclusion procedure is considered.

DL CA output power results

E-UTRA CA configutation (BCS)	Bands			UL							DL												LTE Rel 8 Tx. Power [dBm]	LTE Rel 10 Tx. Power [dBm]	Delta
	PCC	SCC1	SCC2	PCC							PCC				SCC1				SCC2						
	1st	2nd	3rd	Band	Mode	BW (MHz)	Channel	Freq. (MHz)	RB Allocation	RB offset	Band	BW (MHz)	Channel	Freq. (MHz)	Band	BW (MHz)	Channel	Freq. (MHz)	Band	BW (MHz)	Channel	Freq. (MHz)			
41C	41C	41C		41	QPSK	20	41055	2636.5	1	0	41	20	41055	2636.5	41	20	40857	2616.7					24.40	24.36	-0.04
41D	41D	41D	41D	41	QPSK	20	41055	2636.5	1	0	41	20	41055	2636.5	41	20	40857	2616.7	41	20	40659	2596.9	24.40	24.35	-0.05

DL CA with 4x4 MIMO output power results

E-UTRA CA configutation (BCS)	Bands			UL							DL												LTE Rel 8 Tx. Power [dBm]	LTE Rel 10 Tx. Power [dBm]	Delta
	PCC	SCC1	SCC2	PCC							PCC				SCC1				SCC2						
	1st	2nd	3rd	Band	Mode	BW (MHz)	Channel	Freq. (MHz)	RB Allocation	RB offset	Band	BW (MHz)	Channel	Freq. (MHz)	Band	BW (MHz)	Channel	Freq. (MHz)	Band	BW (MHz)	Channel	Freq. (MHz)			
[41C]	41C	41C		41	QPSK	20	41055	2636.5	1	0	41	20	41055	2636.5	41	20	40857	2616.7					24.40	24.37	-0.03
[41D]	41D	41D	41D	41	QPSK	20	41055	2636.5	1	0	41	20	41055	2636.5	41	20	40857	2616.7	41	20	40659	2596.9	24.40	24.35	-0.05

Note:

1. Per KDB 941225 D05A LTE Rel. 10 KDB Inquiry Sheet: SAR is excluded for Carrier Aggregation when measured power does not exceed LTE Release 8 by more than a 1/4 dB.
2. When the same frequency band is used for both contiguous and non-contiguous in DL CA Intra band, power was measured using the configuration with the largest aggregated bandwidth and maximum output power among the contiguous and non-contiguous in DL CA Intra band configurations.

- END -