

CMW500 Hands On LTE Carrier Aggregation

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ROHDE & SCHWARZ

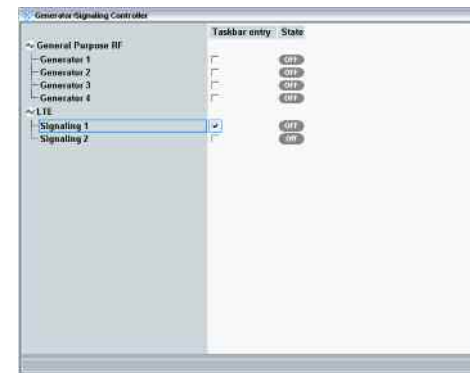
The LTE-CA Hands ON session requires following items:

- A CMW500 loaded with the following Hardware
 - CMW-B590D x2 – Advanced Front End
 - CMW-B570B x4 – Transceiver Module
 - CMW-B300B x2 – Signaling Unit Wideband
 - CMW-B450B x1 – Data Application Unit
- CMW Signaling Software Applications
 - CMW-K0
- CMW Firmware
 - BASE 3.2.20
 - DAU 3.2.11
 - LTE 3.2.50
- A Samsung Galaxy S4-A supporting LTE Carrier Aggregation (LTE Band3+LTE Band5)
- A Valid Test SIM Card
 - CMW-Z04



RESET CMW and MAP LTE Signaling Application

- Reset the CMW
 - Use the “Close” tab to close all the open windows
 - Press the “RESET” key
 - Select “Preset” tab
- Map the LTE Signaling Application
 - Press the “SIGNAL GEN” tab
 - Scroll in the Generator/Signaling Controller windows and locate the LTE Signaling entry
 - Checkmark the LTE Signaling TaskbarEntry
 - Hit the “LTE Signaling” hot tab at the bottom of the CMW display



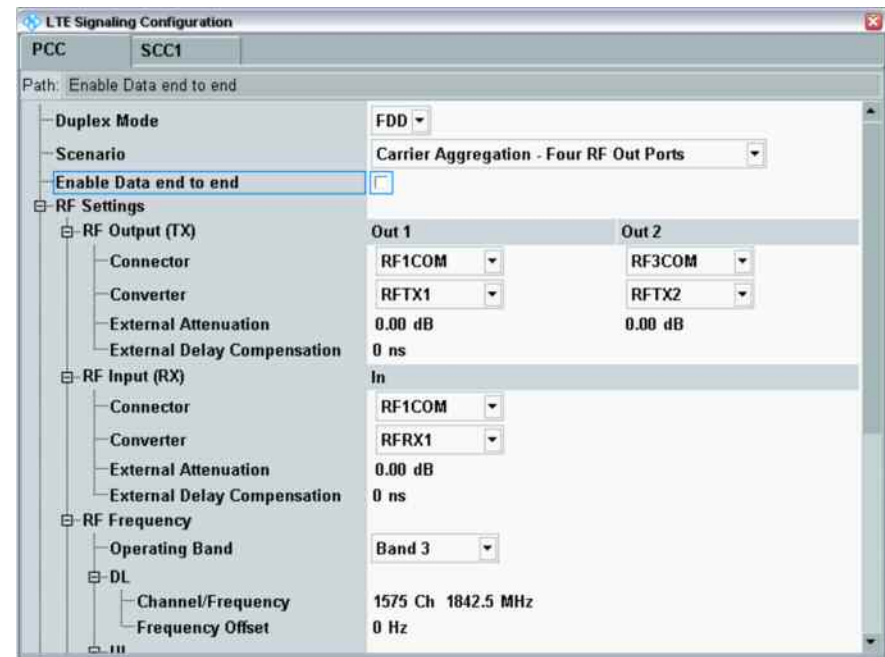
TEST in TEST MODE Connection

■ Set the CMW for Carrier Aggregation Mode

- Press the “Config” tab
- Press the “PCC” tab
- Expand the “Scenario” entry and select the “Carrier Aggregation – Four RF Out Ports”

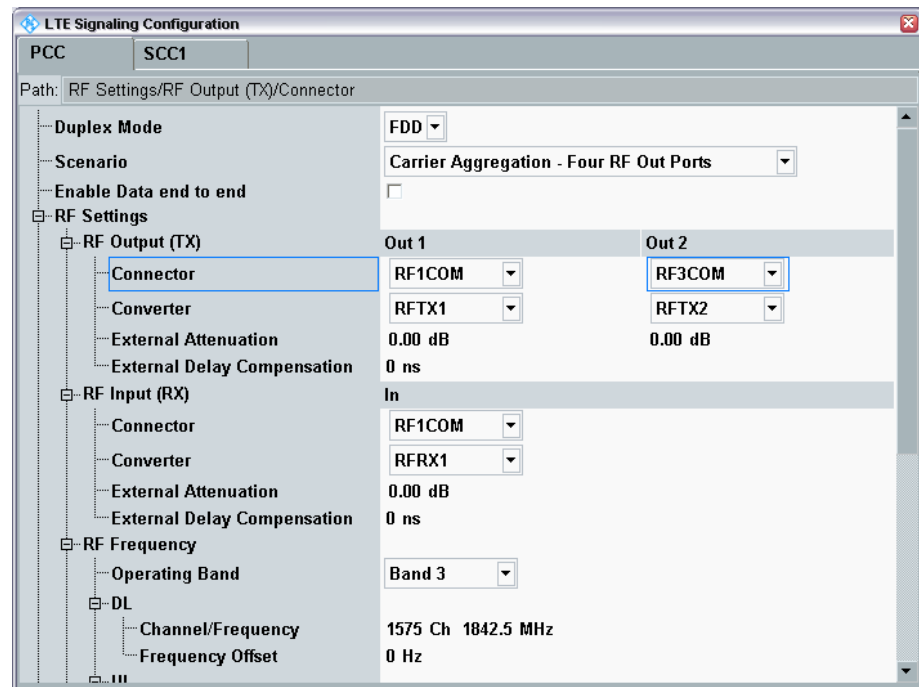
■ Set CMW for Test Mode

- Uncheckmark the “Enable Data end to end”



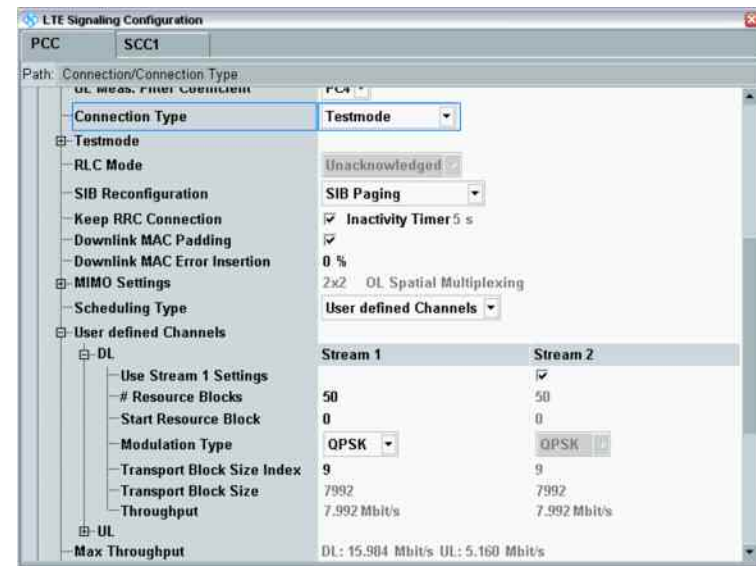
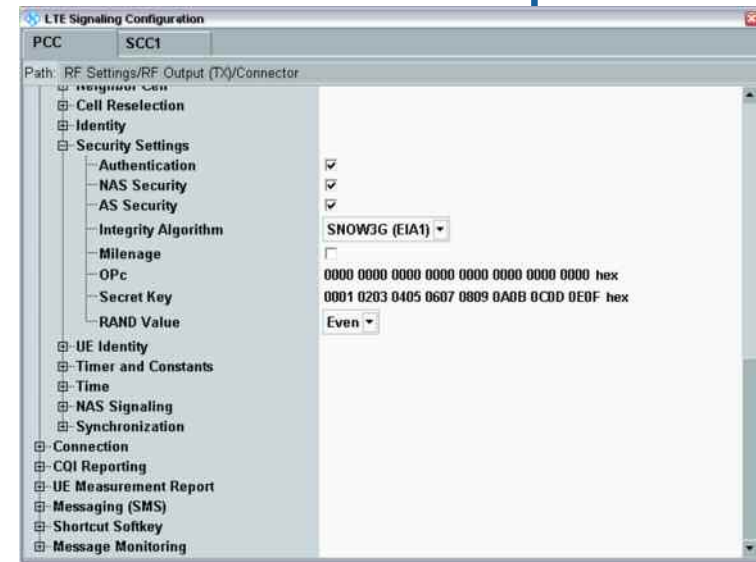
Set the Primary Component Carrier Cell – Step1

- ! Press the “PCC” tab
- ! Expand the “RF Settings” entry
 - Expand the “RF Output (TX)” entry
 - Set Out1 Connector to “RF1COM” port
 - Set Out1 Converter to “RFTX1”
 - Set Out2 Connector to “RF3COM” port
 - Set Out2 Converter to “RFTX2”
- ! Expand the “RF Input (RX)” entry
 - Set In Connector to “RF1COM” port
 - Set In Converter to “RFRX1”
- ! Expand the “RF Frequency” entry
 - Set the “Operating Band” to “Band 3”



Set the Primary Component Carrier Cell – Step2

- Expand the “Network” Entry
 - Expand the “Security Settings” entry
 - Set the “Integrity Algorithm” to “SNOW3G(EIA1)”
- Expand the “Connection” Entry
 - Set the “Connection Type” to “Testmode”
 - Checkmark “Downlink MAC Padding”
 - Change “Scheduling Type” to “User Defined Channels”
- Expand the “User Defined Channels”
 - Expand the “DL” entry
 - Set the “Transport Block Size Index” to “9”



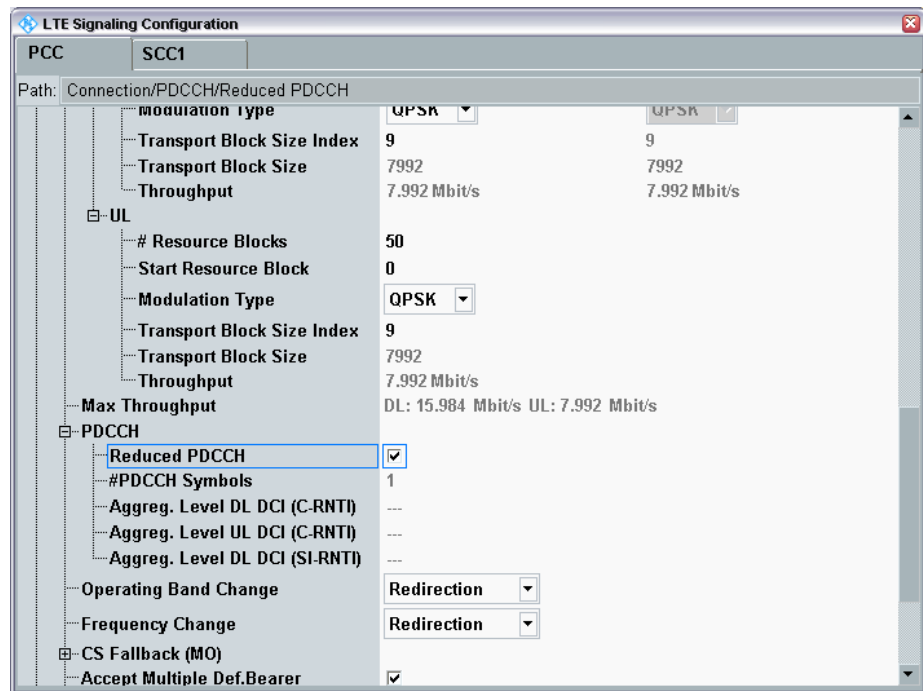
Set the Primary Component Carrier Cell – Step3

- ! Expand the “User Defined Channels”
 - Expand the “UL” entry
 - Set the “Transport Block Size Index” to “9”

- ! Expand the “PDCCH” entry
 - Checkmark “Reduced PDCCH”

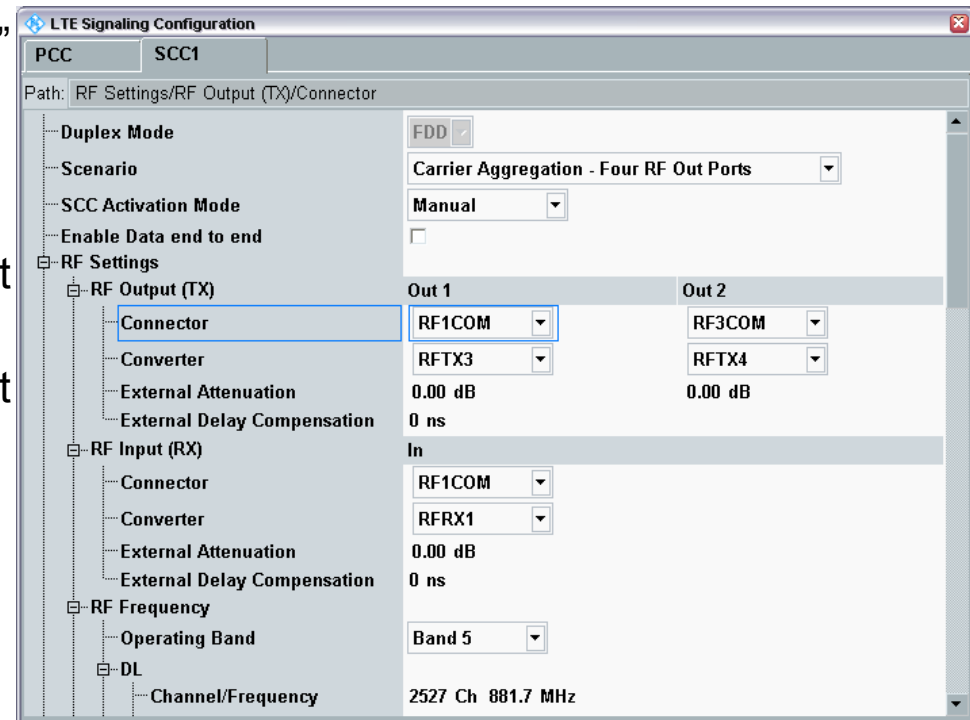
- ! Set the “Operating Band Change” to “Redirection”
- ! Set the “Frequency Change” to “Redirection”

- ! Checkmark “Accept Multiple Def.Bearer”



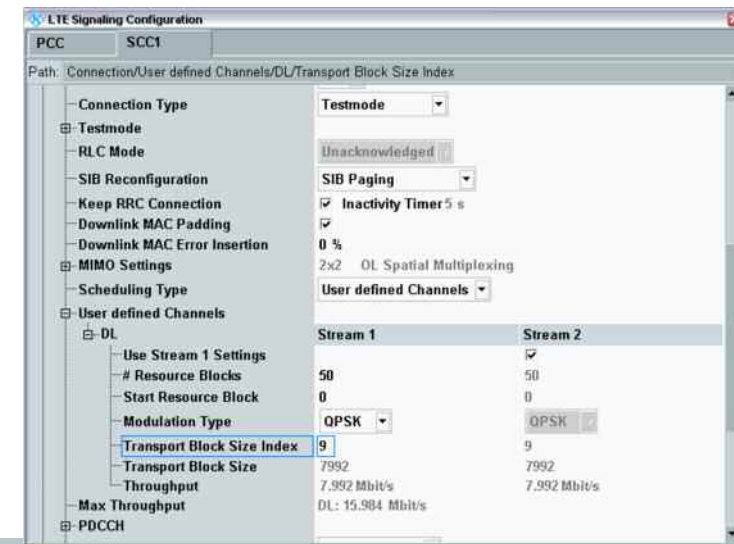
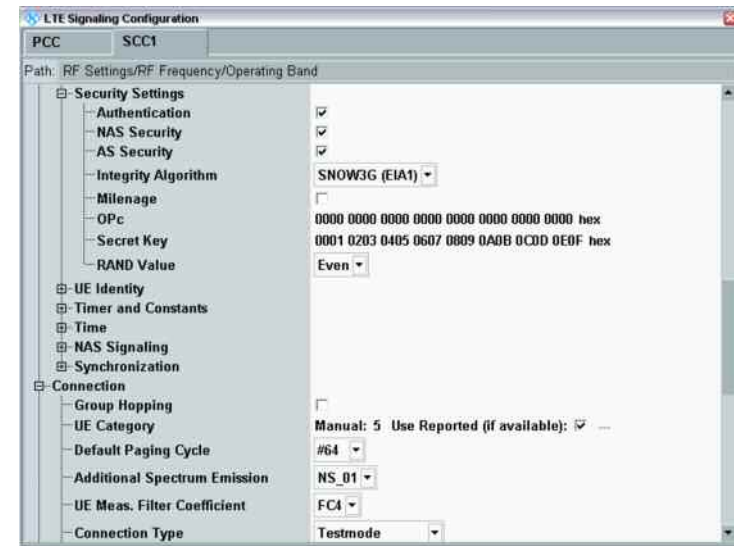
Set the Secondary Component Carrier Cell – Step1

- ! Press the “SCC1” tab
- ! Set the “SCC Activation Mode” to “Manual”
- ! Uncheckmark “Enable Data end to end”
- ! Expand “RF Settings” entry
 - Expand the “RF Output (TX)” entry
 - Set Out1 Connector to “RF1COM” port
 - Set Out1 Converter to “RFTX3”
 - Set Out2 Connector to “RF3COM” port
 - Set Out2 Converter to “RFTX4”
 - Expand the “RF Input (RX)” entry
 - Set In Connector to “RF1COM” port
 - Set In Converter to “RFRX1”
 - Expand the “RF Frequency” entry
 - Set the “Operating Band” to “Band 5”



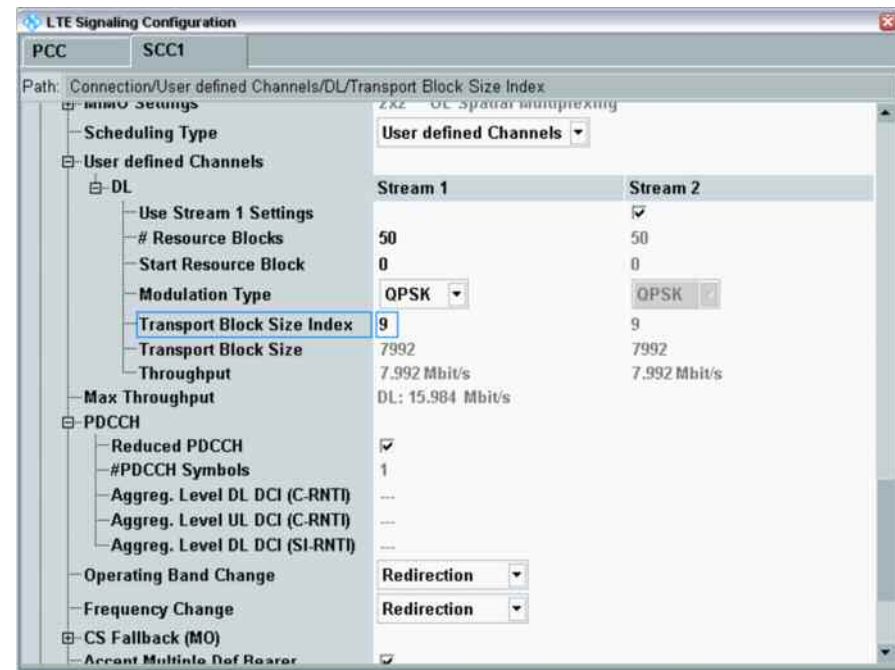
Set the Secondary Component Carrier Cell – Step2

- Expand the “Network” Entry
 - Expand the “Security Settings” entry
 - Set the “Integrity Algorithm” to “SNOW3G(EIA1)”
- Expand the “Connection” Entry
 - Set the “Connection Type” to “Testmode”
 - Checkmark “Downlink MAC Padding”
 - Change “Scheduling Type” to “User Defined Channels”
- Expand the “User Defined Channels” entry
 - Expand the “DL” entry
 - Set the “Transport Block Size Index” to “9”



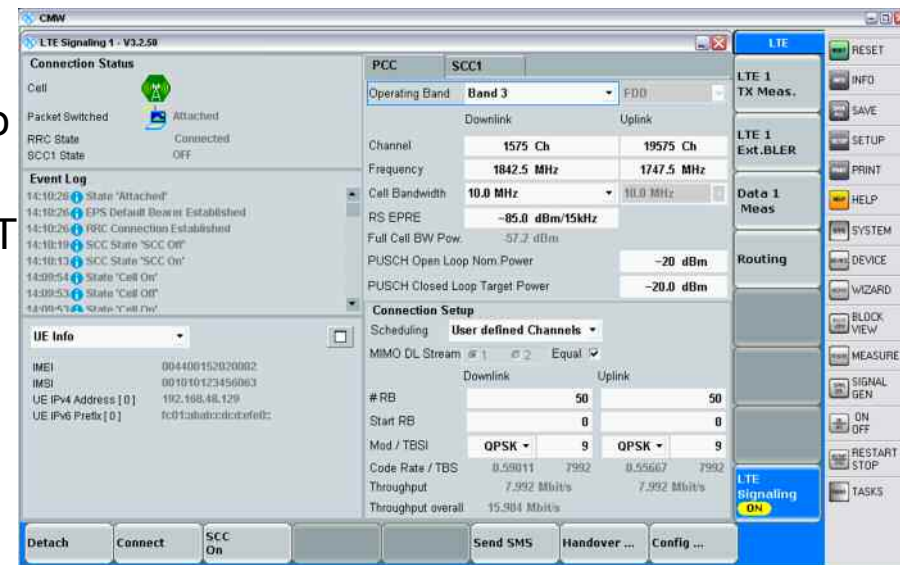
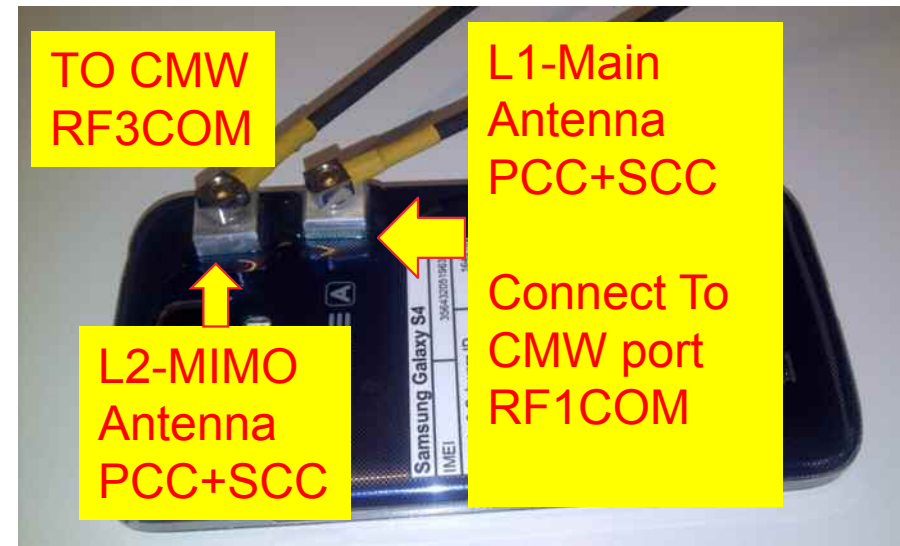
Set the Secondary Component Carrier Cell – Step3

- Expand the “PDCCH” entry
 - Checkmark “Reduced PDCCH”
- Set the “Operating Band Change” to “Redirection”
- Set the “Frequency Change” to “Redirection”
- Checkmark “Accept Multiple Def.Bearer”



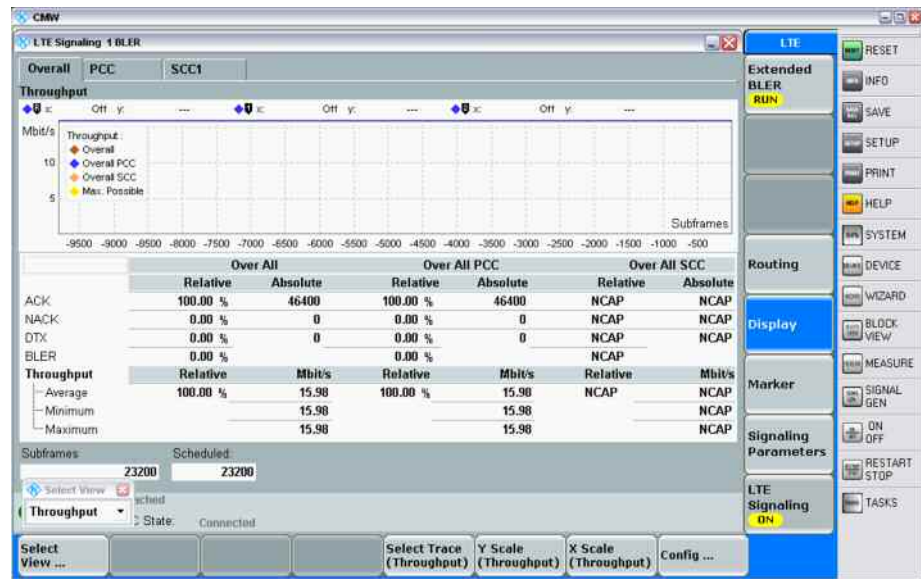
Attach DUT

- ▮ Close the Config screen
- ▮ Press the “PCC” tab
- ▮ Press the hot tab “LTE Signaling”
- ▮ Press the “ON/OFF” tab to start the LTE cell
 - Wait until the message “State ‘Cell On’” appears in the “Event Log” frame
 - At this time the CMW is waiting for a DUT to Attach
- ▮ DUT RF Connection
 - Connect the primary RF port of the DUT to the CMW RF connector “RF1COM”
 - Connect the secondary RF port of the DUT to the CMW RF connector “RF3COM”
- ▮ Power ON the DUT
 - The DUT has successfully attached when the “Packet Switched” state in the “Connection Status” frame is “Attached”



Check Throughput using PCC Cell

- Press the “LTE1 Ext. BLER” tab
- Select the Throughput Overall screen
 - Press the “Display” tab
 - Press the “Select View” tab and select the “Throughput”
 - Press the “Overall” tab
- PCC Throughput test
 - Press the “Extended BLER” hot tab
 - Press the “ON/OFF” tab
 - As only the PCC cell is activated you only see valid Throughput measurement in the “Overall” and “PCC” fields
- Press the “LTE signaling” hot tab twice to exit



Establish SCC carrier

- Establish the SCC carrier in 3 steps
 - Press the “SCC On” tab
 - Press the “SCC add RRC” tab
 - Press the “SCC activate MAC” tab
- When the “SCC1 State” is “MAC Activated” under the “Connection Status” Frame, the DUT has established the call with the SCC carrier

The image displays three sequential screenshots of the LTE Signaling 1 - V3.2.50 interface, illustrating the steps to establish the SCC carrier. Each screenshot shows the 'Connection Status' and 'Event Log' sections.

Step 1: SCC On

- Connection Status: Cell (Attached), Packet Switched (Attached), RRC State (Connected), SCC1 State (ON)
- Event Log: 12:21:03 SCC State 'SCC On', 12:19:52 State 'Attached'

Step 2: SCC add RRC

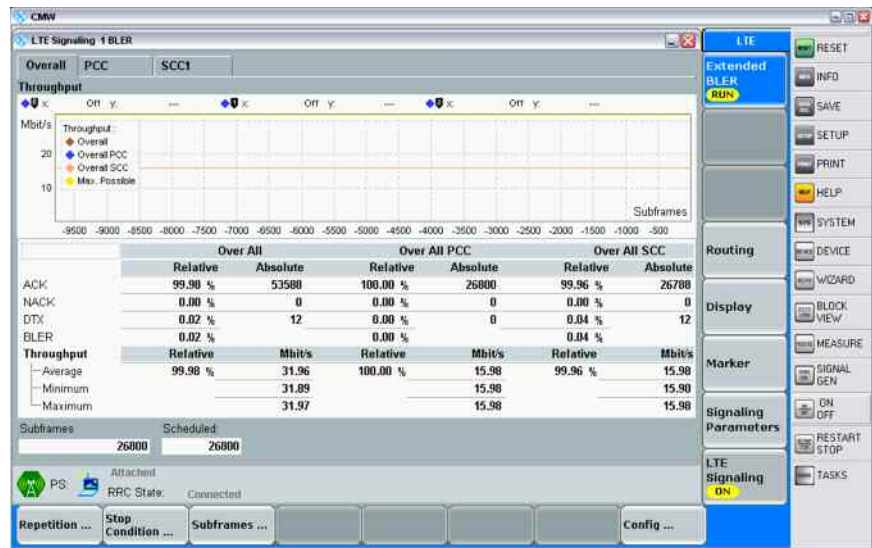
- Connection Status: Cell (Attached), Packet Switched (Attached), RRC State (Connected), SCC1 State (RRC Added)
- Event Log: 12:21:13 SCC State 'SCC RRC Added', 12:21:03 SCC State 'SCC On', 12:19:52 State 'Attached'

Step 3: SCC activate MAC

- Connection Status: Cell (Attached), Packet Switched (Attached), RRC State (Connected), SCC1 State (MAC Activated)
- Event Log: 14:19:18 SCC State 'SCC MAC Activated', 14:19:10 SCC State 'SCC RRC Added', 14:19:07 SCC State 'SCC On', 14:10:26 State 'Attached'

Check Throughput Test with PCC and SCC carriers

- From the Signaling screen, Press the “LTE 1 Ext.BLER” tab
- Select the Throughput Overall screen
 - Press the “Display” tab
 - Press the “Select View” tab and select the “Throughput”
 - Press the “Overall” tab
- PCC and SCC Throughput test
 - Press the “Extended BLER” hot tab
 - If the BLER Measurement is not running, press the “ON/OFF” tab
 - Observe that the Overall PCC and Overall SCC Measurements are now working
 - The Absolute Overall Throughput measurement displays the total throughput over the 2 carriers



MAX Throughput Test using PCC and SCC carriers

Change Scheduling

- From the Extended BLER screen, Press the “Signaling Parameters” tab
- Press the “Connection Setup” tab

Change PCC scheduling

- Press the “PCC” tab
- For “Downlink”, change “Mod” to “64-QAM”
- For “Downlink”, change the “TBSI” to “26”

Change SCC scheduling

- Press the “SCC1” tab
- Change the “Mod” to “64-QAM”
- Change the “TBSI” to “26”

MAX Throughput over 10 MHz bandwidth

- Close the Connection Setup windows
- Observe the Absolute Overall Throughput.
- Maximum Throughput is $2 * 73.392 \text{ Mbit/s} = 146.784 \text{ Mbit/s}$

The screenshot displays the CMW LTE Signaling 1 BLER interface. It shows the 'Connection Setup' for both PCC and SCC1 carriers, with 'User defined Channels' selected. The PCC carrier is configured with 64-QAM modulation and a TBSI of 26, while the SCC1 carrier is configured with QPSK modulation and a TBSI of 6. The overall throughput is shown as 73.392 Mbit/s. Below this, a graph shows the throughput over time, and a table provides detailed performance metrics for ACK, NACK, DTX, and BLER, as well as overall throughput statistics.

Over All		Over All PCC		Over All SCC		
	Relative	Absolute	Relative	Absolute	Relative	Absolute
ACK	99.99 %	47194	99.99 %	23598	99.98 %	23596
NACK	0.00 %	0	0.00 %	0	0.00 %	0
DTX	0.01 %	6	0.01 %	2	0.02 %	4
BLER	0.01 %		0.01 %		0.02 %	
Throughput	Relative	Mbit/s	Relative	Mbit/s	Relative	Mbit/s
- Average	99.99 %	146.77	99.99 %	73.39	99.98 %	73.38
- Minimum		146.05		73.03		73.03
- Maximum		146.78		73.39		73.39

Over All	
	Absolute
ACK	99.99 %
NACK	0.00 %
DTX	0.01 %
BLER	0.01 %
Throughput	Relative
- Average	99.99 %
- Minimum	
- Maximum	

Disconnect the CA Call

From the LTE Signaling screen, press the “LTE Signaling” tab

Disconnect the SCC cell

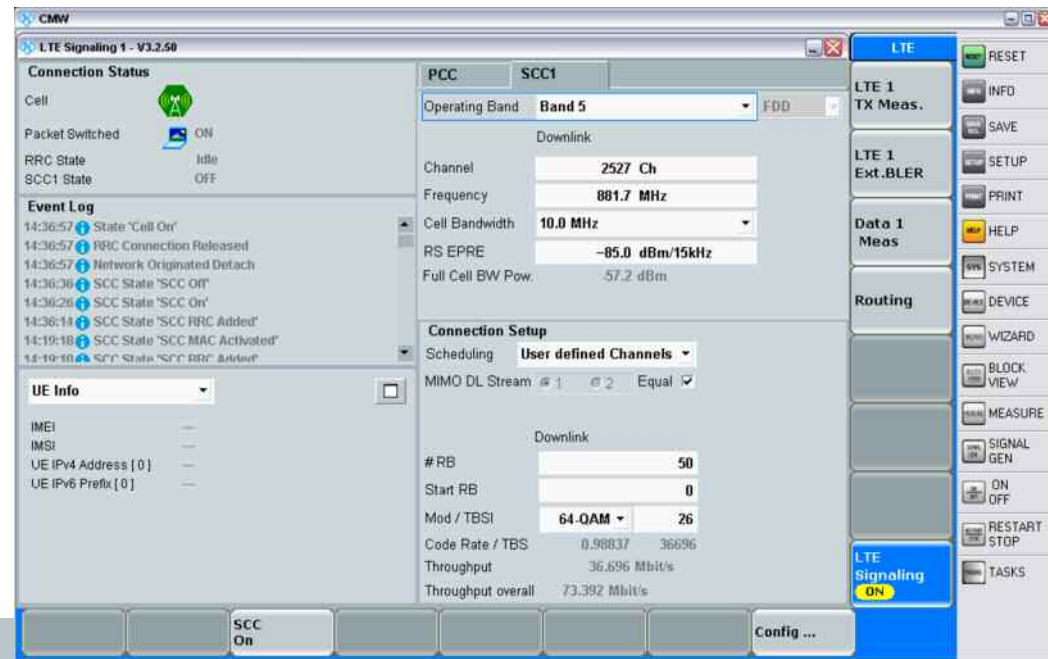
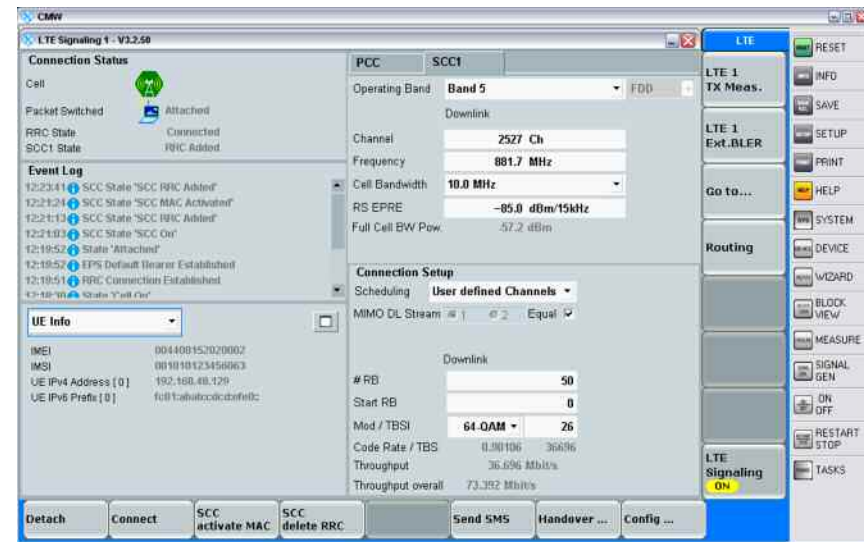
- Press the “SCC deactivate MAC” tab
- Press the “SCC delete RRC” tab
- Press the “SCC Off” tab

Disconnect the PCC cell

- Press the Detach tab
- At this point, the S4-A goes “out of Sync”

Turn OFF the LTE cell

- Press the “LTE signaling” tab
- Press the “ON/OFF” tab



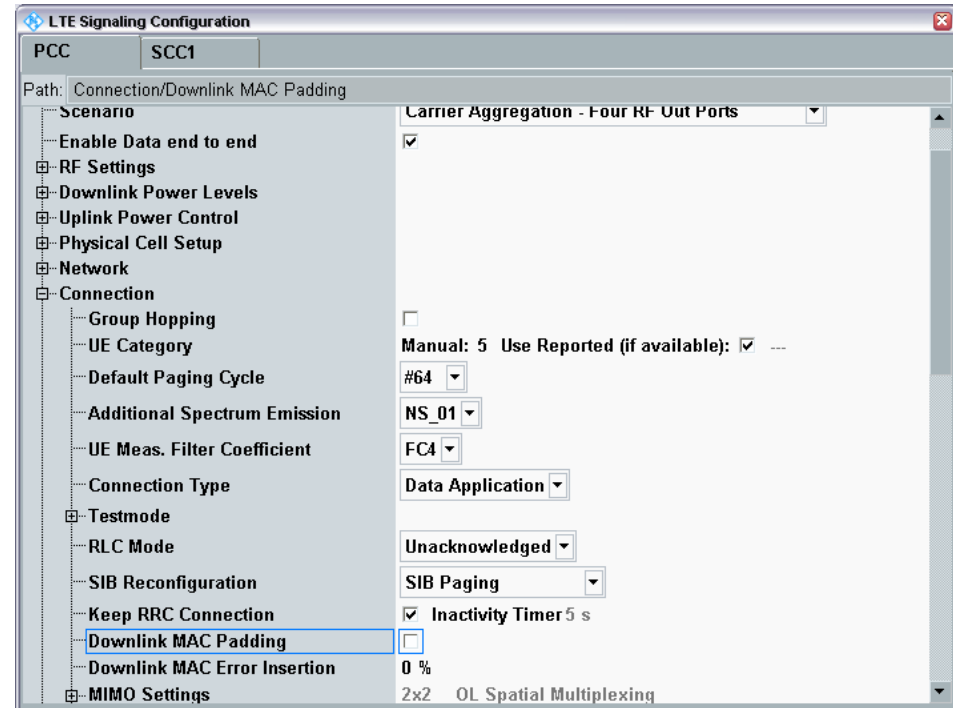
LTE CA Test In DATA end 2 end Mode



Setup the CMW for LTE-CA end 2 end Connection

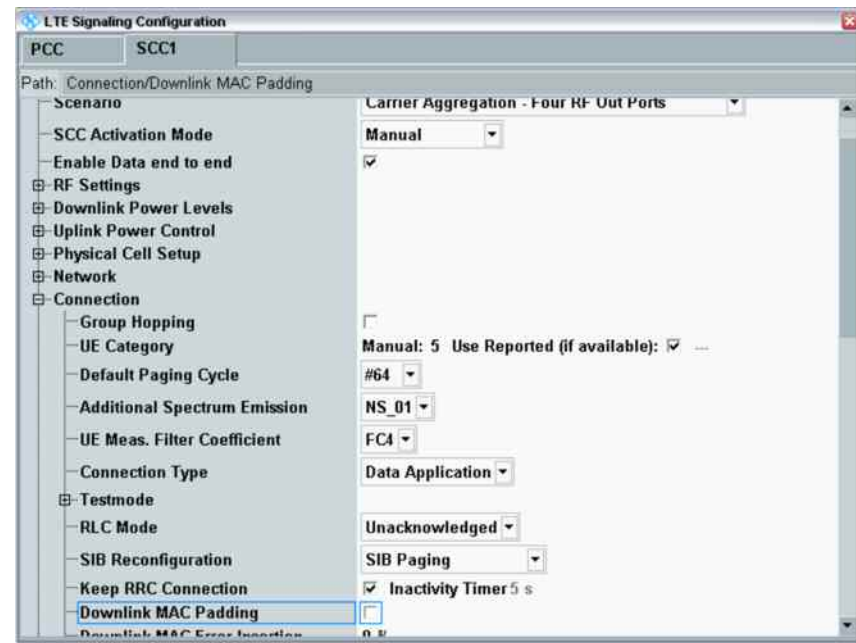
- ! Ensure the LTE cell is OFF
- ! Press the “Config” tab
- ! Scroll up to the top of the screen and checkmark “Enable data end to end”

- ! Set the PCC cell
 - Press the “PCC” tab
 - Expand the “Connection” entry
 - Set the “Connection Type” to “Data Application”
 - Uncheckmark “Downlink MAC Padding”
 - Set the “User Defined Channels – DL” scheduling to:
 - “Modulation Type”: “QPSK”
 - “Transport Block Size Index”: “9”



Setup the CMW for LTE-CA end 2 end Connection

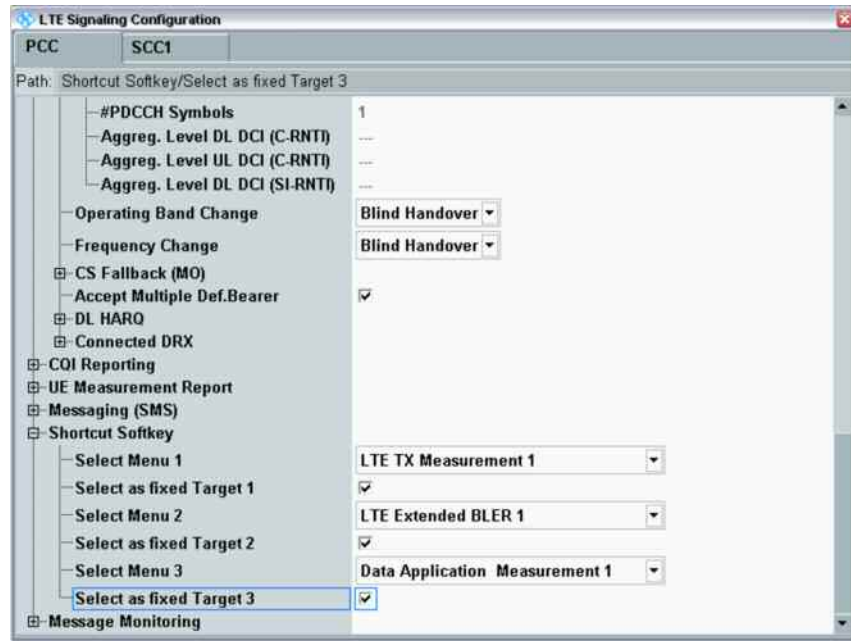
- Set the SCC cell
 - Press the “SCC1” tab
 - Expand the “Connection” entry
 - Set the “Connection Type” to “Data Application”
 - Uncheckmark “Downlink MAC Padding”
 - Set the “User Defined Channels – DL” scheduling to:
 - “Modulation Type”: “QPSK”
 - “Transport Block Size Index”: “9”



Map the Data Application Measurement

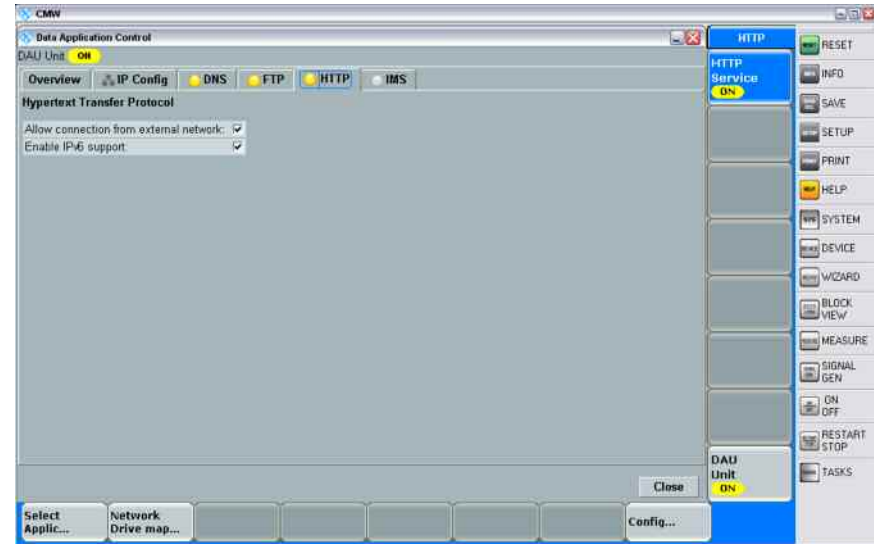
- ▮ Press the “PCC” tab
- ▮ Expand the “Shortcut Softkey”
- ▮ Change the “Select Menu 3” to “Data Application Measurement”
- ▮ Checkmark the “Select as fixed Target 3”

- ▮ Close the Config screen



Start DAU services

- ▮ From the LTE signaling screen, press the “Data 1 Meas” shortcut key
- ▮ Press the “Configure Services” tab
- ▮ Start DNS server
 - Press the “DNS Server” tab
 - Press the “ON/OFF” tab
 - Wait that the service is ON
- ▮ Start FTP server
 - Press the “FTP Server” tab
 - Press the “ON/OFF” tab
 - Wait that the service is ON
- ▮ Start HTTP server
 - Press the “HTTP Server” tab
 - Press the “ON/OFF” tab
 - Wait that the service is ON
- ▮ Press the “Close” tab
- ▮ Press the “Go to RAN” tab to switch back to the LTE Signaling screen



Setup the DUT for a Data Call

▮ Load Application on the DUT

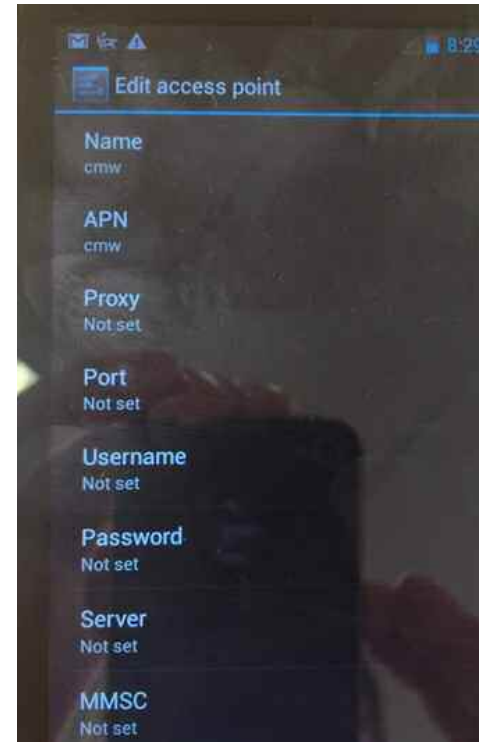
- Connect the DUT via WIFI to the Google Play Store
- Download and install the following applications:
 - Ping&DNS
 - Iperf
 - AndFTP



Setup the DUT for a Data Call

■ Create An access point

- In the Android “Settings” Menu, choose “More networks”, then “Mobile networks”, then “Access Point Names”
- Press the bottom left (Menu) key on the S4-A and choose “+ New APN”
- Create a dummy Access Point with the Name CMW and the APN name CMW.
- Activate the Access Point (if it isn't already activated)

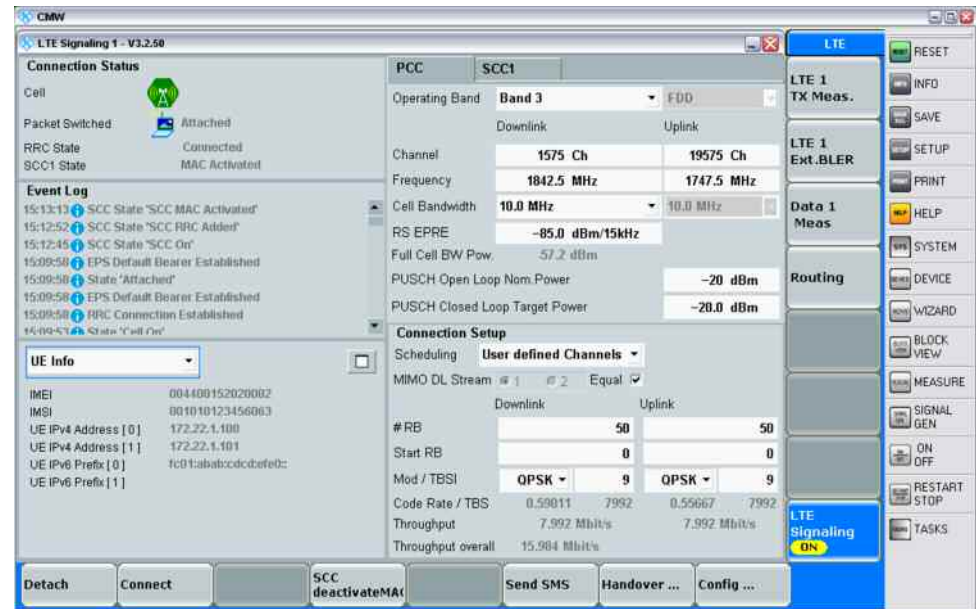


■ Power OFF the DUT



Establish The Data Call

- Start LTE call from a LTE-CA Data end 2 end call
 - From the LTE Signaling screen, press the “LTE Signaling” tab
 - Press the “ON/OFF” tab to start the cell
 - Wait for the message “State ‘Cell On’”
- Power ON the DUT.
- After the DUT Attach to the PCC cell, ensure a valid IP address appears in the UE Info box under “UE IPv4 address” and/or “UE IPv6 Prefix”
 - Default UE IPv4 address starts at 172.22.1.100
- Establish the connection with the SCC cell
 - Press “SCC On” tab
 - Press “SCC add RRC” tab
 - Press “SCC activate MAC” tab



Change Scheduling to the MAX Throughput

- Change the scheduling for the PCC cell
 - From the LTE signaling screen, Press the “PCC” tab
 - For “Downlink”, change “Mod” to “64-QAM”
 - For “Downlink”, change the “TBSI” to “26”

- Change the scheduling for the SCC cell
 - From the LTE signaling screen, Press the “SCC1” tab
 - Change the “Mod” to “64-QAM”
 - Change the “TBSI” to “26”

Maximum Throughput is $2 * 73.392$ Mbit/s = 146.784 Mbit/s

Connection Setup

Scheduling **User defined Channels** ▾

MIMO DL Stream 1 2 Equal

	Downlink	Uplink
#RB	50	50
Start RB	0	0
Mod / TBSI	64-QAM ▾ 26	QPSK ▾ 9
Code Rate / TBS	0.90106 36696	0.55667 7992
Throughput	36.696 Mbit/s	7.992 Mbit/s
Throughput overall	73.392 Mbit/s	

Connection Setup

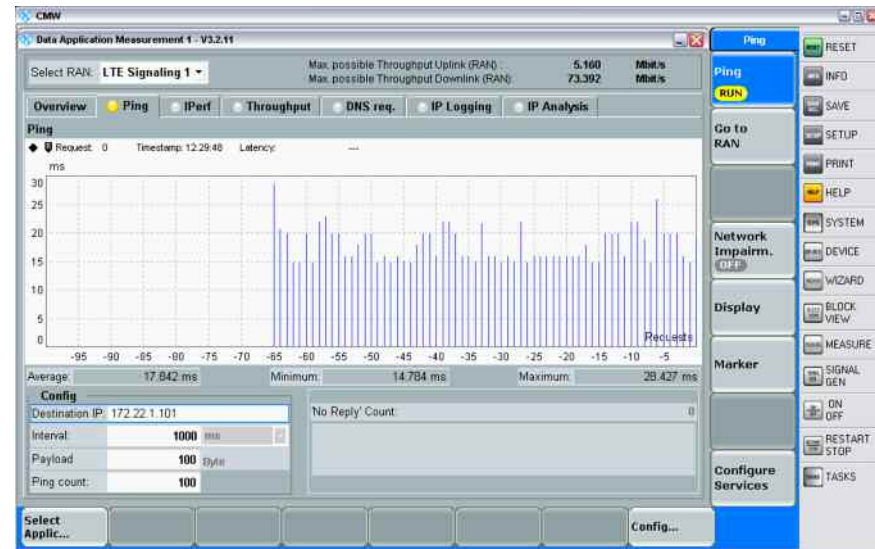
Scheduling **User defined Channels** ▾

MIMO DL Stream 1 2 Equal

	Downlink
#RB	50
Start RB	0
Mod / TBSI	64-QAM ▾ 26
Code Rate / TBS	0.98837 36696
Throughput	36.696 Mbit/s
Throughput overall	73.392 Mbit/s

Ensure IP connectivity is established

- Ensure IP connectivity from CMW DAU to DUT
 - Press the “Data1 meas” tab from the LTE Signaling screen
 - Press the “Ping” tab
 - Under “Destination IP” set the DUT IP address (which can be read from the “UE Info” frame in the LTE Signaling view; example:172.22.1.10x)
 - Press the “Ping” hot tab
 - Press the “ON/OFF” tab
 - Observe the Ping graphical windows. Vertical bar should comes at interval of 1 s
- Stop the Ping
 - Press the “ON/OFF” tab
- Check IP Connectivity from DUT
 - Open “PING&DNS” tool
 - Enter the DAU IP address 172.22.1.201
 - Select the IP address
 - Select the “PING” application
 - Press “Go” tab
 - Ensure the Ping to the DAU comes back with valid data



The screenshot shows the output of the Ping & DNS tool on a mobile device. The output is as follows:

```
--- Sep 26, 2013 6:19:26 PM
--- IP (rmnet0)
fe80::a40:80c6:8efe:b00f%rmnet0
--- IP (rmnet0) 172.22.1.101

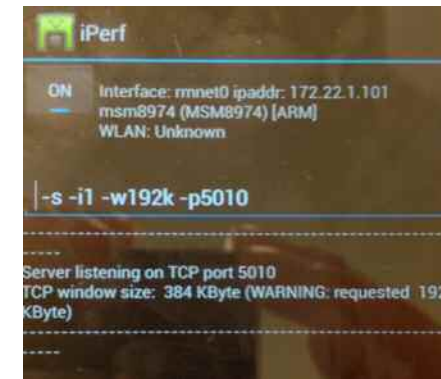
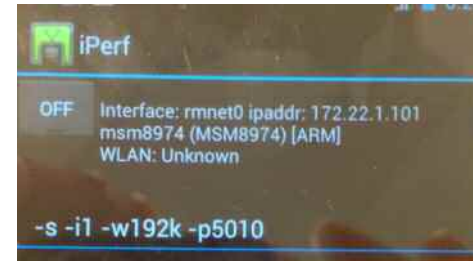
PING 172.22.1.201 (172.22.1.201)
56(84) bytes of data:
64 bytes from 172.22.1.201:
icmp_seq=1 ttl=64 time=15.2 ms
64 bytes from 172.22.1.201:
icmp_seq=2 ttl=64 time=16.3 ms
64 bytes from 172.22.1.201:
icmp_seq=3 ttl=64 time=17.2 ms

--- 172.22.1.201 ping statistics ---
3 packets transmitted, 3 received, 0%
packet loss, time 2005ms
min = 15.208 ms
avg = 16.259 ms
max = 17.233 ms
mdev = 0.841 ms
```



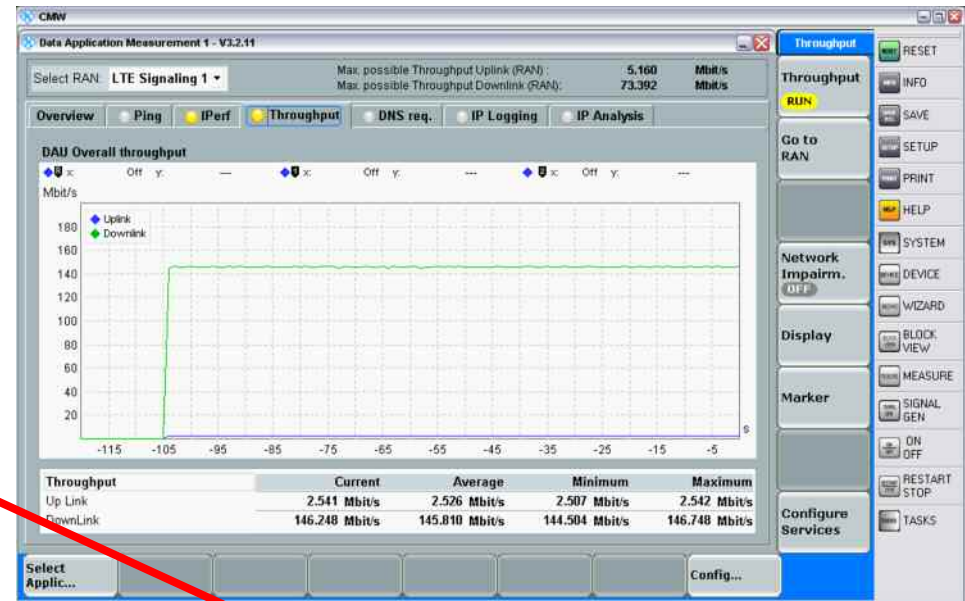
Setup DUT Iperf tool and CMW DAU Iperf Application

- Start Iperf tool on the DUT
 - Run Iperf as a server tool by entering the following parameters:
 - “-s -i1 -w192k -p5010”
 - Start Iperf by pressing the “OFF” tab
 - Locate the DUT IP address displayed in the Iperf tool (172.22.1.10x)
- Setup CMW DAU Iperf tool
 - Press the “Iperf” tab
 - Press the “Config” tab
 - Expand the “Clients” entry
 - Checkmark the “Use” from the 1st row of the Clients entry
 - Set the “UDP or TCP” to “TCP”
 - Set the “Port” to “5010”
 - Set the “UE IP Address” to 172.22.1.10x
 - Set the “Win. size (in kByte)” to “384”
 - Set the “Parallel Conn.” to “4”
 - Press the “OK” tab



TCP/IP Throughput Test

- Start DAU Iperf Application
 - Press the “Iperf “ hot tab
 - Press the “ON/OFF” tab
 - Check that a vertical green bar shows up in the Graphical windows
 - Check that a valid Throughput is displayed in the Downlink field
- Check IP Throughput over time
 - Press the “Throughput” tab
 - Press the “Throughput” hot tab
 - Press “ON/OFF” to start the Throughput Measurement
 - Check the TCP Throughput

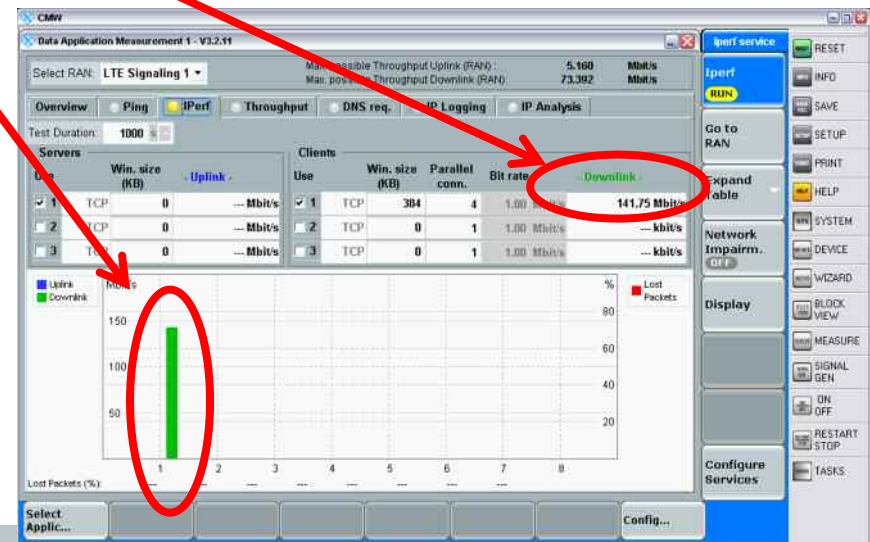


```

iPerf
ON interface: rmmnet0 ipaddr: 172.22.1.101
msm8974 (MSM8974) [ARM]
WLAN: Unknown

-s -i1 -w192k -p5010

[SUM] 98.0-99.0 sec 16.8 MBytes 141 Mbits/sec
[12] 99.0-100.0 sec 4.22 MBytes 35.4 Mbits/sec
[11] 99.0-100.0 sec 4.24 MBytes 35.6 Mbits/sec
[9] 99.0-100.0 sec 4.21 MBytes 35.3 Mbits/sec
[10] 99.0-100.0 sec 4.16 MBytes 34.9 Mbits/sec
[SUM] 100.0-101.0 sec 4.20 MBytes 35.2 Mbits/sec
[12] 100.0-101.0 sec 4.22 MBytes 35.4 Mbits/sec
[10] 100.0-101.0 sec 4.22 MBytes 35.4 Mbits/sec
[12] 101.0-102.0 sec 4.18 MBytes 35.0 Mbits/sec
[11] 101.0-102.0 sec 4.21 MBytes 35.3 Mbits/sec
[10] 101.0-102.0 sec 4.20 MBytes 35.2 Mbits/sec
[9] 101.0-102.0 sec 4.20 MBytes 35.2 Mbits/sec
[SUM] 101.0-102.0 sec 16.8 MBytes 141 Mbits/sec
[12] 102.0-103.0 sec 4.21 MBytes 35.3 Mbits/sec
[11] 102.0-103.0 sec 4.19 MBytes 35.2 Mbits/sec
[10] 102.0-103.0 sec 4.22 MBytes 35.4 Mbits/sec
[9] 102.0-103.0 sec 4.22 MBytes 35.4 Mbits/sec
[SUM] 102.0-103.0 sec 16.8 MBytes 141 Mbits/sec
[12] 103.0-104.0 sec 4.19 MBytes 35.1 Mbits/sec
[11] 103.0-104.0 sec 4.18 MBytes 35.1 Mbits/sec
[9] 103.0-104.0 sec 4.14 MBytes 34.7 Mbits/sec
[10] 103.0-104.0 sec 4.21 MBytes 35.3 Mbits/sec
[SUM] 103.0-104.0 sec 16.7 MBytes 140 Mbits/sec
    
```



TCP/IP Throughput Test

- Check MAC Throughput
 - Press the “Go To RAN” tab
 - Press the “LTE 1 Ext.BLER” tab from the LTE Signaling screen
 - Press the “Extended BLER” tab
 - Press the “ON/OFF” tab
 - Check the Overall Absolute Throughput

```

iPerf
ON Interface: mmnet0 ipaddr: 172.22.1.101
   ipam:9974 (NASM:974) [ARM]
   WLAN: Unknown

-s -t1 -w192k -p5010

[SUM] 99.0-100.0 sec 16.8 MBytes 141 Mbits/sec
[12] 99.0-100.0 sec 4.22 MBytes 35.4 Mbits/sec
[11] 99.0-100.0 sec 4.24 MBytes 35.6 Mbits/sec
[9] 99.0-100.0 sec 4.21 MBytes 35.3 Mbits/sec
[10] 99.0-100.0 sec 4.16 MBytes 34.9 Mbits/sec
[SUM] 100.0-101.0 sec 4.20 MBytes 35.2 Mbits/sec
[10] 100.0-101.0 sec 4.22 MBytes 35.4 Mbits/sec
[SUM] 100.0-101.0 sec 16.7 MBytes 140 Mbits/sec
[12] 101.0-102.0 sec 4.18 MBytes 35.0 Mbits/sec
[12] 101.0-102.0 sec 4.18 MBytes 35.0 Mbits/sec
[11] 101.0-102.0 sec 4.21 MBytes 35.3 Mbits/sec
[10] 101.0-102.0 sec 4.20 MBytes 35.2 Mbits/sec
[9] 101.0-102.0 sec 4.20 MBytes 35.2 Mbits/sec
[SUM] 101.0-102.0 sec 16.8 MBytes 141 Mbits/sec
[12] 102.0-103.0 sec 4.21 MBytes 35.3 Mbits/sec
[11] 102.0-103.0 sec 4.17 MBytes 35.0 Mbits/sec
[10] 102.0-103.0 sec 4.19 MBytes 35.2 Mbits/sec
[9] 102.0-103.0 sec 4.22 MBytes 35.4 Mbits/sec
[SUM] 102.0-103.0 sec 16.8 MBytes 141 Mbits/sec
[12] 103.0-104.0 sec 4.19 MBytes 35.1 Mbits/sec
[11] 103.0-104.0 sec 4.18 MBytes 35.1 Mbits/sec
[9] 103.0-104.0 sec 4.14 MBytes 34.7 Mbits/sec
[10] 103.0-104.0 sec 4.21 MBytes 35.3 Mbits/sec
[SUM] 103.0-104.0 sec 16.7 MBytes 140 Mbits/sec
[11] 104.0-105.0 sec 4.19 MBytes 35.1 Mbits/sec
[10] 104.0-105.0 sec 4.19 MBytes 35.1 Mbits/sec

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