

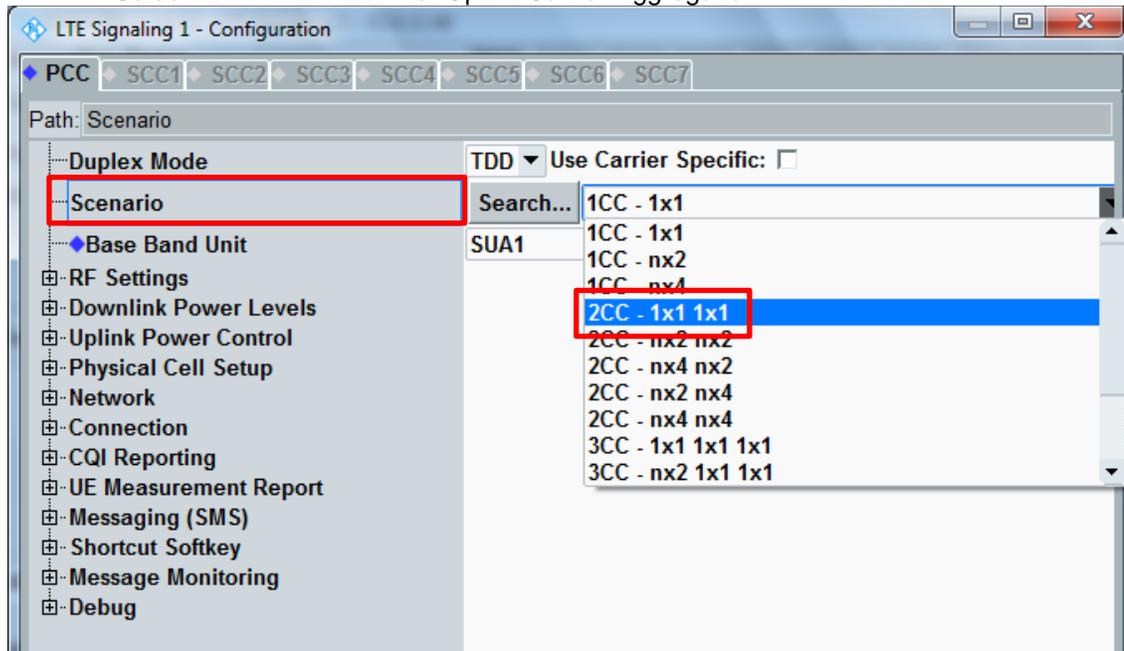
LTE Downlink Carrier Aggregation configurations

1. DL Intra Band(contiguous)

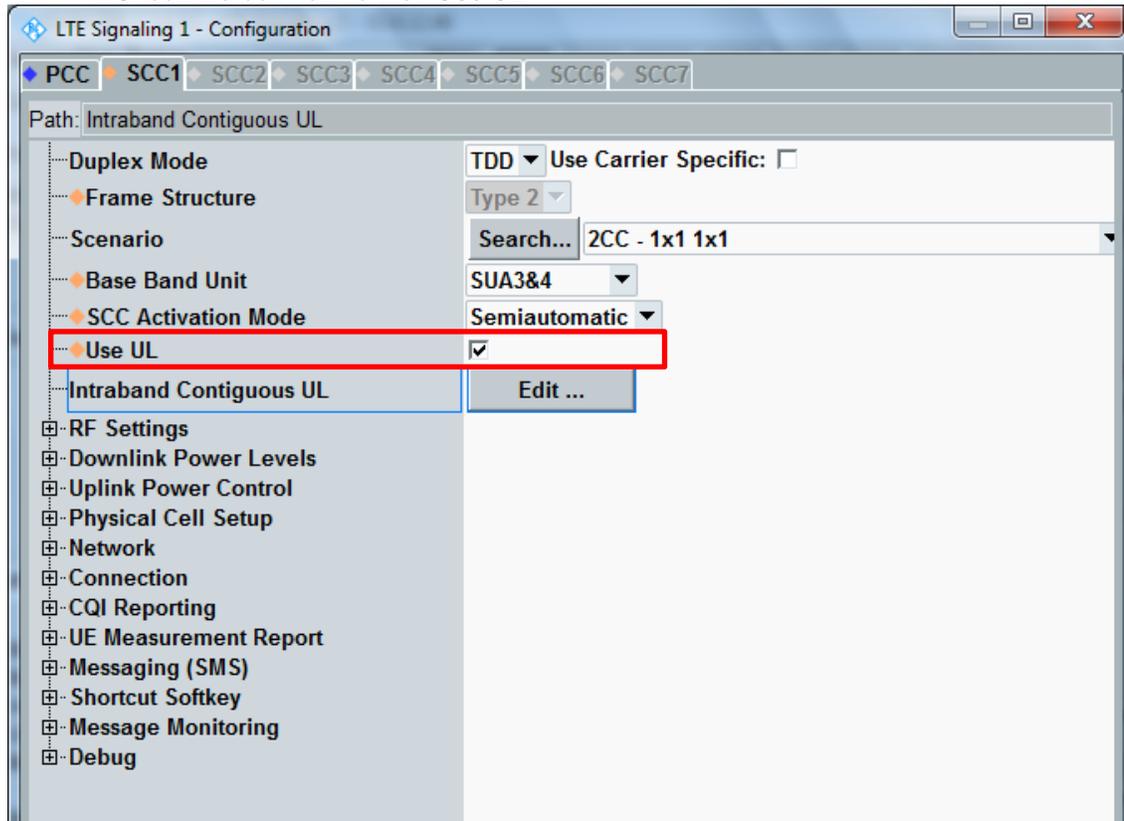
E-UTRA CA configuration	Bandwidth Combination	E-UTRA Band	Allowed Channel BW Per Carrier (MHz)					Max Aggregated BW
			1st Carrier	2nd Carrier	3rd Carrier	4th Carrier	5th Carrier	
41C	(0)	Band 41	10	20				40
			15	15, 20				
			20	10, 15, 20				
	(1)	Band 41	5, 10	20				40
			15	15, 20				
			20	5,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

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

CMW 500 V 3.8.12 - LTE Signaling 1 - X3.8.12.48

Connection Status: **PCC** | SCC1 | SCC2 | SCC3 | SCC4 | SCC5 | SCC6 | SCC7

Cell:

Packet Switched: ON

RRC State: Idle

SCC1 State: OFF

Event Log:

- 06:13:39 State 'Cell On', 2CC 1x1 1x1
- 06:13:21 Signaling Unit Startup
- 06:13:21 Data end to end enabled
- 06:13:20 Starting Data Application Unit

UE Info:

- IMEI: ---
- IMSI: ---
- Voice Domain Pr...: ---
- UE's Usage Setti...: ---
- Default Bearer: IPv4 address IPv6 prefix
- Dedicated Bearer: TFT Port Range DL / UL

Configuration:

- Operating Band: Band 41 | TDD
- Channel: 40620 Ch | 40620 Ch
- Frequency: 2593.0 MHz | 2593.0 MHz
- Cell Bandwidth: 20.0 MHz | 20.0 MHz
- RS EPRE: -85.0 dBm/15kHz
- Full Cell BW Pow.: -54.2 dBm
- PUSCH Open Loop Nom.Power: 23 dBm
- PUSCH Closed Loop Target Power: 24.0 dBm
- Sched.: User def. Channels
- # RB: 100 | 1
- Start RB: 0 | 99
- Mod / TBSI: QPSK | 5 | QPSK | 10
- Code Rate / TBS: 0.328 8760 | 0.583 144
- Throughput: 3.478 Mbit/s | 0.057 Mbit/s
- 64/256-QAM:
- Downlink Multicenter: Uplink Multicenter:

Routing: LTE Signaling ON

Config ...

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

CMW 500 V 3.8.12 - LTE Signaling 1 - X3.8.12.48

Connection Status: PCC | **SCC1** | SCC2 | SCC3 | SCC4 | SCC5 | SCC6 | SCC7

Cell:

Packet Switc...: ON

RRC State: Idle

SCC1 State: OFF

Event Log:

- 06:13:39 State 'Cell On', 2CC 1x1 1x1
- 06:13:21 Signaling Unit Startup
- 06:13:21 Data end to end enabled
- 06:13:20 Starting Data Application Unit

UE Info:

- IMEI: ---
- IMSI: ---
- Voice Domain ...: ---
- UE's Usage S...: ---
- Default Bearer: IPv4 address IPv6 prefix
- Dedicated Be...: TFT Port Range DL / UL

Configuration:

- Operating Band: Band 41 | TDD
- Channel: 40818 Ch | 40818 Ch
- Frequency: 2612.8 MHz | 2612.8 MHz
- Cell Bandwidth: 20.0 MHz | 20.0 MHz
- RS EPRE: -85.0 dBm/15kHz
- Full Cell BW Pow.: -54.2 dBm
- PUSCH Open Loop Nom.Power: 23 dBm
- PUSCH Closed Loop Target Power: 24.0 dBm
- Sched.: User def. Channels | Multicenter UL:
- # RB: 100 | 1
- Start RB: 0 | 0
- Mod / TBSI: QPSK | 5 | QPSK | 10
- Code Rate / TBS: 0.328 8760 | 0.583 144
- Throughput: 3.478 Mbit/s | 0.057 Mbit/s
- 64/256-QAM:
- Downlink Multicenter: Uplink Multicenter:

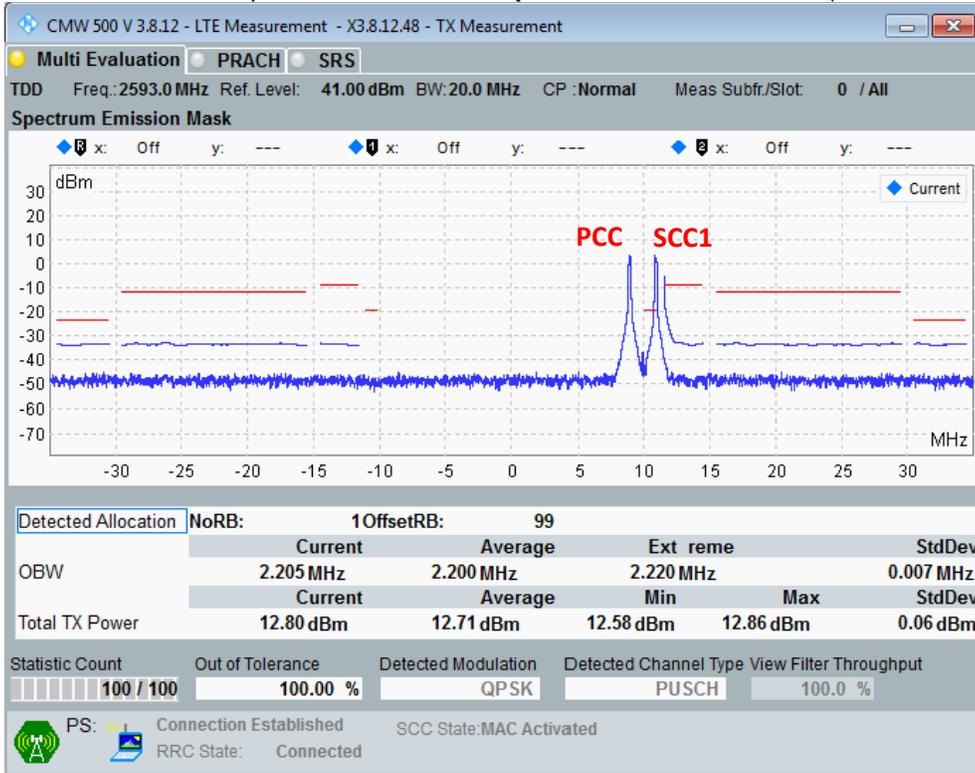
Routing: LTE Signaling ON

Config ...

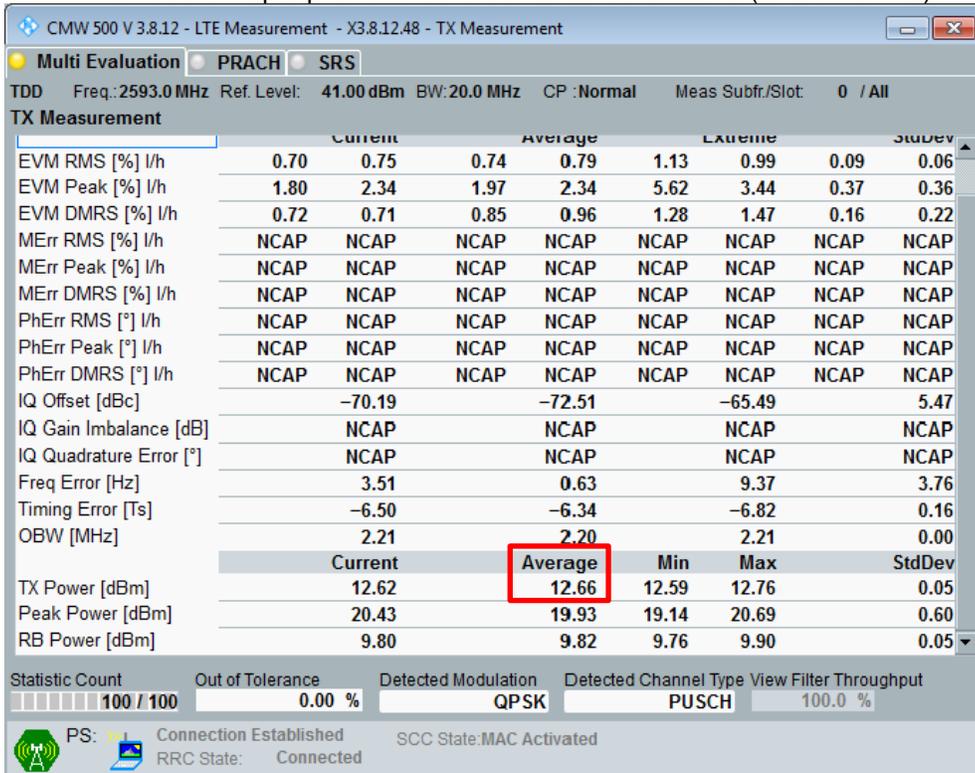
- Click the **“Connect”** button at the bottom of the screen, if necessary, turn the Airplane mode on/off in the DUT

The screenshot displays the CMW 500 V 3.8.12 - LTE Signaling 1 - X3.8.12.48 interface. The main window is titled "LTE" and shows the connection status for SCC1. The "Connection Status" section indicates that the connection is established, with RRC State "Connected" and SCC1 State "MAC Activated". The "Event Log" shows a series of events from 06:16:44 to 06:16:30, including "State 'Connection Established'", "EPS Dedicated Bearer Established", "SCC1: MAC Activated", "SCC1: RRC Added", "SCC1: On", and "SCC1: Off". The "UE Info" section displays various identifiers and settings, including IMEI (355346630026654), IMSI (001010123456063), and Voice Domain (IMS PS Voice preferred CS). The "Configuration" section shows the operating band as Band 41, with downlink and uplink channels at 40818 Ch and 2612.8 MHz. The "Throughput" section shows downlink and uplink rates of 3.478 Mbit/s and 0.057 Mbit/s, respectively. The "LTE Signaling" section is set to "ON". At the bottom of the interface, there are several buttons: "Detach", "Disconnect" (highlighted with a red box), "SCC1 Off", "Send SMS", "Inter/Intra-RAT ...", and "Config ...".

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

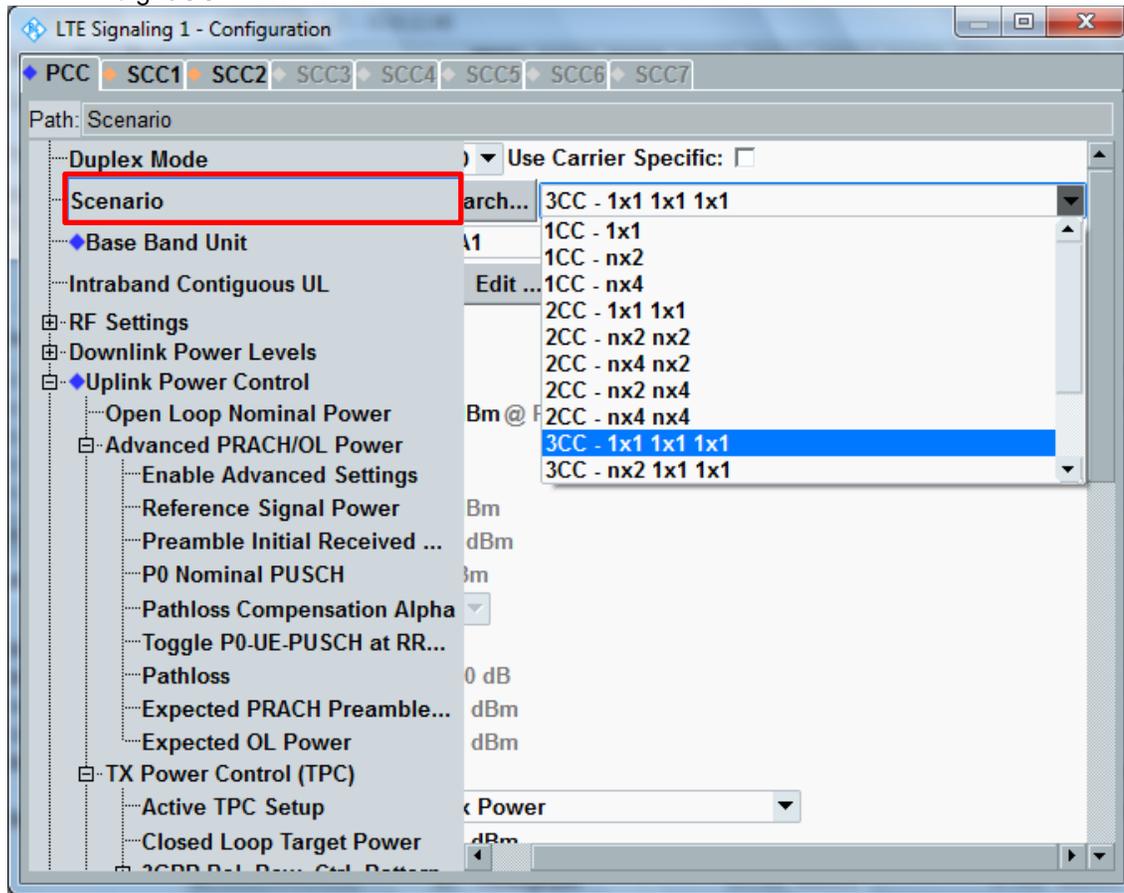


- Read the output power of UL CA in **TX Measurement** (LTE Tx Meas.)

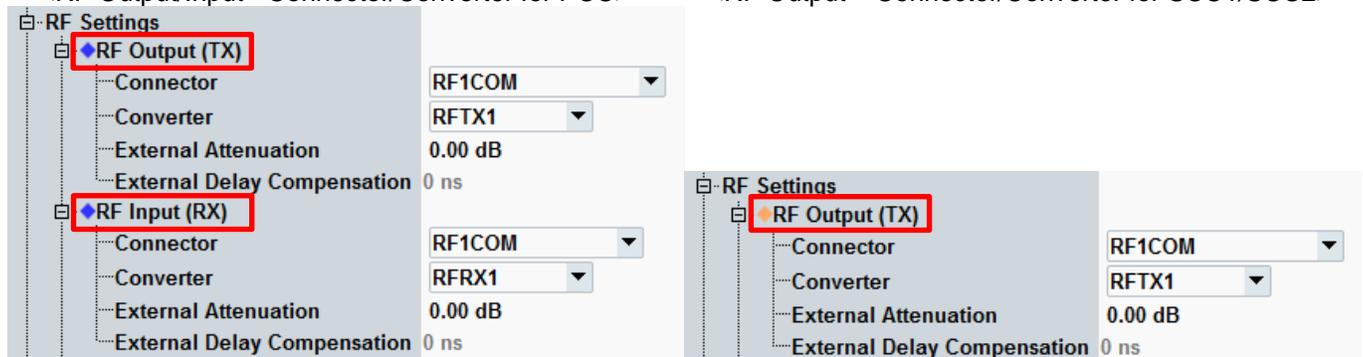


LTE Downlink Carrier Aggregation - Output Power measurement procedures

- 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

The screenshot displays the LTE Signaling 1 - X3.8.12.48 interface. At the top, the 'PCC' tab is selected and highlighted with a red box. Below the tab bar, the 'Connection Status' section shows 'Cell' with a signal strength indicator, 'Packet Switched' as 'Connection Established', and 'RRC State' as 'Connected'. The 'Event Log' section shows a series of events for SCC2 and SCC1. The 'UE Info' section displays IMEI, IMSI, Voice Domain Preference, and Default Bearer information. The main configuration area is divided into 'Downlink' and 'Uplink' sections. The 'Downlink' section shows 'Operating Band' as 'Band 66', 'Channel' as '67036 Ch', 'Frequency' as '2170.0 MHz', and 'Cell Bandwidth' as '20.0 MHz'. The 'Uplink' section shows 'Channel' as '132572 Ch', 'Frequency' as '1770.0 MHz', and 'Cell Bandwidth' as '20.0 MHz'. The 'Sched.' dropdown is set to 'User def. Channels'. The 'Throughput' section shows 'Downlink' as '8.734 Mbit/s' and 'Uplink' as '0.144 Mbit/s'. The 'LTE Signaling' button is highlighted in blue with 'ON' in yellow. At the bottom, there are buttons for 'Detach', 'Disconnect', 'SCC1 activate MAC', 'Multiple SCC Actions', 'Send SMS', 'Inter/Intra-RAT ...', and 'Config ...'.

Downlink	Uplink
Channel: 67036 Ch	Channel: 132572 Ch
Frequency: 2170.0 MHz	Frequency: 1770.0 MHz
Cell Bandwidth: 20.0 MHz	Cell Bandwidth: 20.0 MHz
RS EPRE: -85.0 dBm/15kHz	
Full Cell BW Pow.: -54.2 dBm	
PUSCH Open Loop Nom.Power: 23 dBm	
PUSCH Closed Loop Target Power: 24.0 dBm	
# RB: 100	# RB: 1
Start RB: 0	Start RB: 0
Mod / TBSI: QPSK 5	Mod / TBSI: QPSK 10
Code Rate / TBS: 0.330 8760	Code Rate / TBS: 0.583 144
Throughput: 8.734 Mbit/s	Throughput: 0.144 Mbit/s

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

The screenshot shows the configuration for SCC1. The 'Connection Status' tab is active, and 'SCC1' is selected in the top navigation bar. The 'Operating Band' is set to 'Co-location active with PCC' and 'FDD'. The 'Channel' is '66536 Ch' and the 'Frequency' is '2120.0 MHz'. The 'Cell Bandwidth' is '20.0 MHz'. The 'RS EPRE' is '-85.0 dBm/15kHz' and the 'Full Cell BW Pow.' is '-54.2 dBm'. The 'PCC <-> SCC1' button is visible. The 'Event Log' shows the following events: 06:36:17 SCC2: Off, 06:36:17 SCC2: On, 06:36:17 SCC2: RRC Added, 06:36:16 SCC1: Off, 06:36:16 SCC1: On, 06:36:16 SCC1: RRC Added, and 06:36:12 SCC2: MAC Activated. The 'UE Info' section shows: IMEI: 355346630026654, IMSI: 001010123456063, Voice Domain: IMS PS Voice preferred CS, UE's Usage S...: Data centric, Default Bearer: IPv4 address IPv6 prefix, 5 (cmw50...): 192.168.48.129, Dedicated Be...: TFT Port Range DL / UL, 6 (->5, Def...): 5005 - 5008 / 5005 - 5008. The 'Throughput' is '8.734 Mbit/s'. The 'LTE Signaling' indicator is 'ON'. The bottom bar contains buttons: Detach, Disconnect, SCC1 activate MAC, Multiple SCC Actions, Send SMS, Inter/Intra-RAT ..., and Config ...

The screenshot shows the configuration for SCC2. The 'Connection Status' tab is active, and 'SCC2' is selected in the top navigation bar. The 'Operating Band' is set to 'Band 71' and 'FDD'. The 'Channel' is '68761 Ch' and the 'Frequency' is '634.5 MHz'. The 'Cell Bandwidth' is '20.0 MHz'. The 'RS EPRE' is '-85.0 dBm/15kHz' and the 'Full Cell BW Pow.' is '-54.2 dBm'. The 'PCC <-> SCC2' button is visible. The 'Event Log' shows the following events: 06:36:17 SCC2: Off, 06:36:17 SCC2: On, 06:36:17 SCC2: RRC Added, 06:36:16 SCC1: Off, 06:36:16 SCC1: On, 06:36:16 SCC1: RRC Added, and 06:36:12 SCC2: MAC Activated. The 'UE Info' section shows: IMEI: 355346630026654, IMSI: 001010123456063, Voice Domain: IMS PS Voice preferred CS, UE's Usage S...: Data centric, Default Bearer: IPv4 address IPv6 prefix, 5 (cmw50...): 192.168.48.129, Dedicated Be...: TFT Port Range DL / UL, 6 (->5, Def...): 5005 - 5008 / 5005 - 5008. The 'Throughput' is '8.734 Mbit/s'. The 'LTE Signaling' indicator is 'ON'. The bottom bar contains buttons: Detach, Disconnect, SCC2 activate MAC, Multiple SCC Actions, Send SMS, Inter/Intra-RAT ..., and Config ...

- Connect and Activate MAC for all SCCs

Multiple SCC Actions

SCC	State	Action
SCC1	OFF	activate MAC
SCC2	OFF	activate MAC

Multiple SCC Actions

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

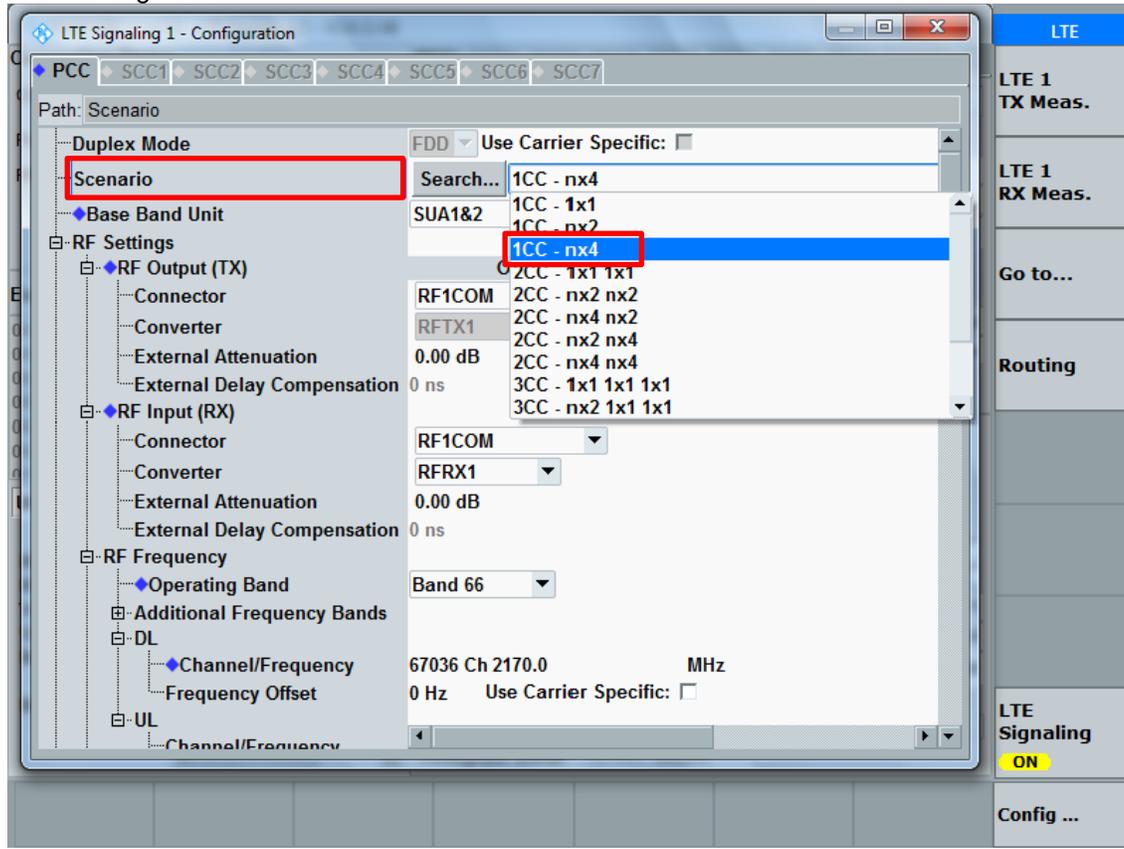
TX Measurement

	Current	Average	Extreme	StdDev
EVM RMS [%] I/h	0.64	0.71	0.68	0.71
EVM Peak [%] I/h	1.51	2.64	1.96	2.23
EVM DMRS [%] I/h	0.61	0.65	0.61	0.60
MErr RMS [%] I/h	NCAP	NCAP	NCAP	NCAP
MErr Peak [%] I/h	NCAP	NCAP	NCAP	NCAP
MErr DMRS [%] I/h	NCAP	NCAP	NCAP	NCAP
PhErr RMS [°] I/h	NCAP	NCAP	NCAP	NCAP
PhErr Peak [°] I/h	NCAP	NCAP	NCAP	NCAP
PhErr DMRS [°] I/h	NCAP	NCAP	NCAP	NCAP
IQ Offset [dBc]	-52.22	-52.32	-49.92	0.85
IQ Gain Imbalance [dB]	NCAP	NCAP	NCAP	NCAP
IQ Quadrature Error [°]	NCAP	NCAP	NCAP	NCAP
Freq Error [Hz]	0.51	0.09	-5.38	1.33
Timing Error [Ts]	-6.30	-5.63	-8.52	2.54
OBW [MHz]	0.27	0.27	0.32	0.02
	Current	Average	Min	Max
TX Power [dBm]	13.51	13.48	13.30	13.59
Peak Power [dBm]	18.40	18.60	17.80	19.50
RB Power [dBm]	13.48	13.46	13.37	13.50

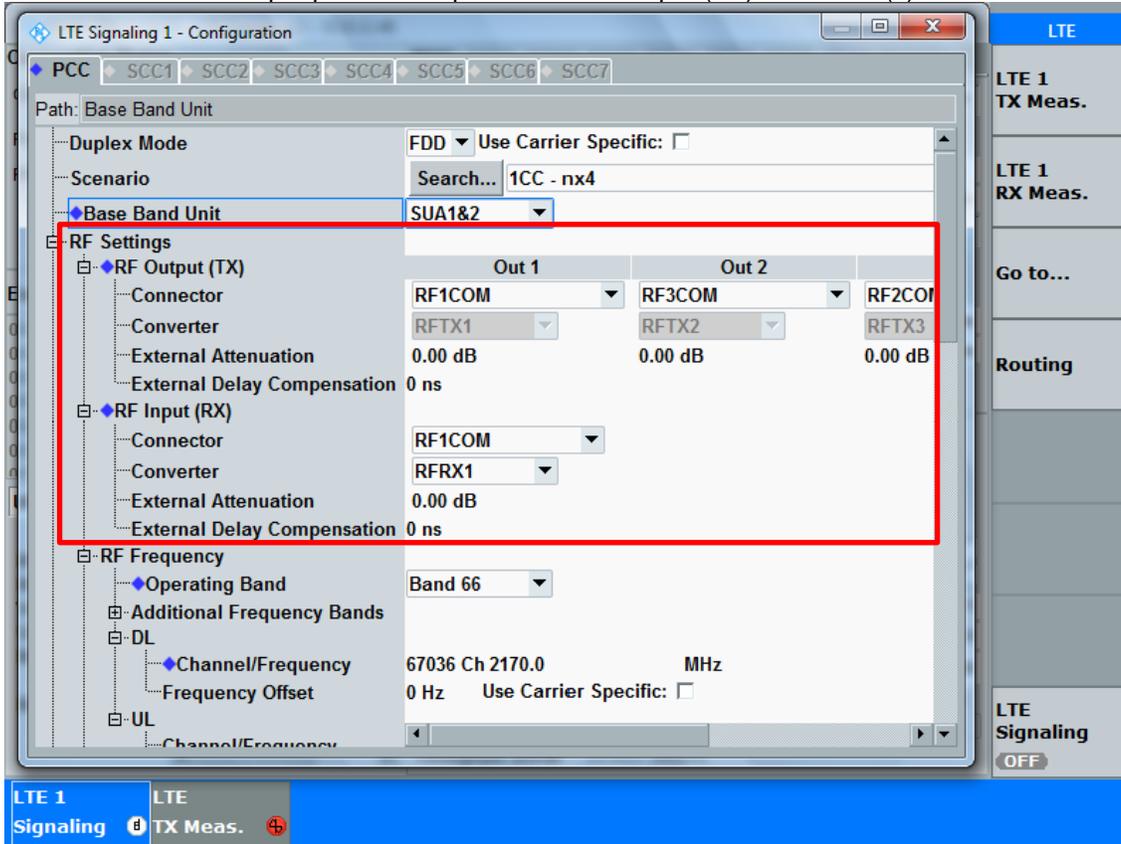
Statistic Count: 100 / 100
Out of Tolerance: 0.00 %
Detected Modulation: QPSK
Detected Channel Type: PUSCH
View Filter Throughput: 100.0 %

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.

CMW 500 V 3.8.12 - LTE Signaling 1 - X3.8.12.48 - RX Measurement

Extended BLER | RLC Throughput

Overall | PCC | SCC1 | SCC2 | SCC3 | SCC4

Throughput (Mbit/s) vs Subframes

	Over All		Stream 1		Stream 2	
	Relative	Absolute	Relative	Absolute	Relative	Absolute
ACK	99.99%	19598	99.99%	9799	99.99%	9799
NACK	0.01%	2	0.01%	1	0.01%	1
DTX	0.00%	0	0.00%	0	0.00%	0
BLER	0.01%		0.01%		0.01%	
Throughput	Relative	Mbit/s	Relative	Mbit/s	Relative	Mbit/s
Average	99.99%	17.47	99.99%	8.73	99.99%	8.73
Minimum		17.38				
Maximum		17.47				

Subframes: 9800 | Scheduled: 9800 | Median CQI PCC: Stream 1 ----

PS: Connection Established | RRC State: Connected

Repetition ... | Stop Condition ... | Subframes ...

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

CMW 500 V 3.8.12 - LTE Measurement - X3.8.12.48 - TX Measurement

Multi Evaluation | PRACH | SRS

FDD Freq.: 1770.0 MHz Ref. Level: 41.00 dBm BW: 20.0 MHz CP: Normal Meas Subfr/Slot: 0 / All

TX Measurement

	Current	Average	Extreme	StdDev
EVM RMS [%] I/h	0.64	0.71	0.83	0.04
EVM Peak [%] I/h	1.51	2.23	3.27	0.38
EVM DMRS [%] I/h	0.61	0.60	1.02	0.10
MErr RMS [%] I/h	NCAP	NCAP	NCAP	NCAP
MErr Peak [%] I/h	NCAP	NCAP	NCAP	NCAP
MErr DMRS [%] I/h	NCAP	NCAP	NCAP	NCAP
PhErr RMS [°] I/h	NCAP	NCAP	NCAP	NCAP
PhErr Peak [°] I/h	NCAP	NCAP	NCAP	NCAP
PhErr DMRS [°] I/h	NCAP	NCAP	NCAP	NCAP
IQ Offset [dBc]	-52.22	-52.32	-49.92	0.85
IQ Gain Imbalance [dB]	NCAP	NCAP	NCAP	NCAP
IQ Quadrature Error [°]	NCAP	NCAP	NCAP	NCAP
Freq Error [Hz]	0.51	0.09	-5.38	1.33
Timing Error [Ts]	-6.30	-5.63	-8.52	2.54
OBW [MHz]	0.27	0.27	0.32	0.02
	Current	Average	Min	Max
TX Power [dBm]	13.51	13.48	13.30	13.59
Peak Power [dBm]	18.40	18.60	17.80	19.50
RB Power [dBm]	13.48	13.46	13.37	13.50

Statistic Count: 100 / 100 | Out of Tolerance: 0.00% | Detected Modulation: QPSK | Detected Channel Type: PUSCH | View Filter Throughput: 100.0%

PS: Connection Established | RRC State: Connected

Select View ...

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 (4) downlinks.

LTE Release 10 Carrier Aggregation

Index	2CC	Restriction	Completely Covered by Measurement Superset	Index	3CC	Restriction	Completely Covered by Measurement Superset
2CC#1	41C			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]		

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	40620	2593	1/99	24.35	24.26	-0.09

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 configuration (BCS)	Bands				UL								DL								LTE Rel 8 Tx. Power [dBm]	LTE Rel 10 Tx. Power [dBm]	Delta							
	PCC	SCC1	SCC2	SCC3	PCC				PCC				SCC1				SCC2							SCC3						
	1st	2nd	3rd	4th	Band	Mode	BW (MHz)	Channel	Freq. (MHz)	RB Allocatio	RB offset	Band	BW (MHz)	Channel	Freq. (MHz)	Band	BW (MHz)	Channel	Freq. (MHz)	Band				BW (MHz)	Channel	Freq. (MHz)	Band	BW (MHz)	Channel	Freq. (MHz)
41C	41C	41C			41	QPSK	20	40620	2593	1	99	41	20	40620	2593	41	20	40818	2612.8									24.35	24.27	-0.08
41D	41D	41D	41D		41	QPSK	20	40620	2593	1	99	41	20	40620	2593	41	20	40818	2612.8	41	20	41016	2632.6					24.35	24.36	0.01

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.

DL CA with 4x4 MIMO output power results

E-UTRA CA configuration (BCS)	Bands				UL								DL												LTE Rel 8 Tx. Power [dBm]	LTE Rel 10 Tx. Power [dBm]	Delta				
	PCC	SCC1	SCC2	SCC3	PCC								SCC1				SCC2				SCC3										
	1st	2nd	3rd	4th	Band	Mode	BW (MHz)	Channel	Freq. (MHz)	RB Allocatio	RB offset	Band	BW (MHz)	Channel	Freq. (MHz)	Band	BW (MHz)	Channel	Freq. (MHz)	Band	BW (MHz)	Channel	Freq. (MHz)	Band				BW (MHz)	Channel	Freq. (MHz)	
[41C]	[41C]	[41C]			[41]	QPSK	20	40620	2593	1	99	[41]	20	40620	2593	[41]	20	40818	2612.8										24.35	24.31	-0.04
[41D]	[41D]	[41D]	[41D]		[41]	QPSK	20	40620	2593	1	99	[41]	20	40620	2593	[41]	20	40818	2612.8	[41]	20	41016	2632.6						24.35	24.40	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 -