R&S®CMW500 Digital IQ with CADENCE Emulator

Application Note

Products:

- R&S®CMW500
- R&S®EX-IQ-BOX | R&S®EXBOX-Z3
- R&S®FSQ
- R&S®FSV

This application note explains how to bring a CADENCE system which is attached to an R&S®EX-IQ-BOX into service for the first time.

The first part of the document shows how to setup an LTE Demo without using a UE design. This setup uses the R&S®CMW500 as the downlink transmitter. The emulator receives the downlink via an R&S®EX-IQ-BOX and passes it to an R&S spectrum analyzer (R&S®FSx) via a second R&S®EX-IQ-BOX.

The second part describes the real wiring using up- and downlink. This will only work if a UE design is available on the emulator.

Application Note
Sven Gollon
07-2010 1CM75_1E

ROHDE&SCHWARZ

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The following abbreviations are used throughout this manual:
R&S®EX-IQ-BOX is abbreviated as R&S EX-IQ-BOX, R&S®EXBOX-Z3 is abbreviated as R&S EXBOX-Z3, R&S®CMW500 is abbreviated as R&S CMW500, R&S®FSQ is abbreviated as R&S FSQ and R&S®FSV is abbreviated as R&S FSV.

1 Hardware Setup for LTE Demo

1.1 Schematic Setup

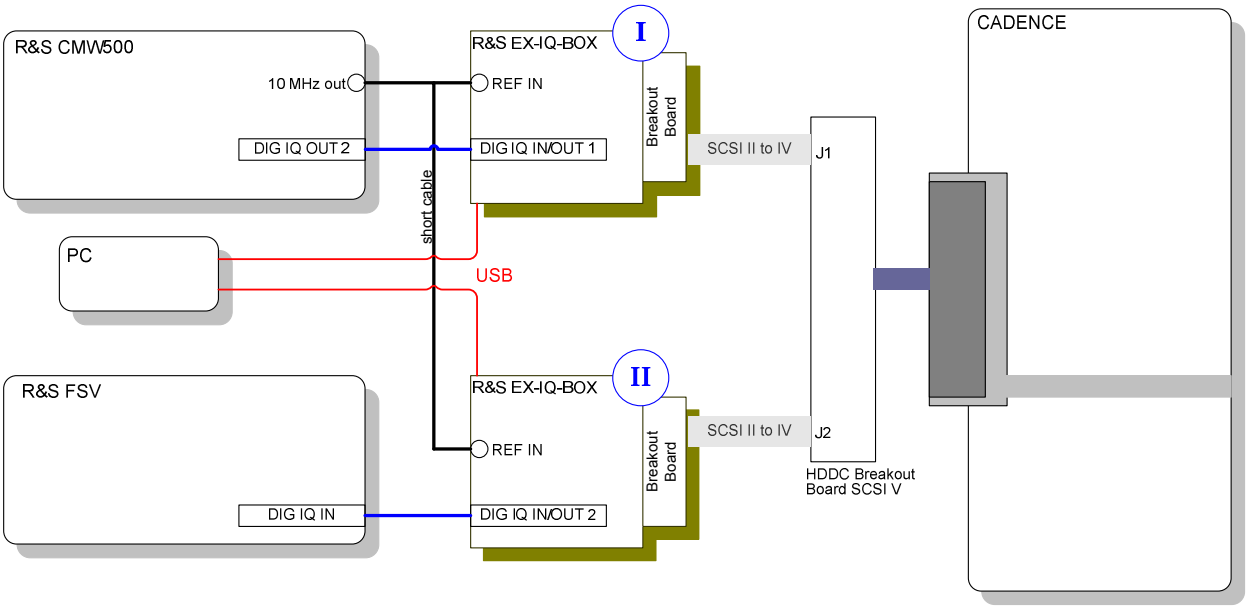


Figure 1: Setup Diagram

1.2 Hardware Requirements for Demo

Amount	Unit	Hardware Key
R&S CMW500 minimum configuration		
1	R&S CMW-B300A Signaling Unit Wideband (SUW)	1202.6304.02
1	R&S CMW-B510A Digital IQ Board	1202.8007.02
Adapter		
2	R&S EX-IQ-BOX	1409.5505K04/.02
2	R&S EXBOX-Z3 CADENCE PALLADIUM Breakout Board	1417.3566.02
1	CADENCE HDDC Breakout Board SCSI V	39BRSA
1	Cadence Palladium Emulator	
R&S FSQ or R&S FSV		
1	R&S FSQ-B17 Digital Baseband Interface	1163.0063.02
Cabeling		
2	R&S SMU-Z6 LVDS cable for connecting digital baseband interfaces	1415.0201.02
1	BNC cable	
1	BNC cable (<= 1m)	
1	BNC T adapter	
2	USB cable	
2	SCSI II to SCSY V cable	

1.3 Cabeling of All Units

External PC	R&S CMW500	R&S EX-IQ-BOX I	R&S EX-IQ-BOX II	CADENCE HDDC Breakout Board SCSI V	R&S FSQ/ R&S FSV
From…/ To…	From…	From…/To…	From…/To…	From…/To…	From…/To…
	DIGIQ OUT2	DIG IQ IN 1			
USB		USB			
USB			USB		
	REF OUT	REF IN			
		REF IN split with BNC T adapter (short cable)	REF IN		
		SCSI II		SCSI IV J1 (lower left)	
			SCSI II	SCSI IV J2 (lower right)	
			DIG IQ IN 2		DIG IQ IN

1.4 Software Requirements

Software Requirements		
R&S CMW500 (installation via R&S Version Manager, SW to be retrieved on http://extranet.rohde-schwarz.com)		
Basic	R&S CMW-BASE	Standard CMW500 Protocol HW and SW Configuration
LTE	R&S CMW-KF500	LTE Example Scenarios
WCDMA	R&S CMW-KF400	WCDMA Example Scenarios
R&S EX-IQ-BOX		
	R&S DigIConf	Digital Interface Configurator for the R&S EX-IQ-BOX, to be installed on an external PC
R&S FSQ or R&S FSV		
LTE	R&S FSQ-K100	Analysis of EUTRA/LTE FDD downlink signals
	R&S FSQ-K101	Analysis of EUTRA/LTE FDD uplink signals
	R&S FSQ-K102	Analysis of EUTRA/LTE downlink MIMO signals

2 Running an Application

2.1 Example LTE

2.1.1 Instructions for LTE Example

CADENCE delayBox box setting in terminalAssign_R_S_Ch*_new.qel files

```
----------
delayBox -add {after_CLK_IN_P_20 4 Ch1_CLK_IN_P}
delayBox -add {long_after_CLK_IN_P_80 8 Ch1_CLK_IN_P}
----------
```

Use default Power Values `LVCMOS33_8 (3.3V, 8 mA)`
Please contact CADENCE for the complete Tar ball settings

Note: Do all settings in the following order: 1, 2, 3...6

1. Start R&S CMW500 including R&S CMW500 Base Software and PT Server
2. R&S DigIConf
   - Start the R&S DigIConf program on R&S CMW500.
   - Change Number of Ex-IQ-Boxes to “2” in the select box.

a. R&S EX-IQ-BOX I

I.	Select R&S EX-IQ-BOX 1	Choose the correct serial number
II.	Select “config…” → “Interface Type: user defined …”	
III.	Set To Default	Preset all parameters and switching states.
IV.	Logic Type:	LVTTL
V.	Direction:	Transmitter
VI.	Protocol → Format:	Parallel
VII.	Protocol → Data Rate:	SDR
VIII.	Protocol → Interleaving:	Not Interleaved
IX.	Data → Word Size:	16 Bit
X.	Data → Word Aligment:	LSB
XI.	Data → Bit Order:	LSB
XII.	Data → Numeric Format:	2’s Complement
XIII.	Clock → Clock rate:	(read out from CADENCE system) (For example 1.522 MHz) Refer to Figure 2: Palladium: Logic Analyzer.
XIV.	Clock → Clock Source:	External
XV.	Clock → Clock Phase:	180 deg
XVI.	Switch “State” to “ON”	
XVII.	Refer to Figure 3: LTE: R&S DigIConf: Setup of the R&S EX-IQ-BOX I (Transmitter).	

b. R&S EX-IQ-BOX II

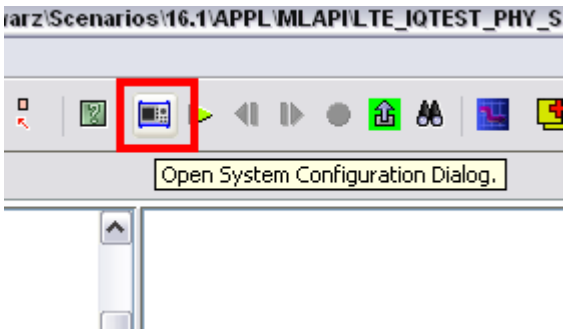
I.	Select R&S EX-IQ-BOX 2	Choose the correct serial number
II.	Select “config…” → “Interface Type: user defined …”	
III.	Set To Default	Preset all parameters and switching states.
IV.	Logic Type:	LVTTL
V.	Direction:	Receiver
VI.	Protocol → Format:	Parallel
VII.	Protocol → Data Rate:	SDR
VIII.	Protocol → Interleaving:	Not Interleaved
IX.	Data → Word Size:	16 Bit
X.	Data → Word Aligment:	LSB
XI.	Data → Bit Order:	LSB
XII.	Data → Numeric Format:	2’s Complement
XIII.	Clock → Clock rate:	(read out from CADENCE system) (For example 1.522 MHz) Refer to Figure 2: Palladium: Logic Analyzer.
XIV.	Clock → Clock Source:	External
XV.	Clock → Clock Phase:	180 deg
XVI.	Switch “State” to “ON”	
XVII.	Refer to Figure 4: LTE: R&S DigIConf: Setup of R&S EX-IQ-BOX II (Receiver).	

CMW500

3. Open Project Explorer and load a LTE sample scenario
   `C:\Rohde-Schwarz\Scenarios\15.11\APPL\MLAPI\LTE_SAMPLE_SCN\1.0\TestProjectLTE_Sample_Scn.tpd`

   Refer to Figure 5: LTE: Test Project with LLAPI test case “ll_001” loaded within Project Explorer.

4. Apply the RF/DIG IQ settings within the "System Configuration" dialog.
   To open the GUI, click the "Open System Configuration Dialog" button, see the following figure.



Apply the following settings:

a. UE connected to: DIGITAL IQ
b. Direction Settings: Downlink Only
c. Dig IQ OUT 2: Sample Rate: 7.68 Msps
   Enable Source: Digital IQ OUT
d. AUX A: Direction OFF
e. AUX B: Direction OFF
f. Click the “Save Changes” button 
   Refer to Figure 6: LTE: System Configuration with applied DIGITAL IQ settings.

5. Start the test case within the Project Explorer.
   Follow the instructions until the MMI Comand Dialog:
   `"5 MHz Cell is setup, Press Send to finish scenario"`
   Refer to Figure 7: MMI Command Dialog message.

6. R&S FSQ/R&S FSV settings

   Note: EUTRA/LTE Downlink PC Software for the Signal Analyzer R&S FSQ must be installed and licensed on an external PC/laptop.
   With R&S FSV this is not necessary.

   a. Start R&S FSQ/R&S FSV
   b. After booting up Signal Analyzer software, press "PRESET"
   c. (Start EUTRA/LTE Downlink PC Software on external PC/Laptop) for R&S FSQ
   d. Apply "General Settings":
      I. Duplexing: FDD
      II. Link Direction: Downlink
      III. Source: Digital IQ
      IV. VISA RSC: IP Address of your R&S FSQ
      V. Refer to Figure 7: MMI Command Dialog message.
   e. Apply "Advanced Settings":
      I. Source Sampling Rate: 7.68 MHz
      II. Full Scale Level: 223mV
      III. Refer to Figure 8, Figure 9 and Figure 10.

Result on R&S FSx

Refer to Figure 12: EUTRA/LTE Downlink PC Software: Results.

Result on CADENCE

Refer to Figure 13 and Figure 14.

Screenshots for LTE Example

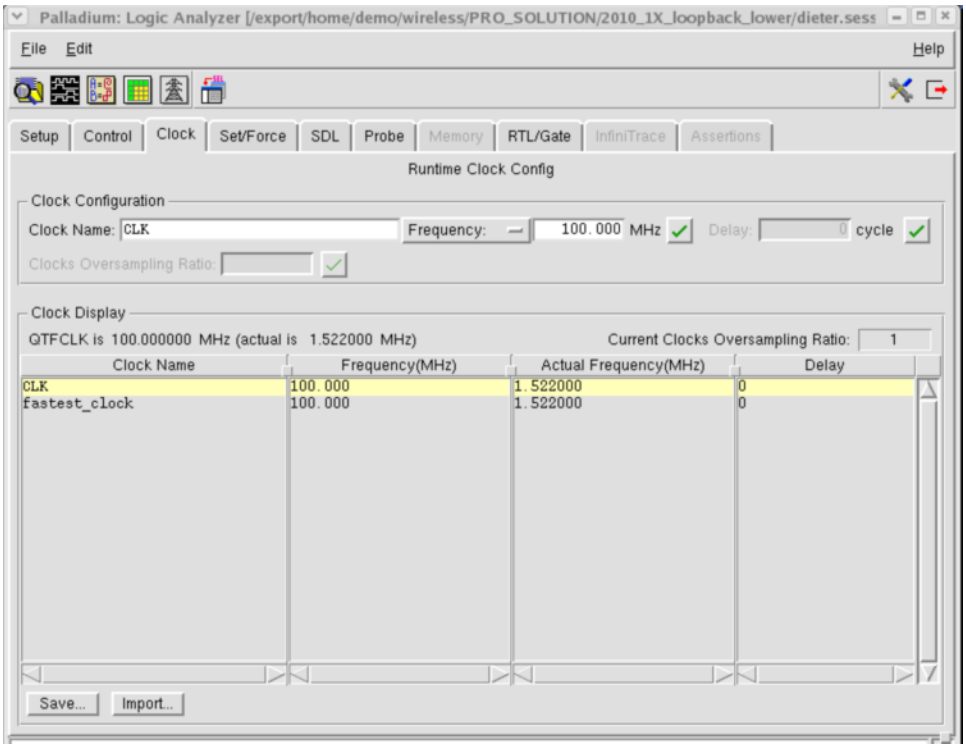


Figure 2: Palladium: Logic Analyzer

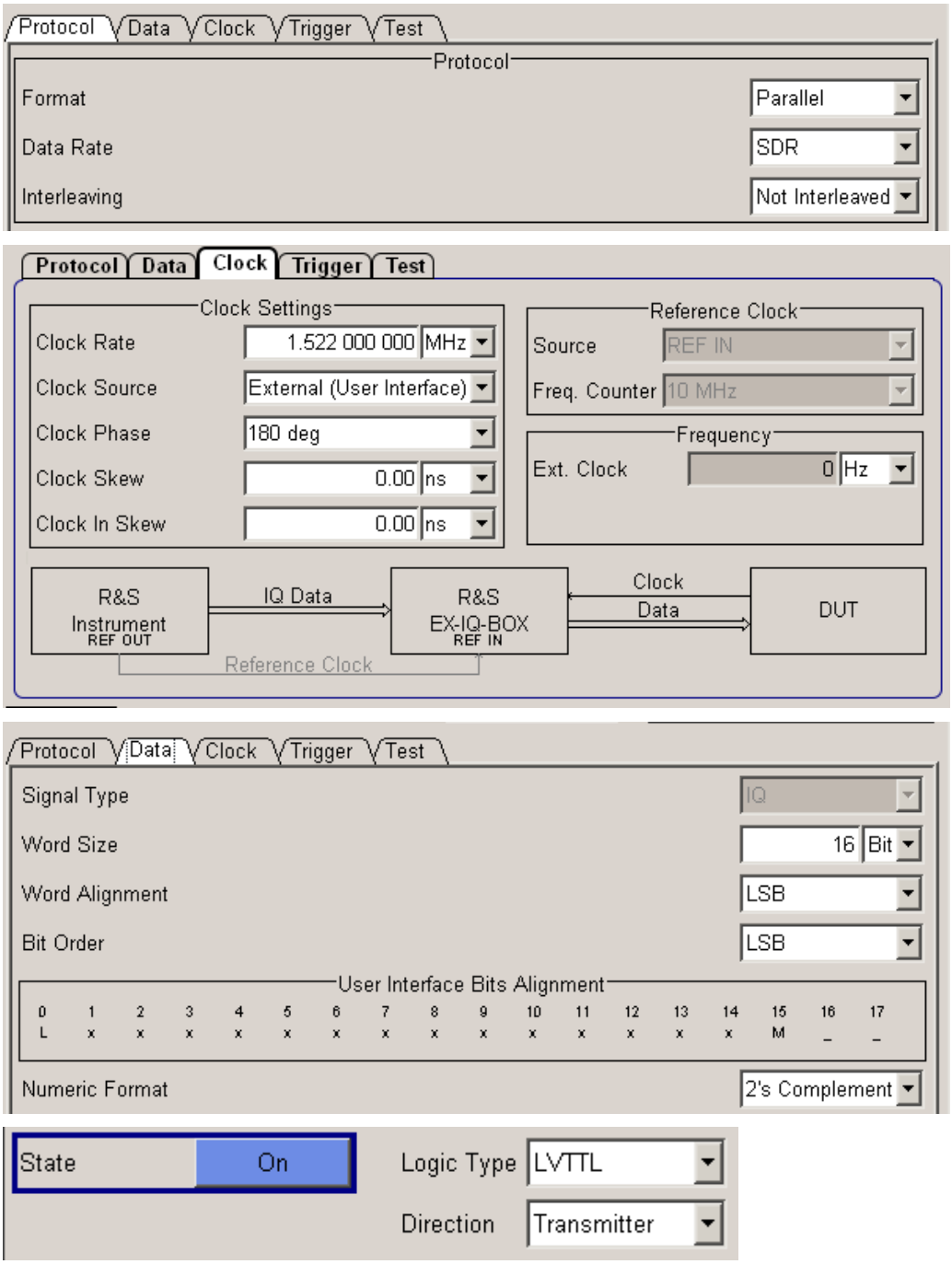


Figure 3: LTE: R&S DigIConf: Setup of the R&S EX-IQ-BOX I (Transmitter)

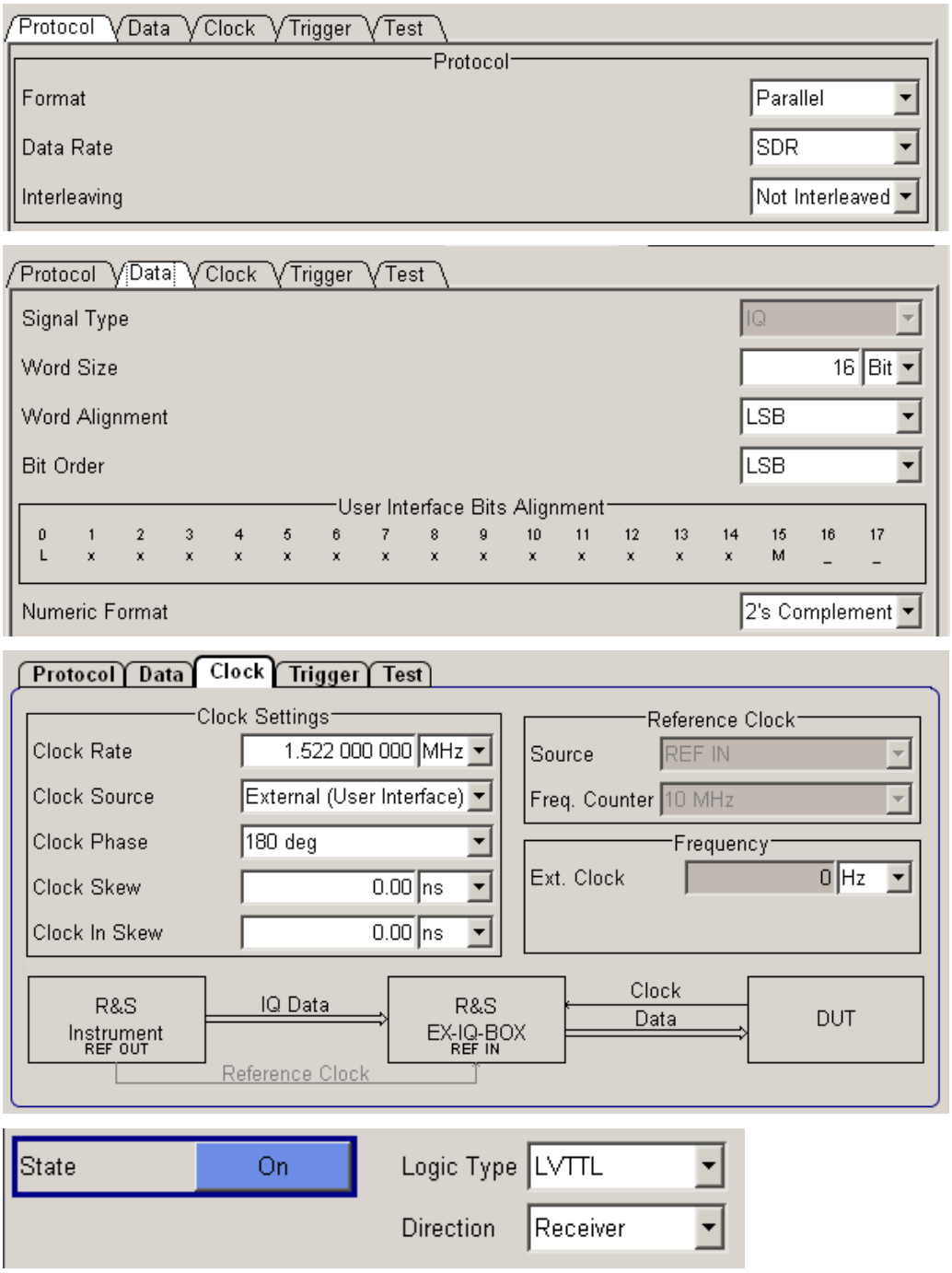


Figure 4: LTE: R&S DigIConf: Setup of R&S EX-IQ-BOX II (Receiver)

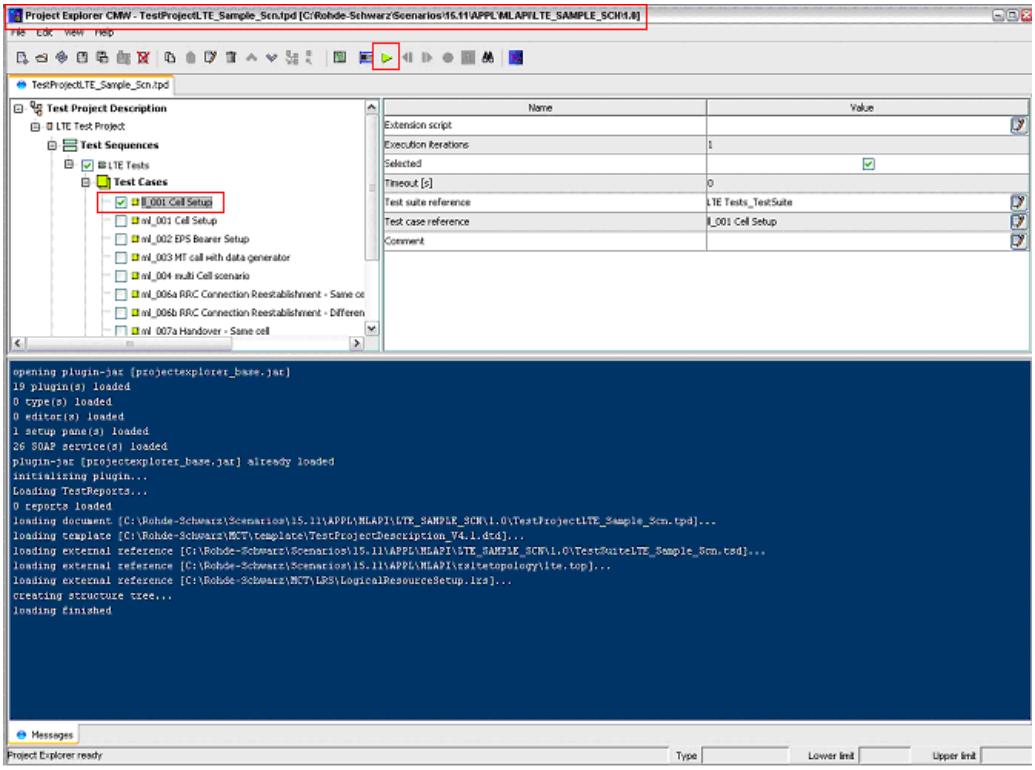


Figure 5: LTE: Test Project with LLAPI test case "ll_001" loaded within Project Explorer

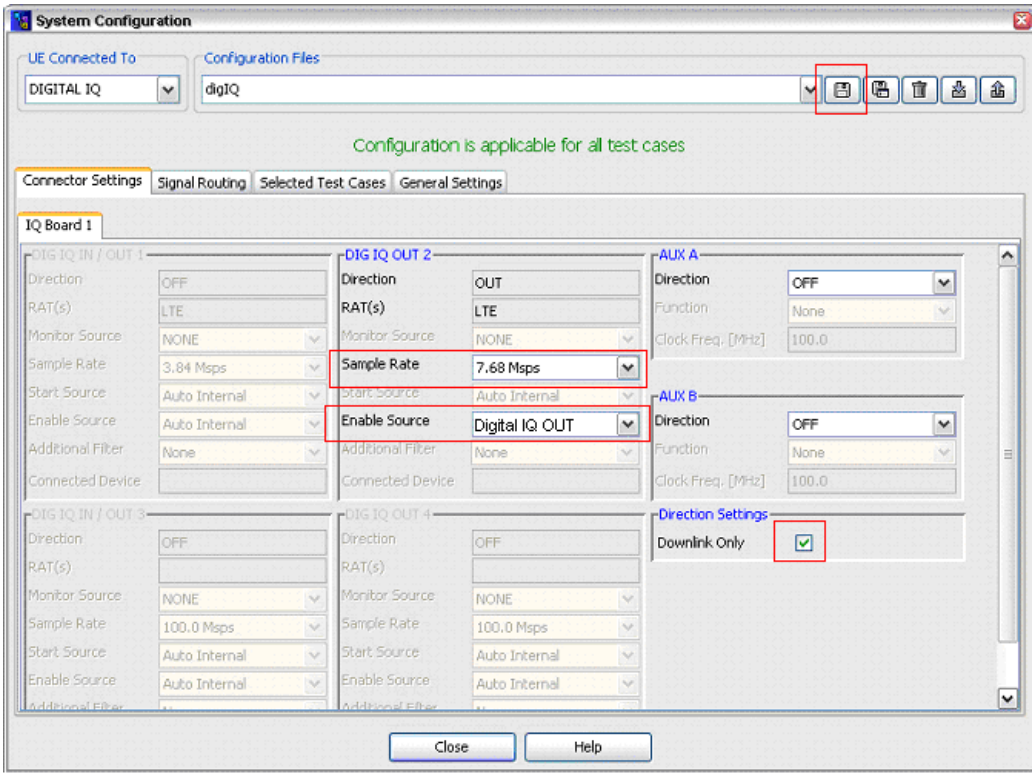


Figure 6: LTE: System Configuration with applied DIGITAL IQ settings

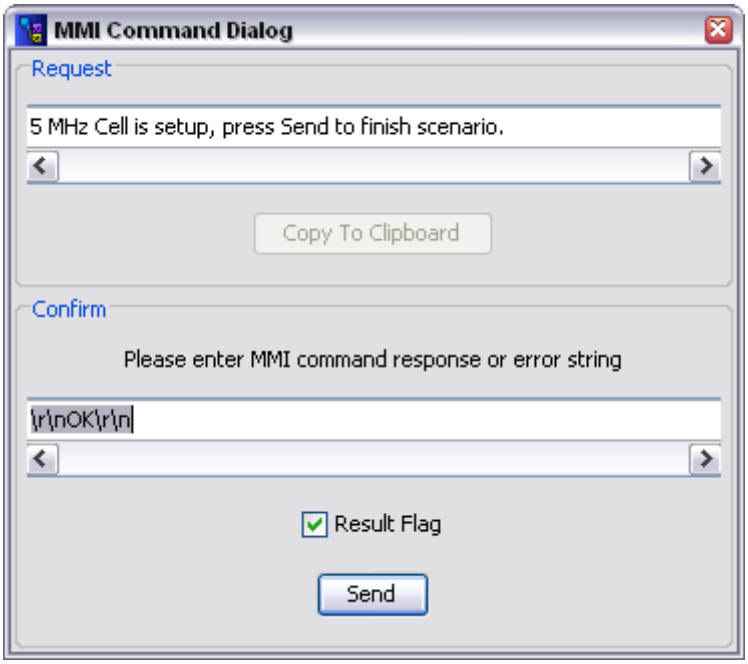


Figure 7: MMI Command Dialog message

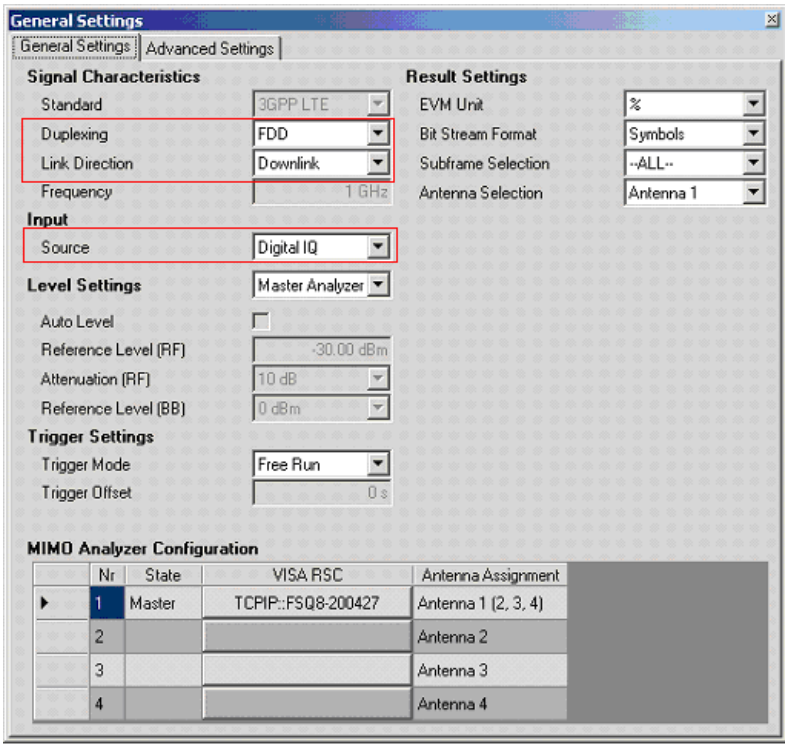


Figure 8: LTE EUTRA/LTE Downlink PC Software: General Settings

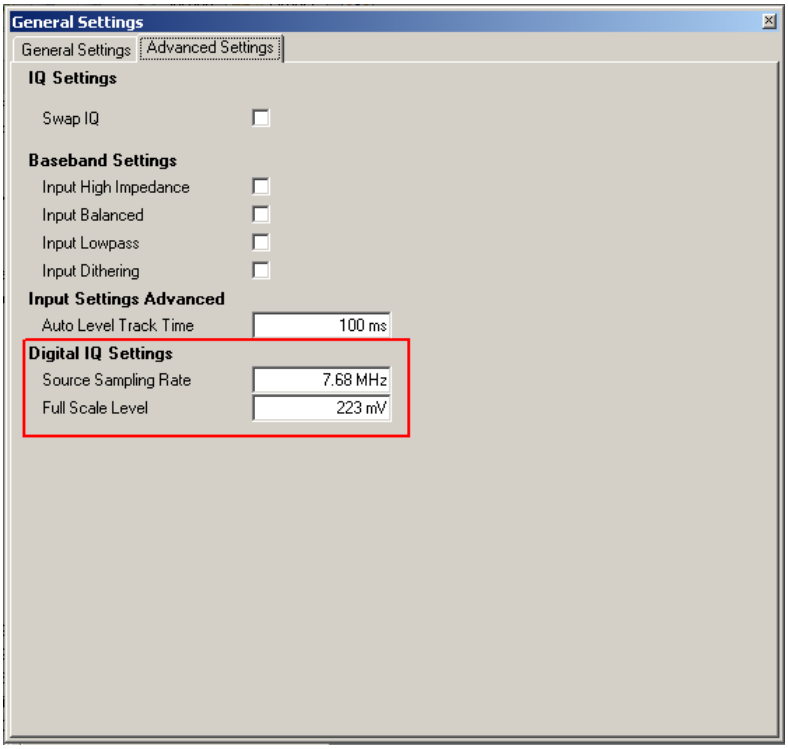


Figure 9: LTE EUTRA/LTE Downlink PC Software: Advanced Settings

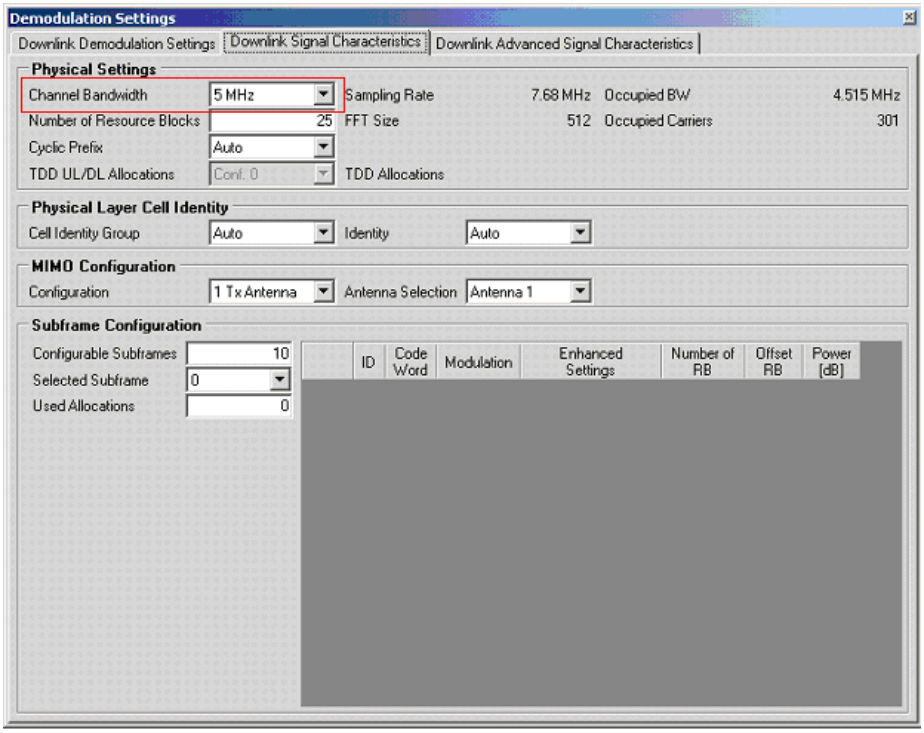


Figure 10: EUTRA/LTE Downlink PC Software: Downlink Signal Characteristics

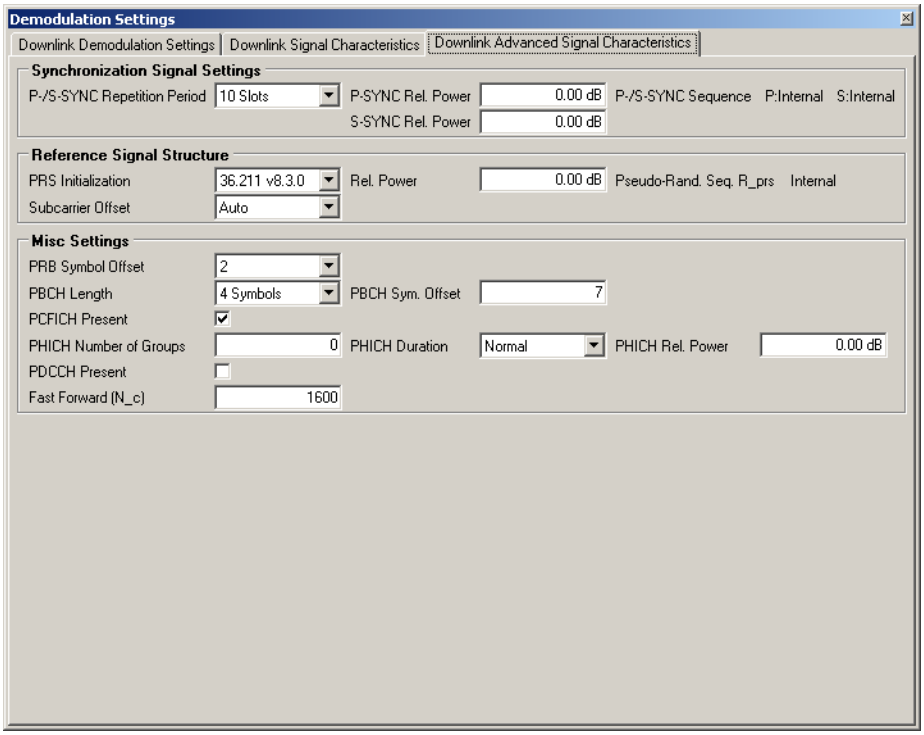


Figure 10: EUTRA/LTE Downlink PC Software: Downlink Advanced Signal Characteristics

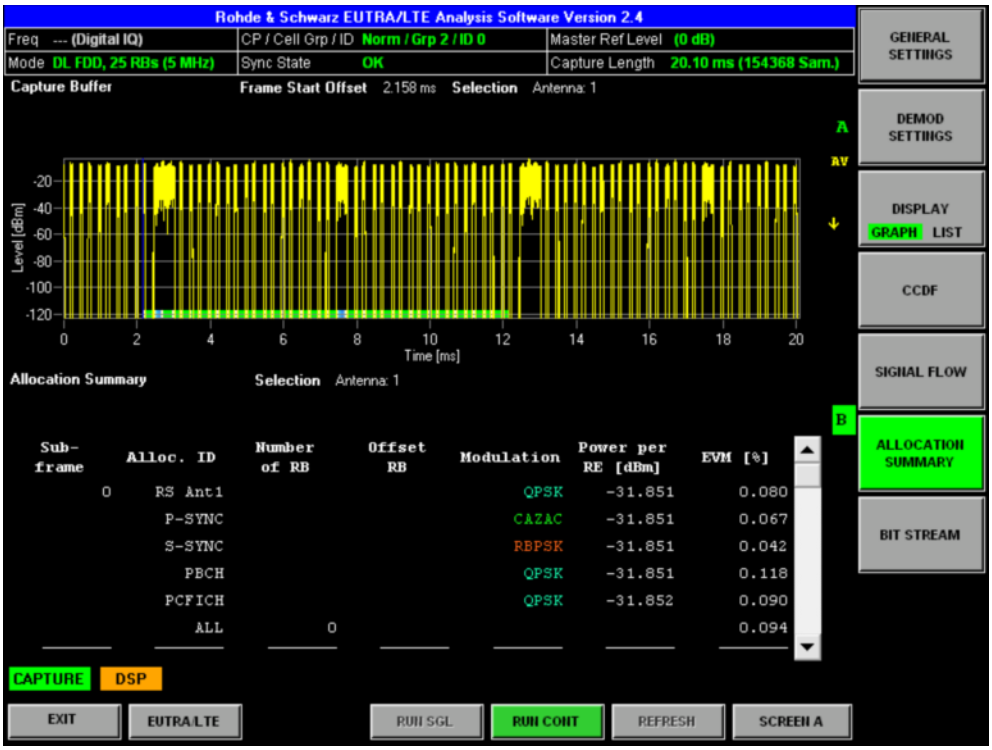


Figure 12: EUTRA/LTE Downlink PC Software: Results

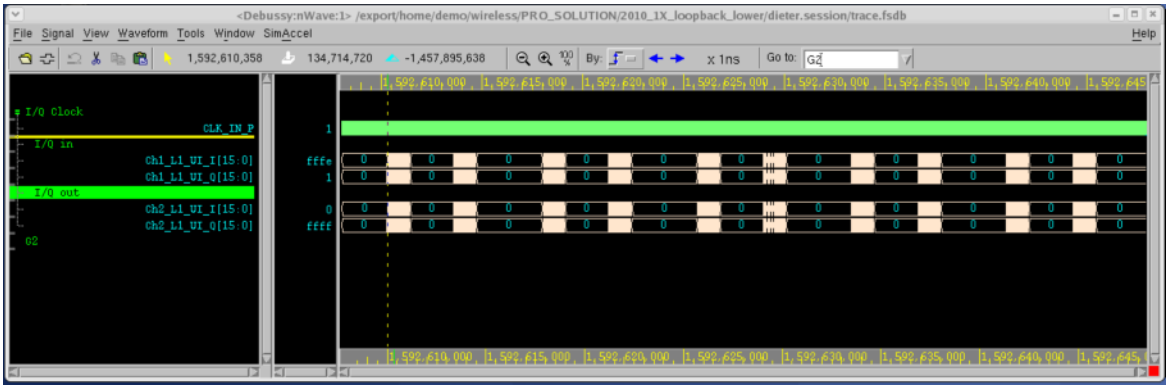


Figure 13: Palladium Waveform of I/Q with LTE traffic

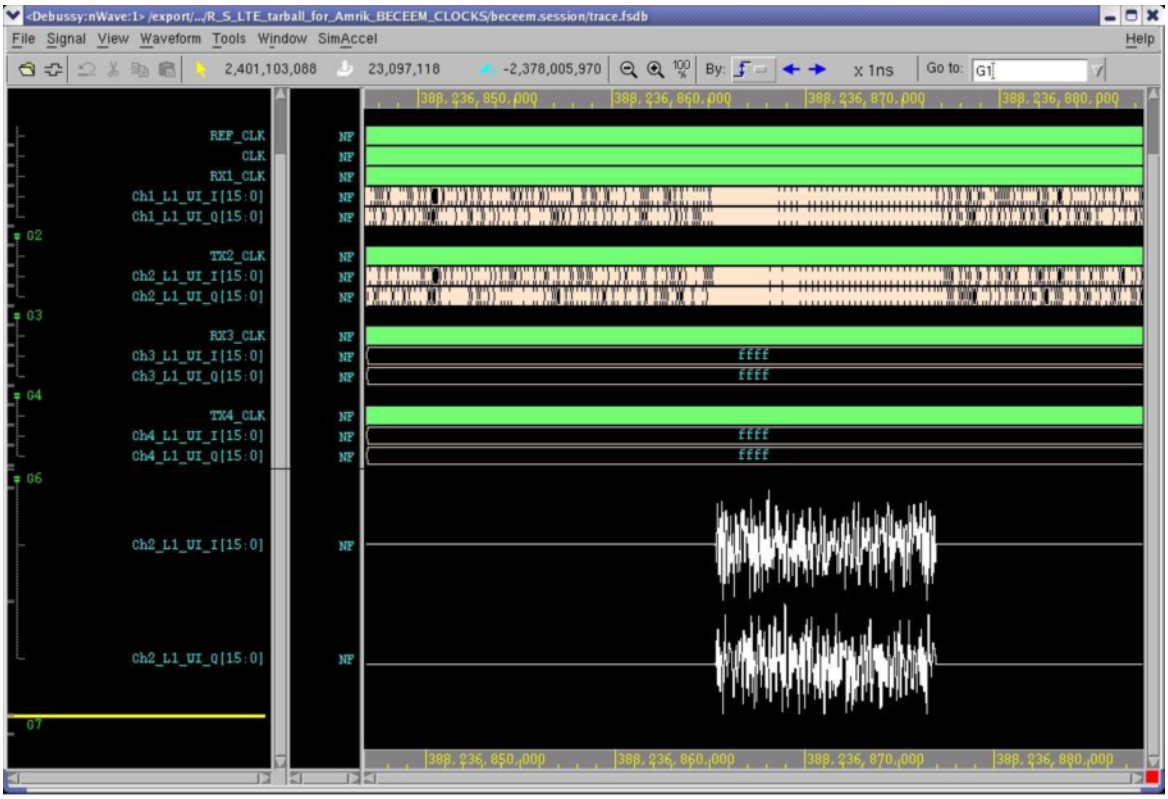


Figure 14: Palladium Waveform of I/Q with LTE traffic

3 Hardware Setup for Real Simulation

3.1 Schematic Setup

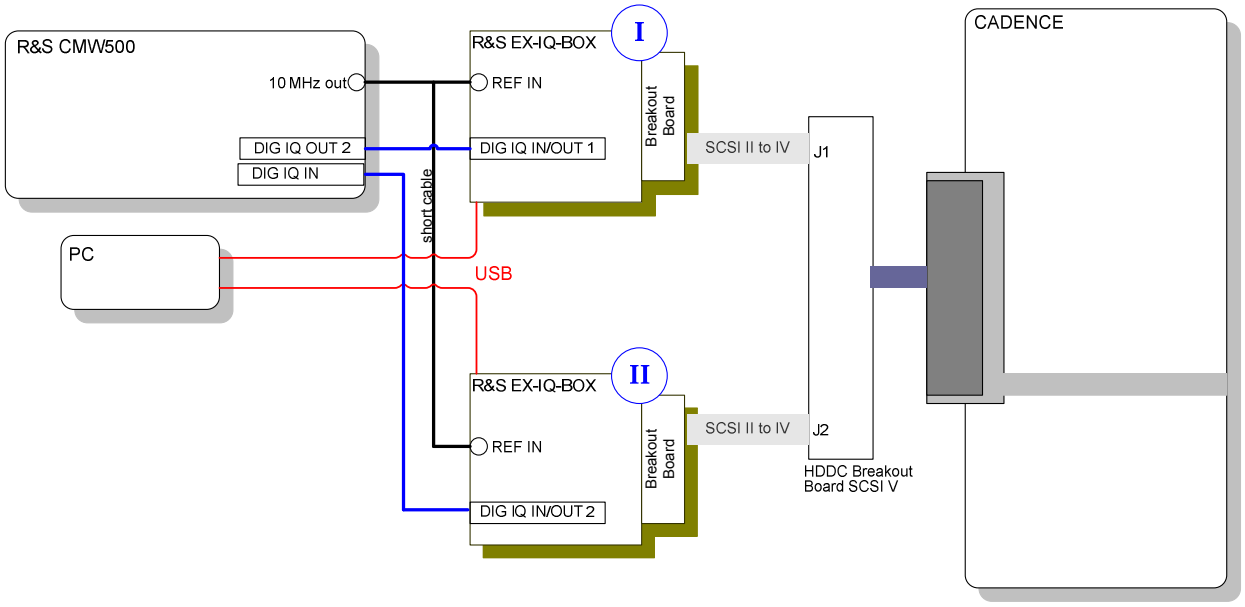


Figure 14: Setup Diagram

3.2 Hardware Requirements for Real Simulation

Amount	Unit	Hardware Key
R&S®CMW500 minimum configuration		
1	R&S CMW-B300A Signaling Unit Wideband (SUW)	1202.6304.02
1	R&S CMW-B510A Digital IQ Board	1202.8007.02
Adapter		
2	R&S EX-IQ-BOX	1409.5505K04/.02
2	R&S EXBOX-Z3 CADENCE PALLADIUM Breakout Board	1417.3566.02
1	CADENCE HDDC Breakout Board SCSI V	39BRSA
1	Cadence Palladium Emulator	
Cabeling		
2	R&S SMU-Z6 LVDS cable for connecting digital baseband interfaces	1415.0201.02
1	BNC cable	
1	BNC cable (<= 1m)	
1	BNC T adapter	
2	USB cable	
2	SCSI II to SCSY V cable	

3.3 Cabeling of all Units

External PC	R&S CMW500	R&S EX-IQ-BOX I	R&S EX-IQ-BOX II	CADENCE HDDC Breakout Board SCSI V
From…/ To…	From…	From…/To…	From…/To…	From…/To…
	DIGIQ OUT2	DIG IQ IN 1		
USB		USB		
USB			USB	
	REF OUT	REF IN		
		REF IN split with BNC T adapter (short cable)	REF IN	
		SCSI II		SCSI IV J1 (lower left)
			SCSI II	SCSI IV J2 (lower right)
	DIG IQ IN/OUT 1		DIG IQ OUT 2	

3.4 Software Requirements

Software Requirements		
R&S CMW500 (installable via R&S Version Manager, SW to be retrieved on http://extranet.rohde-schwarz.com)		
Basic	R&S CMW-BASE	Standard R&S CMW500 Protocol Tester HW and SW Configuration
LTE	R&S CMW-KF500	LTE Example Scenarios
WCDMA	R&S CMW-KF400	WCDMA Example Scenarios
Ex IQ Box		
	R&S DigIConf	Digital Interface Configurator for the R&S EX-IQ-BOX, to be installed on an external PC

3.5 Example LTE

3.5.1 Instructions for LTE Example

Note: Do all settings in the following order: 1, 2, 3…6

1. Start R&S CMW500 including R&S CMW500 Base Software and PT Server
2. R&S DigIConf
   - Start the R&S DigIConf program
   - Afterwards change Number of Ex-IQ-Boxes to “2” in the select box

a. R&S EX-IQ-BOX I

I.	Select R&S EX-IQ-BOX 1	Choose the correct serial number
II.	Select “config…” → “Interface Type: user defined …”	
III.	Set To Default	Preset all parameters and switching states.
IV.	Logic Type:	LVTTL
V.	Direction:	Transmitter
VI.	Protocol → Format:	Parallel
VII.	Protocol → Data Rate:	SDR
VIII.	Protocol → Interleaving:	Not Interleaved
IX.	Data → Word Size:	16 Bit
X.	Data → Word Aligment:	LSB
XI.	Data → Bit Order:	LSB
XII.	Data → Numeric Format:	2’s Complement
XIII.	Clock → Clock rate:	(read out from CADENCE system) (For example 1.522 MHz) Refer to Figure 2: Palladium: Logic Analyzer.
XIV.	Clock → Clock Source:	External
XV.	Clock → Clock Phase:	180 deg
XVI.	Switch “State” to “ON”	
XVII.	Refer to Figure 3: LTE: R&S DigIConf: Setup of the R&S EX-IQ-BOX I (Transmitter).	

b. EX-IQ-BOX II

I.	Select R&S EX-IQ-BOX 1	Choose the correct serial number
II.	Select “config…” → “Interface Type: user defined …”	
III.	Set To Default	Preset all parameters and switching states.
IV.	Logic Type:	LVTTL
V.	Direction:	Receiver
VI.	Protocol → Format:	Parallel
VII.	Protocol → Data Rate:	SDR
VIII.	Protocol → Interleaving:	Not Interleaved
IX.	Data → Word Size:	16 Bit
X.	Data → Word Aligment:	LSB
XI.	Data → Bit Order:	LSB
XII.	Data → Numeric Format:	2’s Complement
XIII.	Clock → Clock rate:	(read out from CADENCE system) (For example 1.522 MHz) Refer to Figure 2: Palladium: Logic Analyzer.
XIV.	Clock → Clock Source:	External
XV.	Clock → Clock Phase:	180 deg
XVI.	Switch “State” to “ON”	
XVII.	Refer to Figure 4: LTE: R&S DigIConf: Setup of R&S EX-IQ-BOX II (Receiver).	

R&S CMW500

3. Open Project Explorer and load an UL + DL LTE sample scenario
   `C:\Rohde-Schwarz\Scenarios\15.11\APPL\MLAPI\LTE_SAMPLE_SCN\1.0\TestProjectLTE_Sample_Scn.tpd`
   For example, load test case "ml_002".

4. Apply the RF/DIG IQ settings within the "System Configuration" dialog
   a. UE connected to: DIGITAL IQ
   b. Direction Settings: ---
   c. Dig IQ OUT 2: Sample Rate: 7.68 Msps
      Enable Source: Digital IQ OUT
   d. Dig IQ IN/OUT 1: Sample Rate: 7.68 Msps
      Enable Source: Auto Internal
   e. AUX A: Direction OFF
   f. AUX B: Direction OFF
   g. Click the “Save Changes” button 
      Refer to Figure 6: LTE: System Configuration with applied DIGITAL IQ settings.

5. Start the test case within Project Explorer.
   For example, start test case "ml_002" (real UL is needed)

4 Troubleshooting

4.1 Testing the HW

4.1.1 Instructions to Test the HW Setup

R&S DigIConf

1. Start the R&S DigIConf program.
2. Change Number of Ex-IQ-Boxes to “2” in the select box.

a. R&S EX-IQ-BOX I

I.	Select R&S EX-IQ-BOX 1	Choose the correct serial number
II.	Select “config…” → “Interface Type: user defined …”	
III.	Set To Default	Preset all parameters and switching states.
IV.	Logic Type:	LVTTL
V.	Direction:	Transmitter
VI.	Protocol → Format:	Parallel
VII.	Protocol → Data Rate:	SDR
VIII.	Protocol → Interleaving:	Not Interleaved
IX.	Data → Word Size:	16 Bit
X.	Data → Word Aligment:	LSB
XI.	Data → Bit Order:	LSB
XII.	Data → Numeric Format:	2’s Complement
XIII.	Clock → Clock rate:	(read out from CADENCE system) (For example 1.522 MHz)
XIV.	Clock → Clock Source:	External
XV.	Clock → Clock Phase:	180 deg
XVI.	Test → Test Signal:	Sine
XVII.	Test → Fequency:	20 kHz
XVIII.	Test → Amplitude:	0 dBFS
XIX.	Test → TX Test:	“ON”
XX.	Switch “State” to “ON”	
XXI.	Refer to Figure 15: R&S EX-IQ-BOX transmitter settings.	

b. R&S EX-IQ-BOX II

I.	Select R&S EX-IQ-BOX 2	Choose the correct serial number
II.	Start Transient Recorder 1…	
III.	Data Source:	DIG IQ OUT 2
IV.	Smart Graphic:	On
V.	Display Type:	I/Q
VI.	State:	On
VII.	Select “config…” → “Interface Type: user defined …”	
VIII.	Logic Type:	LVTTL
IX.	Direction:	Receiver
X.	Protocol → Format:	Parallel
XI.	Protocol → Data Rate:	SDR
XII.	Protocol → Interleaving:	Not Interleaved
XIII.	Data → Word Size:	16 Bit
XIV.	Data → Word Aligment:	LSB
XV.	Data → Bit Order:	LSB
XVI.	Data → Numeric Format:	2’s Complement
XVII.	Clock → Clock rate:	(read out from CADENCE system) (For example 1.522 MHz)
XVIII.	Clock → Clock Source:	External
XIX.	Clock → Clock Phase:	180 deg
XX.	Switch “State” to “ON”	

3. EX-IQ-BOX II Transient Recorder 1…
   Refer to Figure 17: .

Result on R&S EX IQ BOX II

If you can see the Sine in the Transient Recorder, the HW setup is OK.
If there is a spike, the HW setup is faulty.

Result on CADENCE

Sine wave sampled with the interface CLK without spikes.

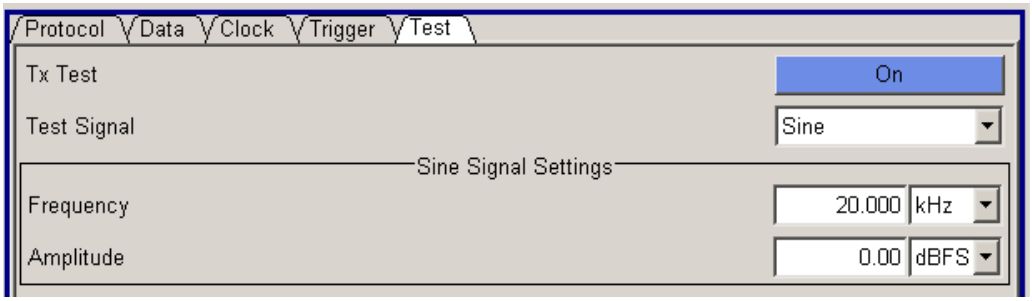


Figure 15: R&S EX-IQ-BOX transmitter settings

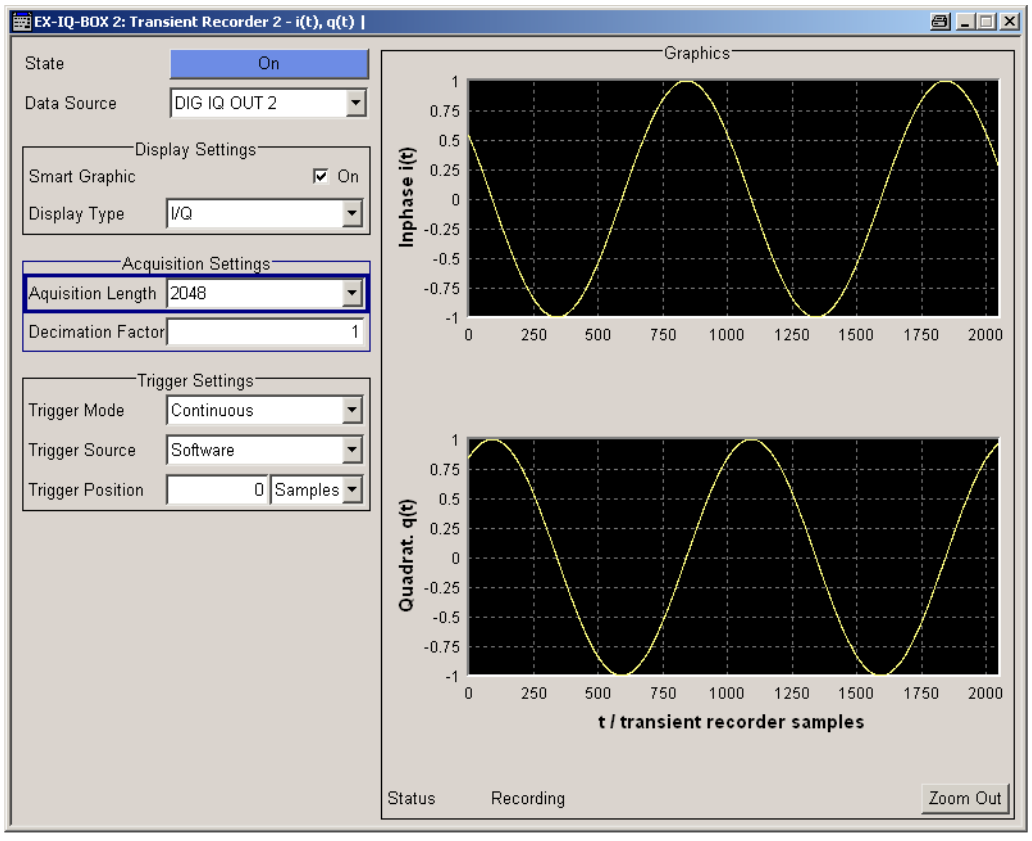


Figure 17: R&S EX-IQ-BOX receiver Transient Recorder

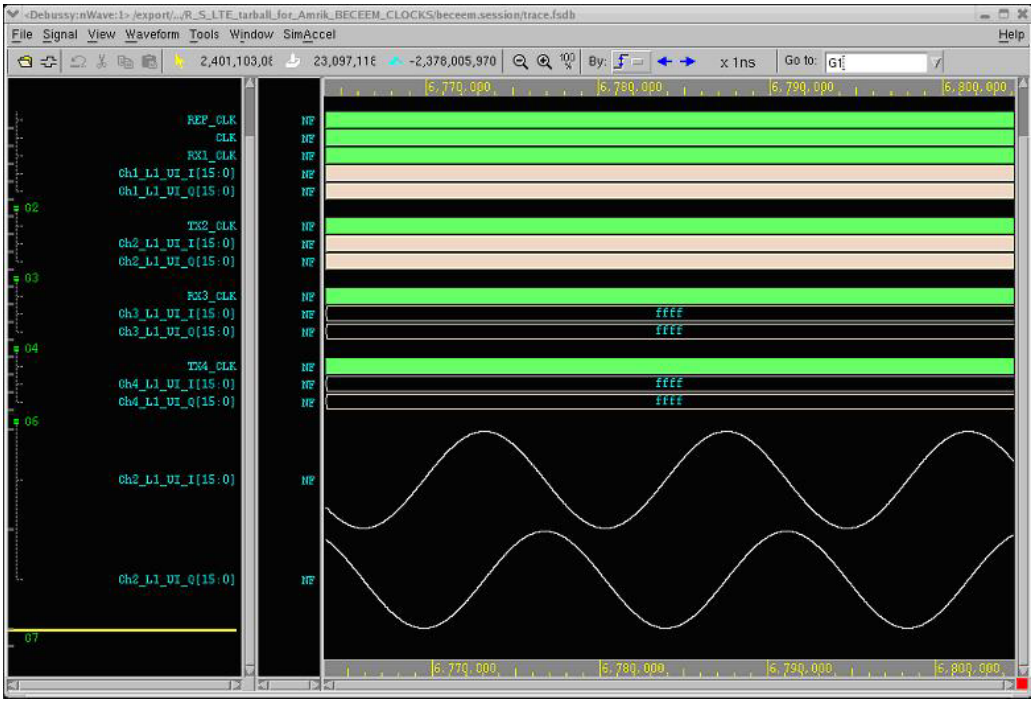


Figure 17: Palladium Waveform of I/Q with sine wave

About Rohde & Schwarz
Rohde & Schwarz is an independent group of companies specializing in electronics. It is a leading supplier of solutions in the fields of test and measurement, broadcasting, radiomonitoring and radiolocation, as well as secure communications. Established more than 75 years ago, Rohde & Schwarz has a global presence and a dedicated service network in over 70 countries. Company headquarters are in Munich, Germany.

Environmental commitment
- Energy-efficient products
- Continuous improvement in environmental sustainability
- ISO 14001-certified environmental management system

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