Rohde & Schwarz Products:

R&S®FSQ, R&S®FSQ-K100, R&S®FSQ-K101,
R&S®SMU200A, R&S®SMATE200A, R&S®SMJ100A,
R&S®AFQ100A, R&S®AMU200A, R&S®WinIQSIM2™,

LTE Measurement Guide

Application Note

The object of this application note is to illustrate how to setup and analyze a 3GPP EUTRA/LTE downlink respectively uplink signal. For signal generation an R&S®SMU200A is used while on the analysis side an R&S®FSQ with external PC software, referred to as R&S®FSQ-K100 and R&S®FSQ-K101 for downlink and uplink direction respectively, is used. Further, the installation procedure of the 3GPP EUTRA/LTE analysis software R&S®FSQ-K100/K101 is shown and features, settings and display options are described briefly.

ROHDE & SCHWARZ

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1 Note / Introduction

This application notes subject is to illustrate how to setup 3GPP EUTRA/LTE down- respectively uplink signals on the signal generator, R&S®SMU200A, and analyze them with an R&S®FSQ and external PC software. Since the LTE standard is not finalized yet, an external analysis software, referred to as R&S®FSQ-K100/K101, is provided which, compared to integrated personalities of a spectrum analyzer, is more flexible in terms of software updates.

The LTE standard is not complete defined yet and continuously enhancing. Therefore the personalities of the signal generator and analyzer software will be enhanced as well, to provide always up-to-date functionality according to the standard. This means the given screenshots in this document might differ for upcoming versions.

In addition, the paper guides thru the installation process of R&S®FSQ-K100/K101 (version 1.1 beta 2) analysis software for 3GPP EUTRA/LTE downlink respectively uplink signals. General program settings, display options and software features are described subsequently.

The document is not intended to give a UMTS LTE technology introduction, therefore please refer to the Rohde & Schwarz application note 1MA111.

http://www.rohde-schwarz.com/appnote/1MA111.html

Utilized firmware and software versions:

R&S®FSQ8:	Firmware release 4.15
R&S®FSQ-K100/K101:	Software version 1.1 Beta 2
R&S®SMU200A:	Firmware 02.04.252 Beta (incl. patch for EUTRA/LTE stage 2 with signal uplink functionality)

In general, for generating 3GPP EUTRAL/LTE signals, the Rohde & Schwarz RF signal generators SMU200A, SMJ100A and SMATE200A are available. The appropriate software option for those generators, referred to as Digital Standard 3GPP EUTRA/LTE, is option SMx-K55. Alternatively, PC simulation software, referred to as WinIQSIM2™, can be used to generate waveforms for digitally modulated signals which can be uploaded on the previous mentioned generators. For this software option SMx-K255 is required.

Besides RF generators, 3GPP EUTRA/LTE personality is also available for the baseband signal generator and IQ modulation generator referred to as AMU200A and AFQ100A respectively. The required software options are correspondingly AMU-K55 or AMU-K255 for the baseband respectively AFQ-K255 for the IQ modulation generator.

On the signal analysis side the FSQ family supports the 3GPP EUTRA/LTE standard. Currently an external PC software, referred to as FSQ-K100/K101, for signal analysis is utilized in order to provide expeditiously updates according the enhancing standard. Once the standard reaches a more final status, an integrated personality for the spectrum analyzers will be available.

For obtaining the latest beta soft- and firmware versions for signal generators and analyzers please contact the R&S support center at customersupport@rohde-schwarz.com.

2 Software Installation FSQ-K100/K101

2.1 PC Requirements

The R&S®FSQ-K100 software requires the following minimum PC hardware and software requirements:

Operating System	Windows 2000 + Service Pack 3 or Windows Server 2003 or Windows XP + Service Pack 2
Free Hard Disc Space	20 MByte + 280 MByte (Microsoft .NET Framework 2.0 x86) *) + 460 MByte (Matlab MCR 2006b) *) + 40 MByte (Intel IPP Library Version 4.1) *) + 10 MByte (Microsoft Visual C++ 2005 SP1) *) + 50 MByte (National Instrument VISA Implementation) *)
RAM	512 MByte
Graphics	800 x 600 pixel resolution
Measurement Instrument Connection	IEEE bus (with installed hardware drivers) or LAN connection
Add software components	Microsoft .NET Framework 2.0 (or a later version) Microsoft Internet Explorer 5.01 (or a later version)

**) These components are required once per operating system, for updates to a later R&S®FSQ-K100/K101 software version these components are not needed to be reinstalled.*

2.2 Application Framework Installer

The R&S®FSQ-K100/K101 software requires a number of software components to be installed before the application can be executed. A software tool, referred to as application framework installer, will perform the installation of the required components. The installer itself does not need to be installed on the PC hence it can be executed directly from CD for instance.

In order to start the installation process of the required environmental software, launch the framework installer software (FrameworkInstaller.EXE). The application installer window (Figure 2-1) is separated in three blocks:

1) Table and status of required software components
    - “Component” and “Version” column, listing required software components and version
    - “Installed?” column, indicates if the software is already installed at the operating system
    - “Source Found?” column, indicates if the installation source code is found on the local hard disc
2) Framework Summary Status is intended as information block
3) Control buttons, “Start Installation”, “Refresh” and “Exit”

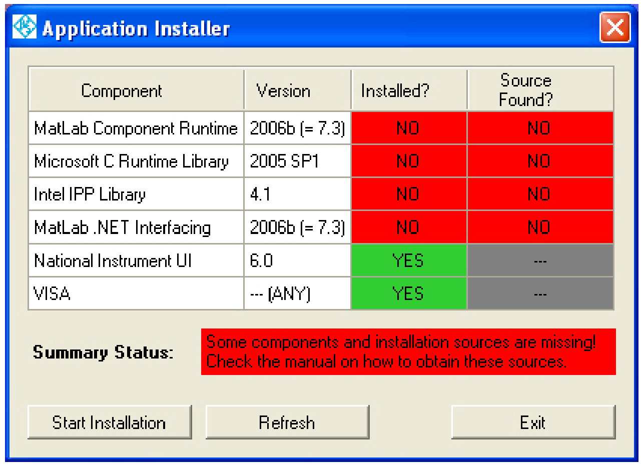


Figure 2-1 Framework Application Installer

In case that some components are missing and the according installation source code is not found on the hard drive, provide them to your system (anywhere on your hard drive), press the refresh button and continue with “Start Installation” after the relevant indicator turns green. Figure 2-2 shows the installation in progress, “Work…” is displayed in the currently installed module.

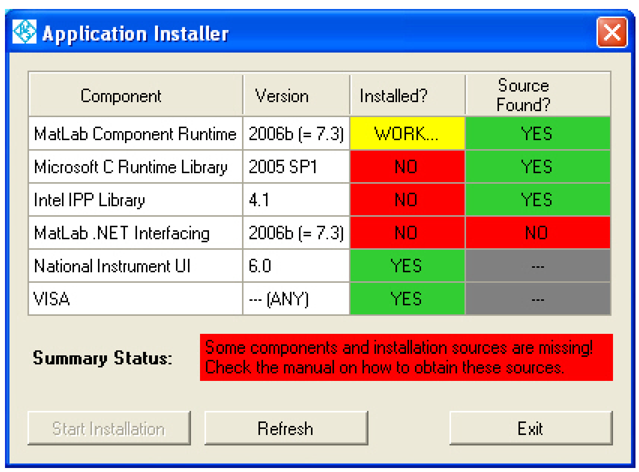


Figure 2-2 Framework Application Installer – Installation in Progress

After the framework is added to the system successfully the column “Installed?” as well as the summary status turns green, shown in Figure 2-3.

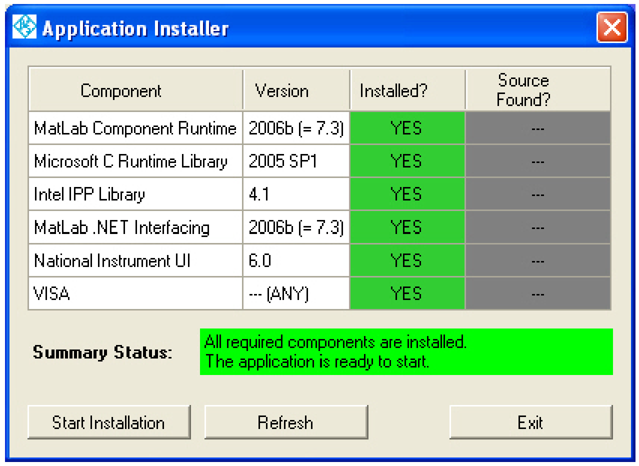


Figure 2-3 Framework Application Installer – Installation successfully completed

Note: The required software can also be installed manually without using the application framework installer!

2.3 Installation of R&S FSQ-K100/K101 Software

When the required framework for the R&S®FSQ-K100/K101 is available on the PC, the application software itself can be installed. Select the installer, named EUTRA_LTE_PC_SW_1.1_BETA2.EXE, and start the process.

Consecutively the installation steps are illustrated in detail and described briefly:

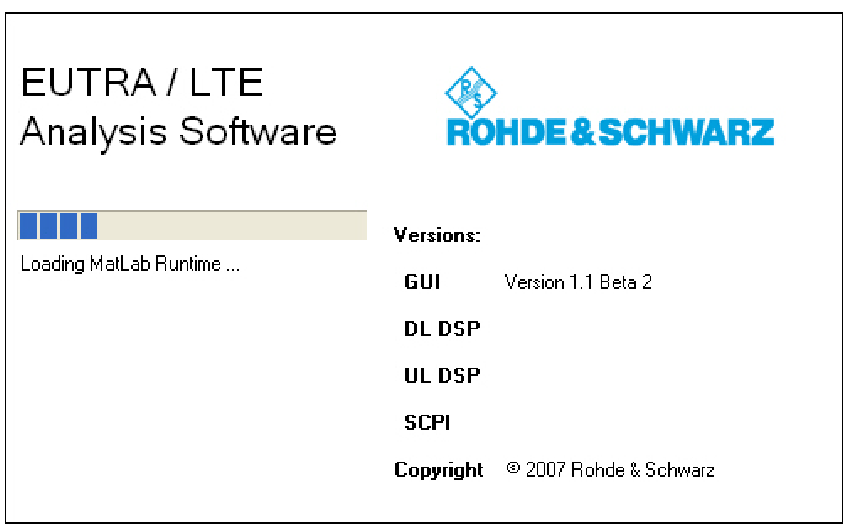


Figure 2-4 Installing FSQ-K100/K101 – Startup screen

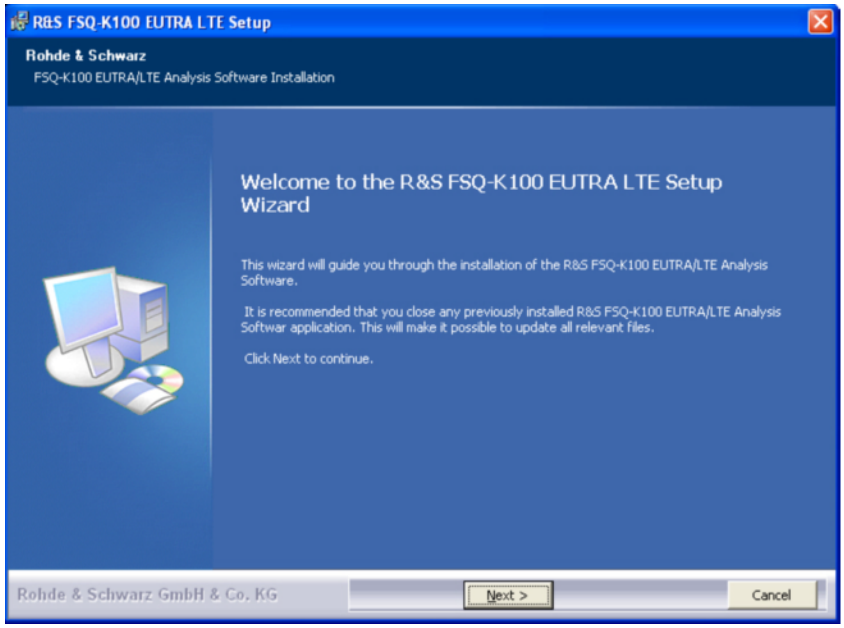


Figure 2-5 Installing FSQ-K100/K101 – Startup installation wizard

- Press “Next” in order to continue

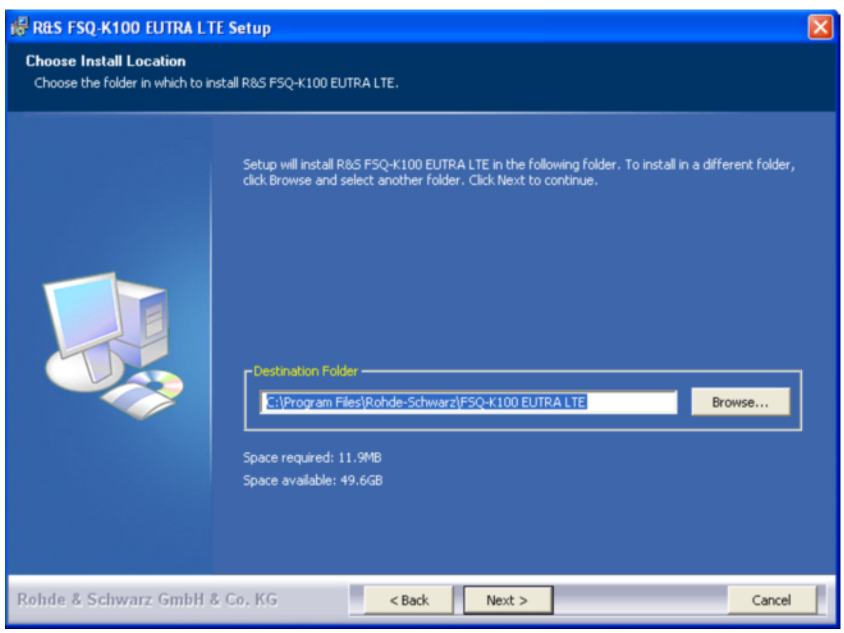


Figure 2-6 Installing FSQ-K100/K101 – Select installation directory

- Set installation folder

Note: If you intend to have different R&S®FSQ-K100/K101 versions installed on your PC it is recommended to choose different destination folders in order to avoid file conflicts of different versions!

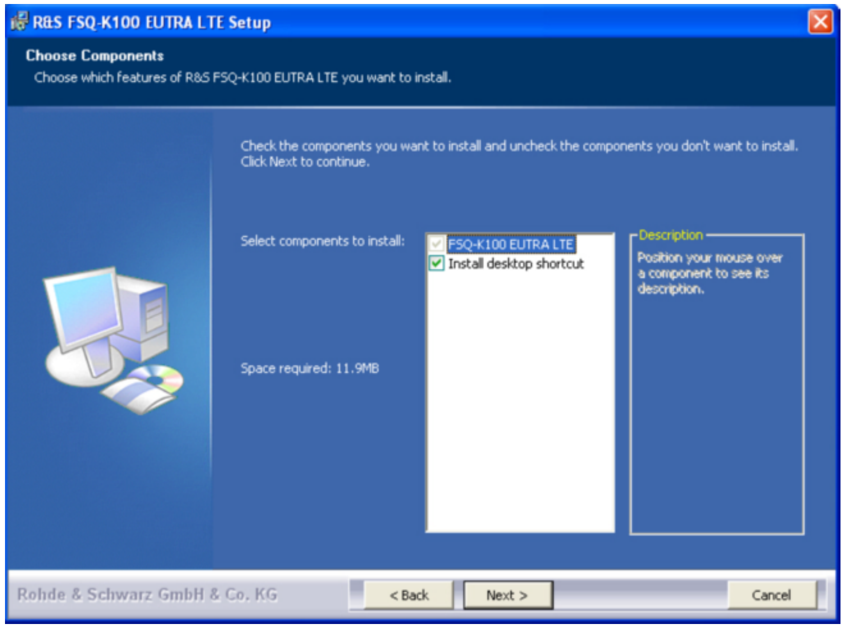


Figure 2-7 Installing FSQ-K100/K101 – Select installation feature set

- Create program desktop shortcut if box is checked

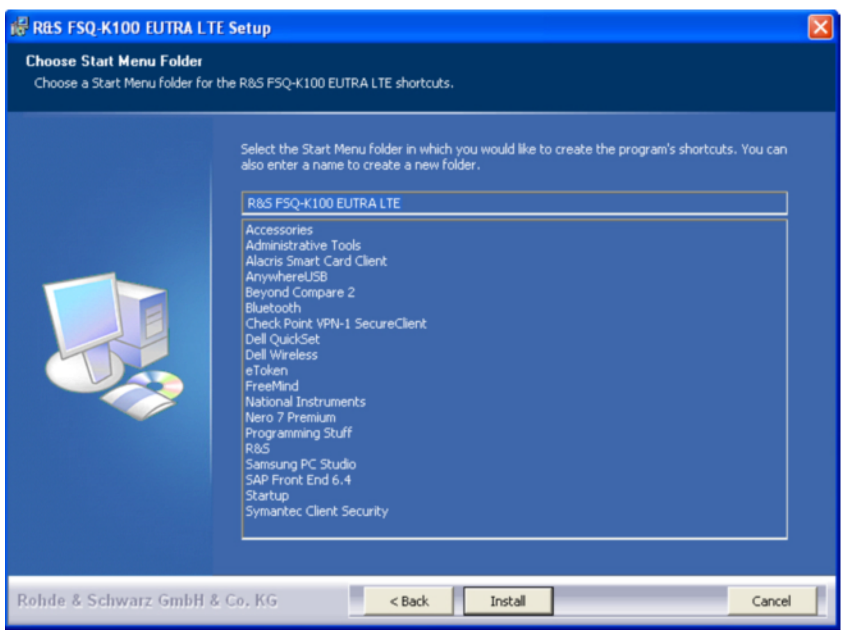


Figure 2-8 Installing FSQ-K100/K101 – Select Windows start menu folder

- Create windows start menu entry:

Start → Programs → R&S FSQ-K100 EUTRA LTE

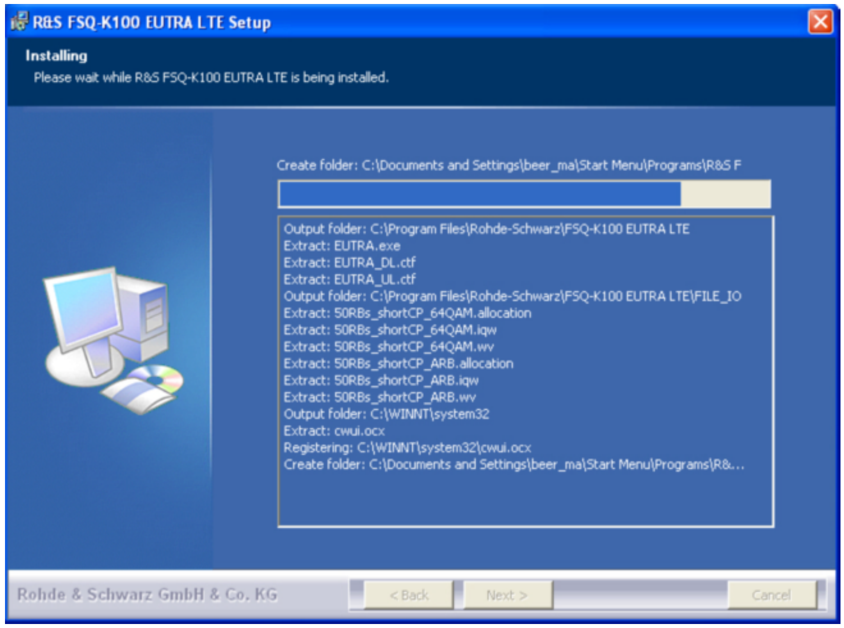


Figure 2-9 Installing FSQ-K100/K101 – Installation progress

- ➢ List installed program components and display progress bar

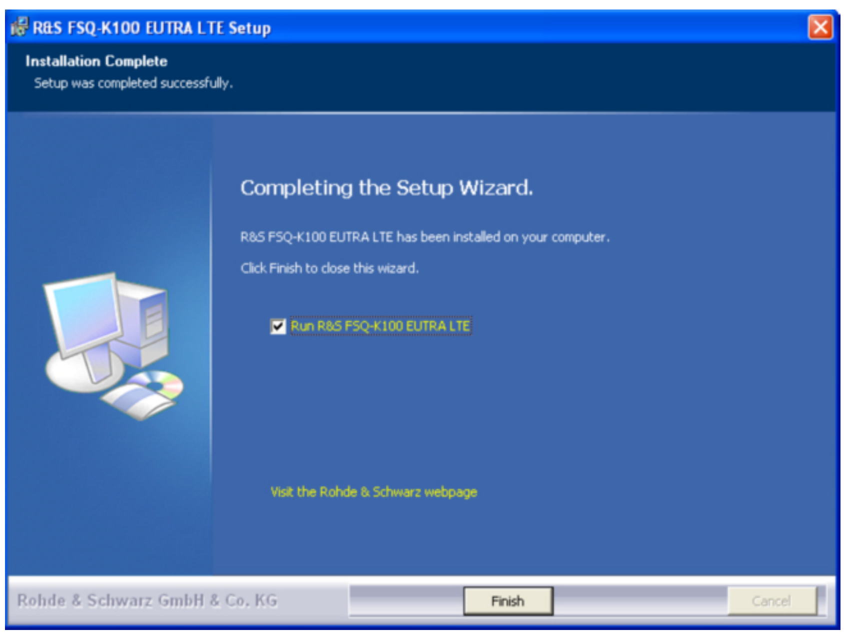


Figure 2-10 Installing FSQ-K100/K101 – Installation completed

- ➢ Installation is completed
- ➢ Check "Run R&S FSQ-K100 EUTRA LTE" box in order to run program after pressing "Finish" button

3 General Program Features FSQ-K100/K101

This chapter is introducing general program features and practical settings whereas important points are described briefly.

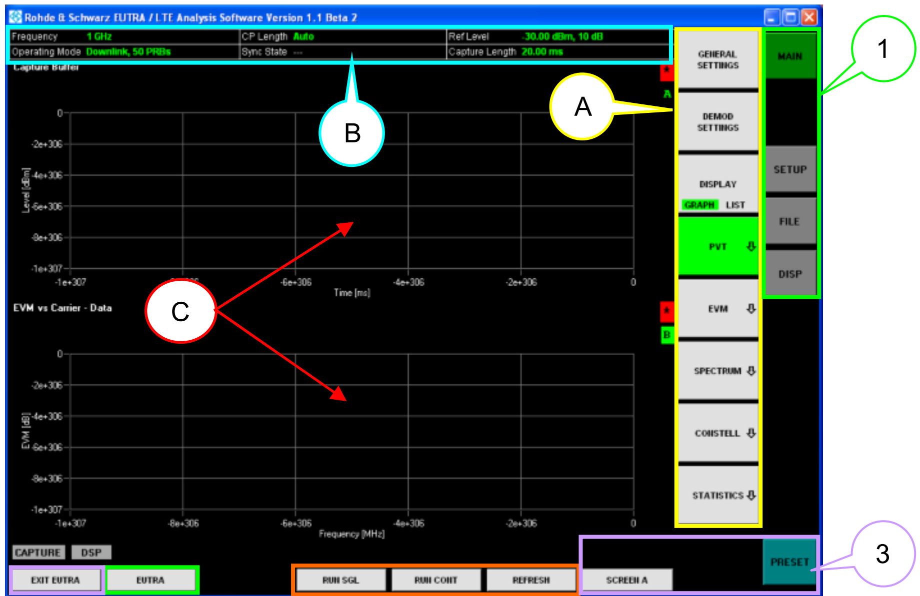


Figure 3-1 FSQ-K100/K101 – Main Application Window

Permanent available buttons, composed in colored boxes:

①. Green boxes: Access sub-menus

②. Orange box: Data recording options

③. Purple boxes: Common program features

Menu & setting sensitive blocks:

A. Yellow box: Sub-menu content (shown in Figure 3-2)

B. Blue box: Measurement settings

C. Red pointers: Display area, screen A & B, for analyzed data

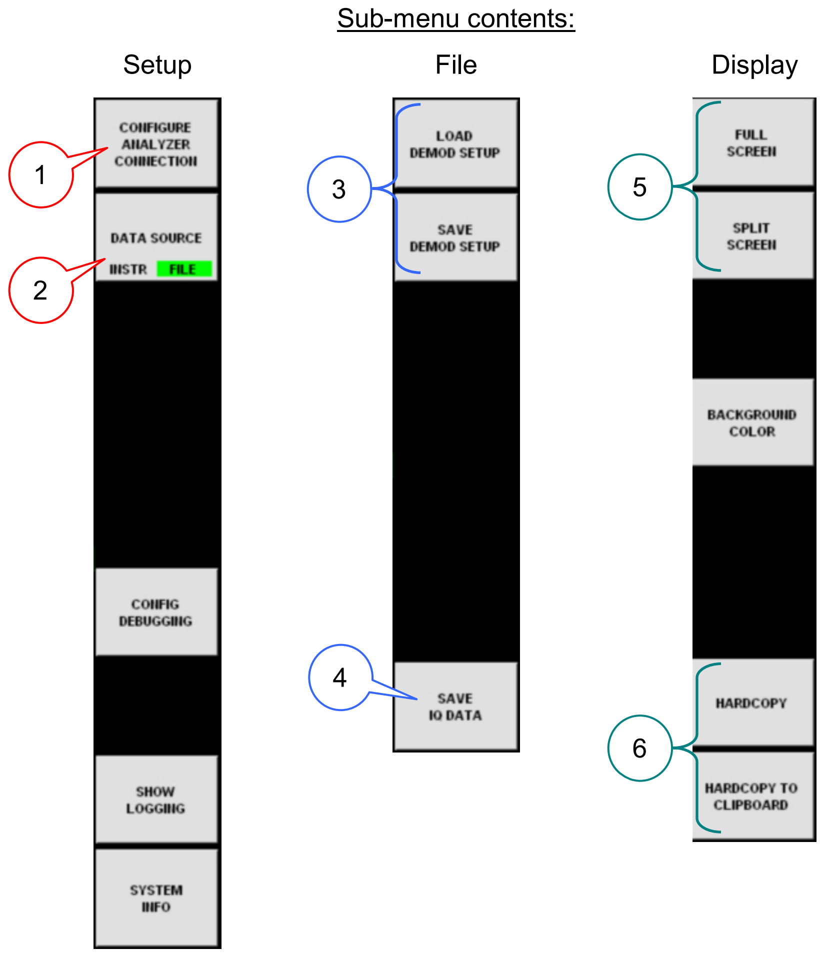


Figure 3-2 FSQ-K100/K101 – Sub-menu contents

①. Configure analyzer connection if data source (2) is set to INSTR

②. Select data source:

- FILE: Analyzing IQ ASCII data file (no analyzer required)
  → I and Q values are expected in alternating rows:
  < I value 1 > \new line
  < Q value 1 > \new line
  < I value 2 > \new line
  < Q value 2 > \new line
- INSTR: Capture and analyze data from FSQ

③. Load/Save demodulation settings

④. Save IQ data to file, e.g. after capturing from analyzer

⑤. Setup display area, full or split screen

⑥. Take screenshot from K100/K101, either to file or clipboard

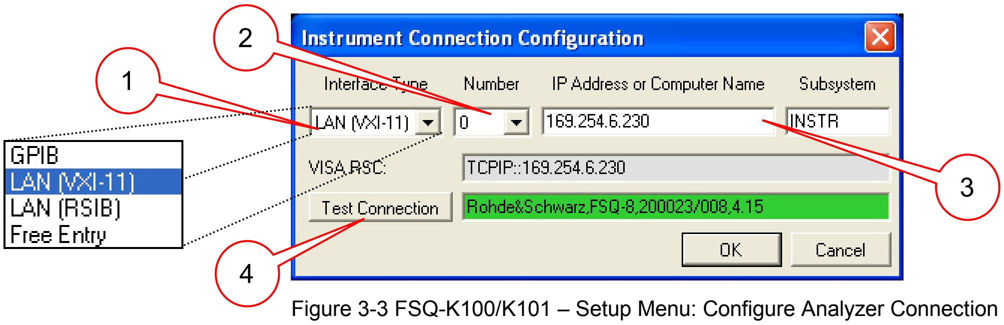


Figure 3-3 FSQ-K100/K101 – Setup Menu: Configure Analyzer Connection

①. Select interface type for remote connecting PC and FSQ

②. Select number of interface, usually "0" (if more than one GPIB or LAN interface is installed for instance the number can differ)

③. Depending from the selected interface type, provide GPIB or IP address respectively a complete VISA string for "Free Entry" selection

④. Test remote control connection with defined settings and show test result right-sided:

- GREEN highlighted: Successfully connected (Figure 3-3)
- RED highlighted: Connection failed
  - ➢ Double-check interface settings (point 1..3)
  - ➢ Check PC and FSQ firewall settings, either permit connection on both sides or disable firewalls completely
  - ➢ For LAN connections check cable configuration, two different types are available: Crossover or 1:1 cables
    - ➔ Crossover cable: Direct connection of PC and FSQ
    - ➔ 1:1 cable: Connecting PC and FSQ via Ethernet HUB

Note: If the PC enables the standby or hibernating mode for power saving issues for instance, the Ethernet card might be disabled and the program cannot link to the interface anymore.

→ Restart the FSQ-K100/K101 software

Further, in power save mode, the IP addresses (FSQ and PC) might have been discarded and need to be renewed:

→ use DOS command: "c:\cmd\ipconfig /renew" or goto

→ Windows Start → Settings → Network Connections → Select LAN connection → Support TAB → Press Repair button

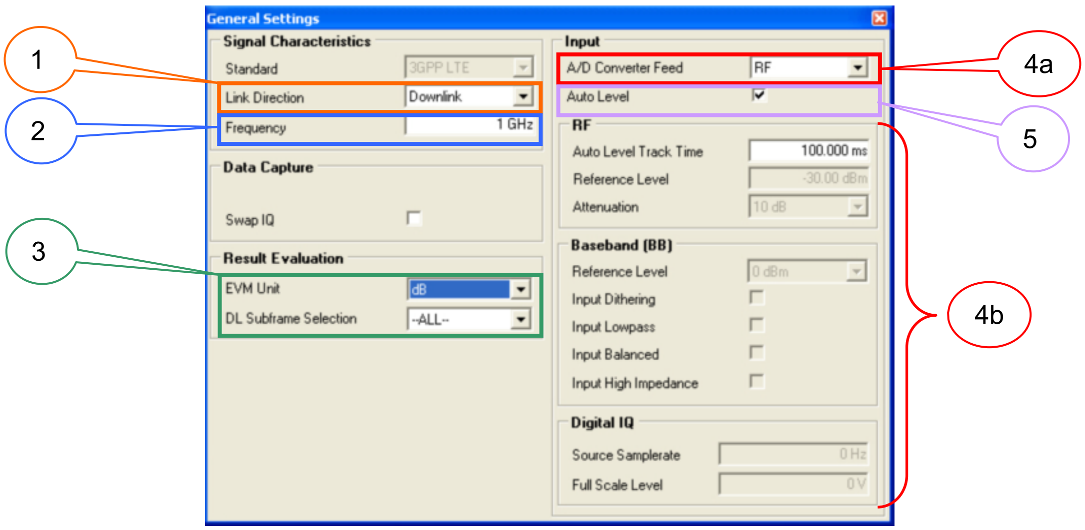


Figure 3-4 FSQ-K100/K101 – General Settings

①. Select radio link direction: downlink respectively uplink

②. Set signal center frequency

③. Make selections for result evaluation

④. Set FSQ signal input port (4a) and corresponding port settings (4b)

⑤. In case of RF port selection (4), auto level feature for input signal can be selected (setting is recommended)

Demodulation Settings for downlink signals:

Demodulation Settings | Signal Characteristics

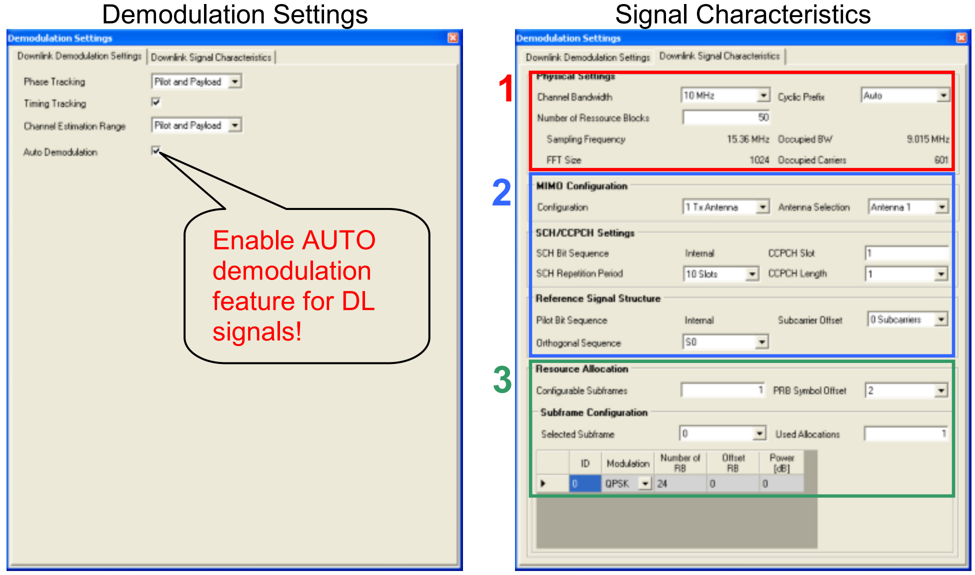


Figure 3-5 FSQ-K100/K101 – Demod Settings: Downlink

Note: Default DL settings, SMU & FSQ-K100, are matched

①. Make physical DL settings according input signal (e.g. signal bandwidth)

②. Setup MIMO and reference signal configuration

③. Setup DL signal resource allocation, only required if auto demodulation feature is not enabled

<u>Demodulation Settings for uplink signals:</u>

Demodulation Settings — Signal Characteristics

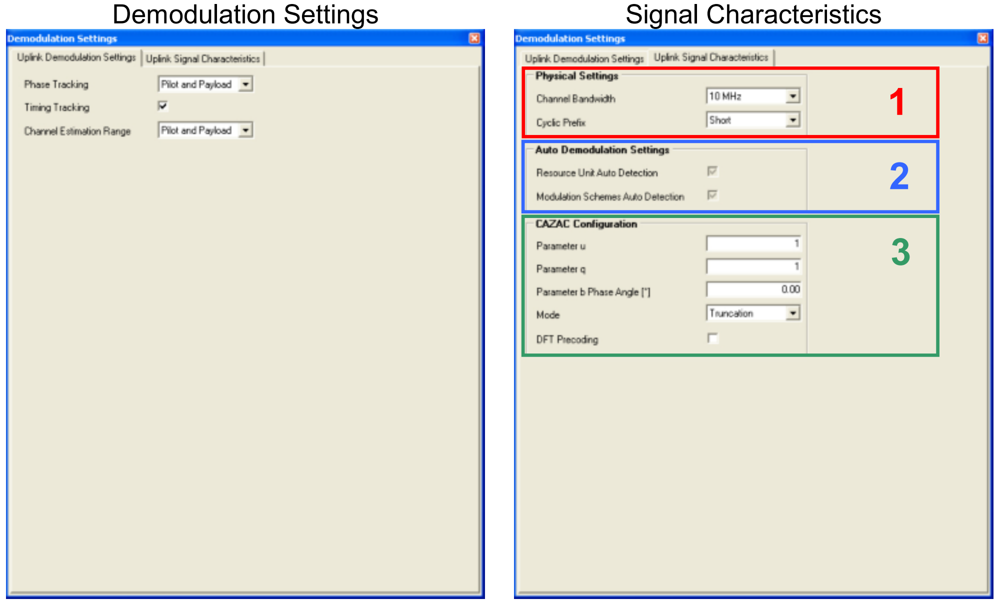


Figure 3-6 FSQ-K100/K101 – Demod Settings: Uplink

Note: Default UL settings, SMU & FSQ-K101, are matched

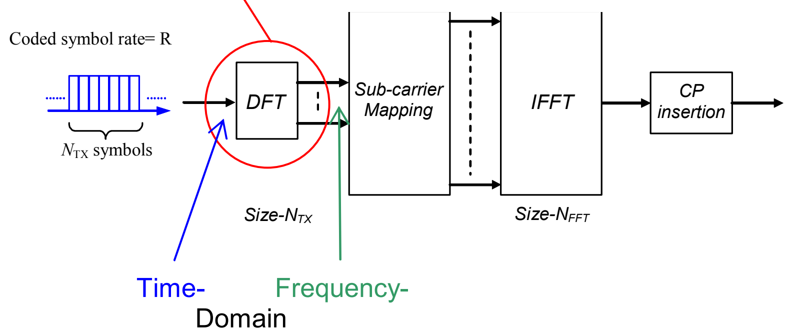
①. Make physical UL settings according input signal

②. Auto Demodulation settings are activated permanently

③. CAZAC (Constant Amplitude Zero Auto-Correlation) configuration:

- The CAZAC parameters u, q and b are describing discrete points on a unit circle depending on the sequence index N. For more details please refer to Figure 3-7 et sqq. where some formulas as well as simulation results are given
- Mode: A good cross-correlation is given for a prime number of sub-carriers, 11 or 13 for instance. While a resource block consists of 12 sub-carriers different CAZAC modes (compared to number of sub-carriers of UE allocation) can be applied:
  - → Truncation: Utilize the next bigger prime number
  - → Repetition: Utilize the next smaller prime number
  - → Direct: Utilize the absolute next prime number

- DFT precoding defines basically the domain, frequency or time, the UL pilot information is added.



→ Adding information in time domain might give a better crest factor than adding it in frequency domain

→ Adding information in frequency domain is compared with time domain operation easier from a mathematical point of view but can worsens the crest factor

$$S_u = (a_u(0)b,\ a_u(1)b, \ldots, a_u(N-1)b) \tag{3.1}$$

$$a_u(k) = e^{-j2\pi * u \frac{k(k+1)/2 + (q*k)}{N}} \tag{3.2}$$

with

$u = 1 \ldots (N-1)$
$k = 0 \ldots (N-1)$
N = sequence index
q = any integer
b = phase angle $[°]$

Figure 3-7 CAZAC formula: **S_u** *(accumulation of discrete CAZAC points incl. rotation)*; **$a_u(k)$** *(discrete CAZAC points)*

The CAZAC formula and the related parameters are describing discrete points on a unit circle. The parameters are supposed to be derived for instance from the UE or cell ID when the standard is completely specified. Currently the parameters can be set by the user in order to have a maximum degree of freedom in terms of design and testing.

The parameter values in detail are of less importance as long as they are the same for signal generation and analysis side.

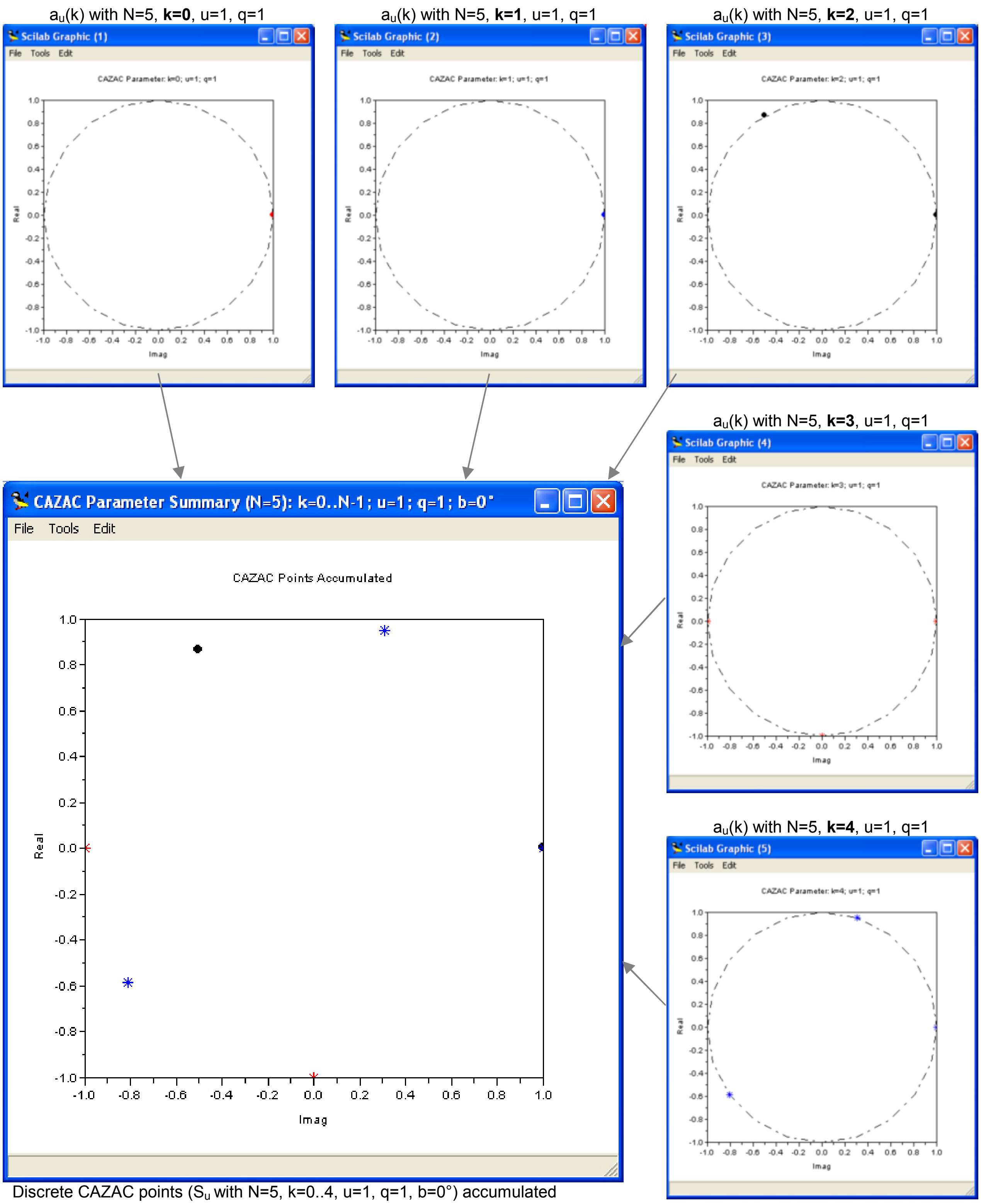


Figure 3-8 Discrete CAZAC points, $a_u(k)$, for different parameter sets (N=5, k=0..4) displayed on unit circles and accumulated (S_u)

Variation of CAZAC parameter u from 1..5 (left to right diagram) while N=120 and q=1

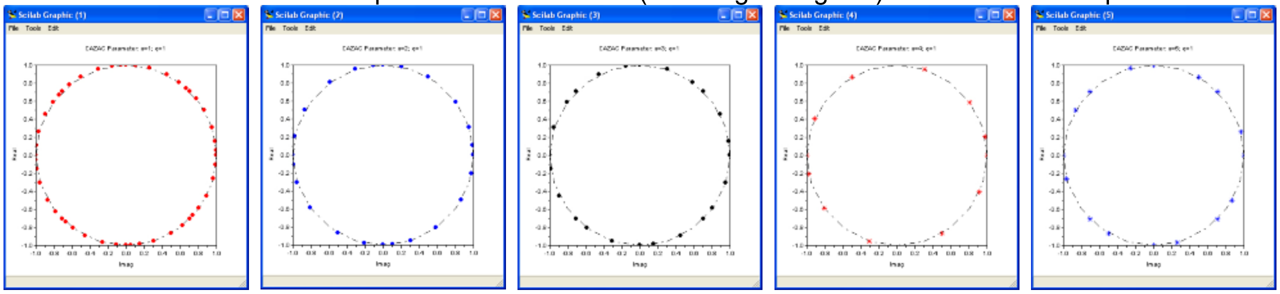


Figure 3-9 Discrete CAZAC points, $a_u(k)$, for different parameter sets (N=120, q=1, u=1..5) displayed on unit circles

Discrete CAZAC points as a function of sequence index N

Sequence index N = 120 Sequence index N = 1000

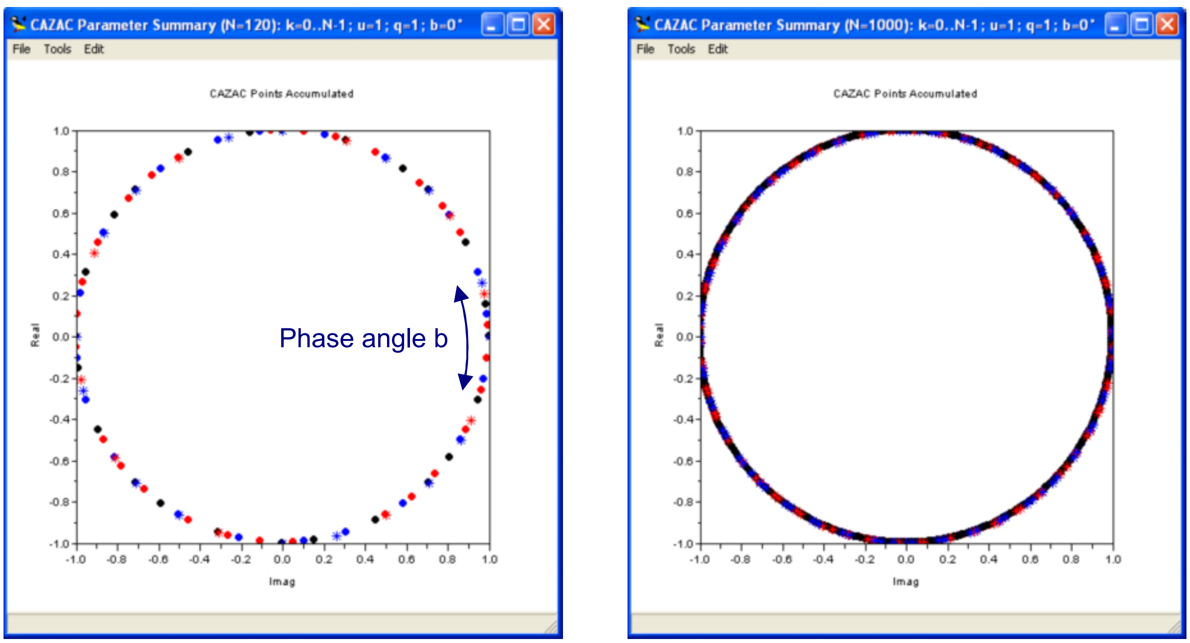


Figure 3-10 Accumulated CAZAC points S_u for N=120 (left side) resp. N=1000 (right side) while u=1, q=1 and b=0°

An increased sequence length, referred to as variable N, increases the number of discrete CAZAC points. Figure 3-8 respectively Figure 3-10 illustrates $a_u(k)$ for N=5 resp. N=120 and 1000 (colored dots and asterisks are representing discrete CAZAC points as a function of k).

For illustrating different CAZAC parameters, $a_u(k)$ is given in Figure 3-9 Discrete CAZAC points, $a_u(k)$, for different parameter sets (N=120, q=1, u=1..5) displayed on unit circlesThe calculations are done for different values of u (1..5) while keeping the sequence index N (120) and CAZAC parameter q (1) constant.

Figure 3-10 (left diagram) contains in addition the behavior of the CAZAC parameter b, referred to as phase angle in deg, which introduces a simple rotation of $a_u(k)$ along the unit circle.

Note: The generator as well as the analyzer side has to be fed with the same settings to ensure a proper UL operation and synchronization! Again, the parameter values in detail are of less importance as long as they are the same for both, generator and analyzer.

Proposed 3GPP CAZAC parameters: u = 1; q = 1; b=0°

4 LTE Downlink

4.1 Generating LTE Downlink Signals

In order to setup a 3GPP EUTRA/LTE downlink (DL) signal with the R&S® SMU200A the following steps have to be performed:

a) Select "Baseband A" block in SMU diagram area (Figure 4-1)

b) Open BB configuration menu by pressing "config.." button

c) Select EUTRA/LTE

→ EUTRA/LTE software menu opens (Figure 4-2)

d) Select signal link direction: Downlink (Figure 4-2: Flag 5)

e) Make general DL settings (Figure 4-2: Flag 6)

f) Configure EUTRA/LTE frame (Figure 4-2: Flag 7)

g) Enable BB (Figure 4-2: Flag 1) and RF (Figure 4-6)

Subsequently the prior steps are illustrated and additional background information is given.

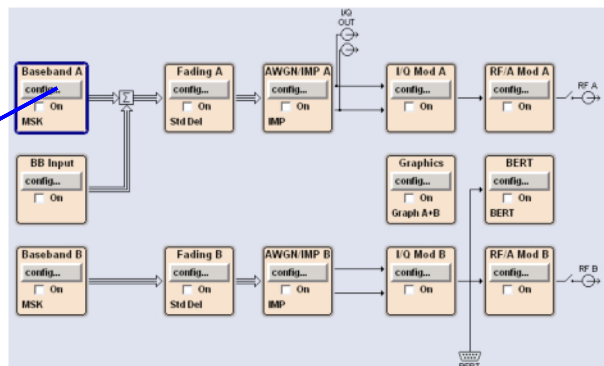


Figure 4-1 SMU200A – Diagram area

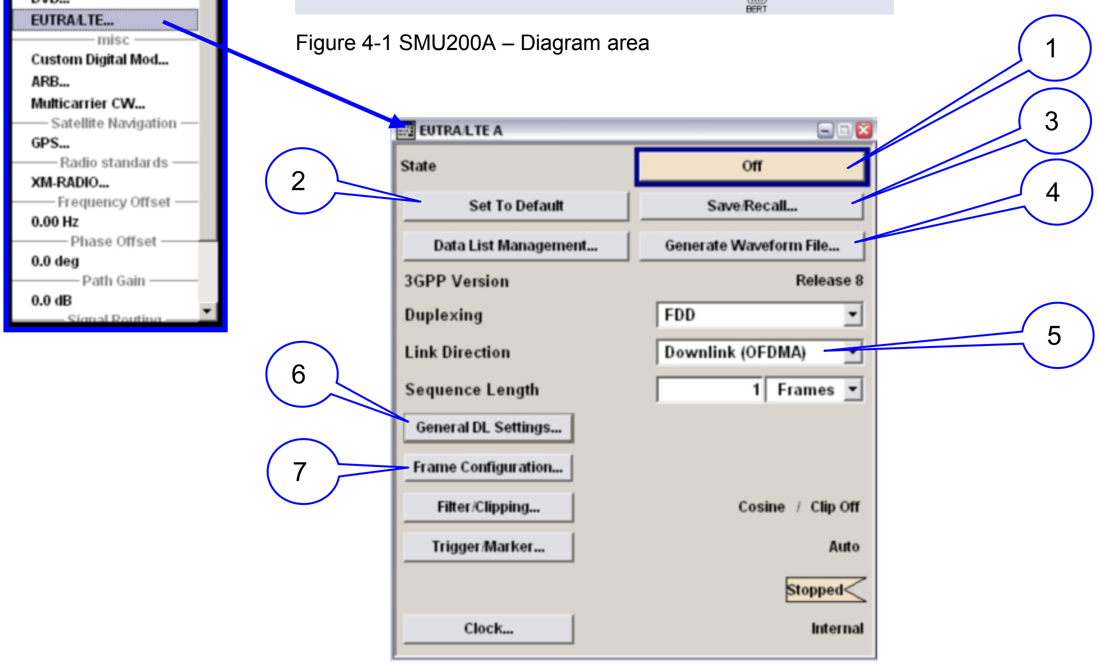


Figure 4-2 SMU EUTRA/LTE BB personality menu (DL)

①. Enable EUTRA/LTE BB → it´s recommended to enable baseband after configuring signal, otherwise signal calculations are triggered with any single modification

②. Set EUTRA/LTE menu to default settings

③. Save or recall EUTRA/LTE settings

④. Save datastream to ARB compatible *.wv file

⑤. Set signal link direction

⑥. Sub-menu for general DL (resp. UL) signals (Figure 4-3)

⑦. Sub-menu for DL (resp. UL) frame configuration (Figure 4-4)

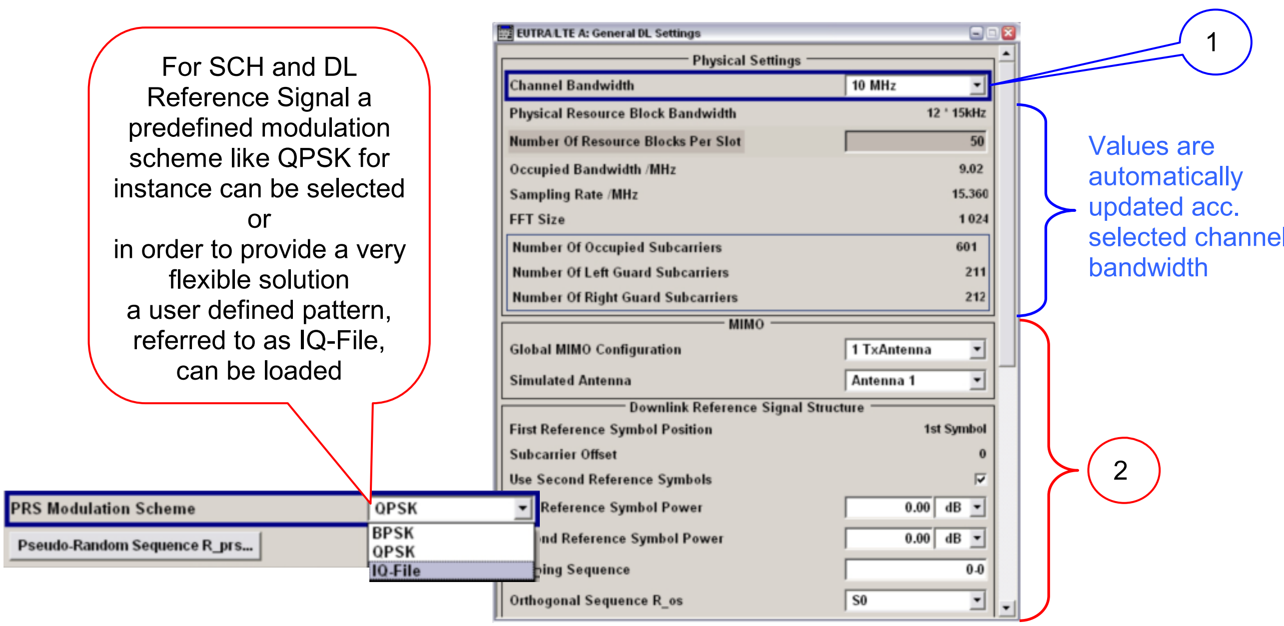


Figure 4-3 SMU EUTRA/LTE DL settings – General DL settings

①. Select channel bandwidth

②. Configure MIMO and reference signal resp SCH/CCPCH settings (default setting are matched with R&S®FSQ-K100 software)

Note: In order to keep flexible in terms of modulation schemes for DL reference signal and SCH it is possible to load user defined pattern, referred to as IQ-File.

In the following table some settings for a manually defined DL signal, 10 configurable subframes, are given:

Subframe	0	1	2	3	4	5	6	7	8	9
Cycle Prefix	Short	Short	Short	Short	Short	Short	Short	Short	Short	Short
Allocations	3	3	0	3	0	2	5	5	5	0
Modulation / Resource Block (for allocation number 1..n)	*Contains LTE DL sync information (P-SCH, S-SCH and CCPCH)	64QAM/1 64QAM/1 64QAM/1		64QAM/1 64QAM/1 64QAM/1		*Contains LTE DL sync information (P-SCH & S-SCH)	64QAM/1 16QAM/1 QPSK/1 64QAM/1 QPSK/1	64QAM/1 16QAM/1 QPSK/1 64QAM/1 QPSK/1	64QAM/1 16QAM/1 QPSK/1 64QAM/1 QPSK/1	

* *defined in EUTRA/LTE standard for DL signal direction*
→ Nevertheless RBs can be allocated in these subframes!

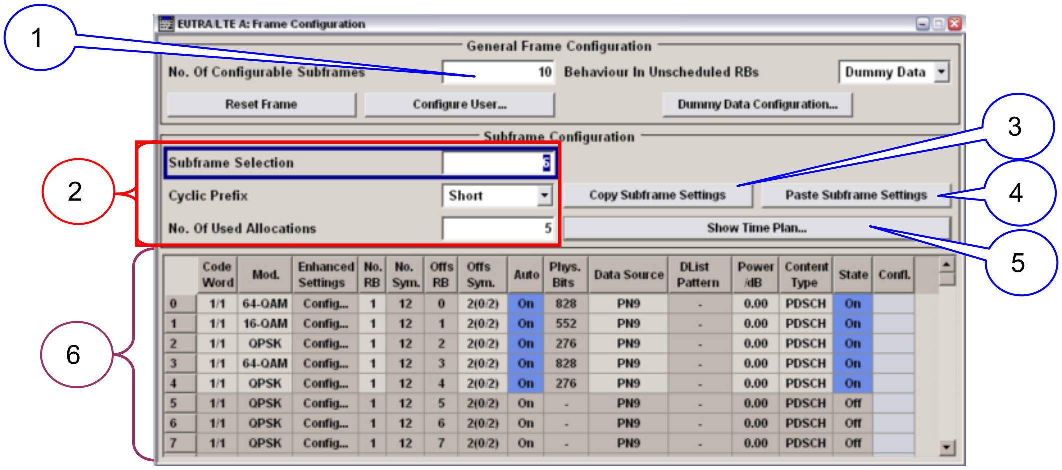


Figure 4-4 SMU EUTRA/LTE DL settings – Frame Configuration

①. Select the number of configurable subframes (1 .. 10)

②. Modify for each subframe (selected in 1) the cycle prefix and the number of used allocations

③. Take settings from the selected subframe (2) and copy to memory

④. Paste setting from memory to selected subframe (2)

⑤. Show timeplan (Figure 4-5) of configured signal

⑥. Configure each subframe (selected in 2) individually

- ➢ Modulation type
- ➢ Number of used resource blocks

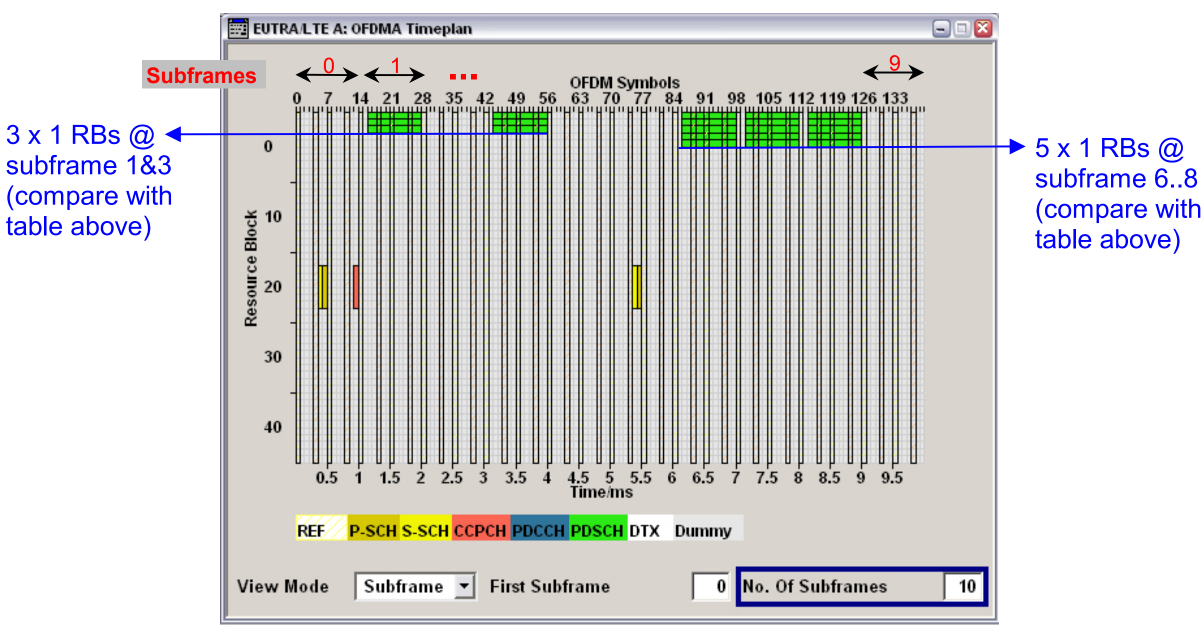


Figure 4-5 SMU EUTRA/LTE DL settings – Timeplan

Frame ↔ Subframe ↔ Slot relation

1 Frame (10ms) = 10 Subframes (10 x 1ms)
1 Subframe (1ms) = 2 Slots (2 x 0.5ms)

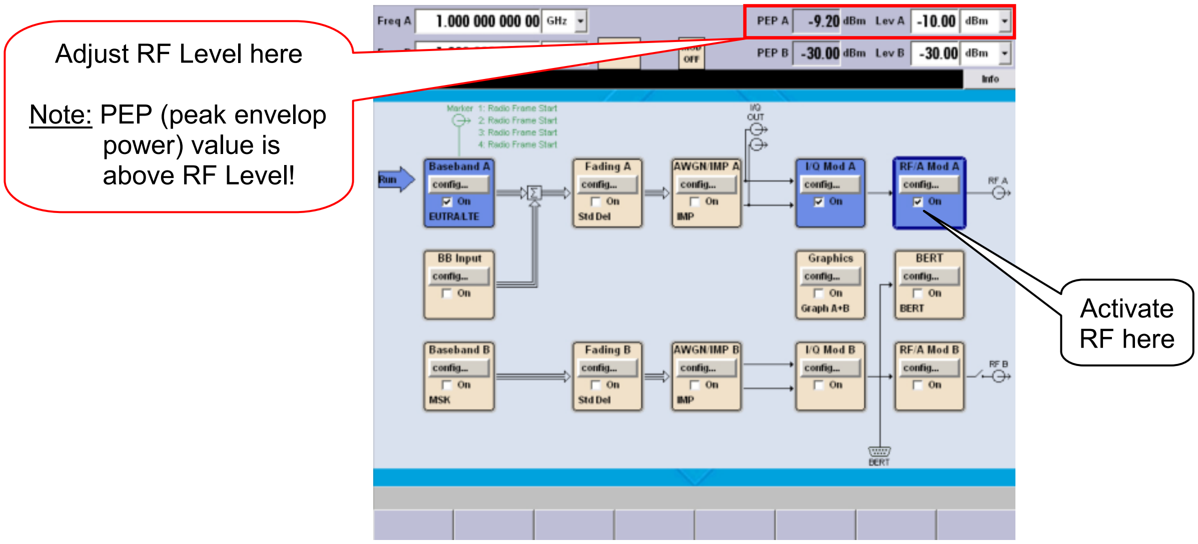


Figure 4-6 SMU EUTRA/LTE DL settings – BB and RF active

After setting up the EUTRA/LTE DL signal the BB has to be enabled by toggling the state button (Figure 4-2: Flag 1). Further, in order to generate an output signal, the SMU RF block has to be activated as well (Figure 4-6).

4.2 Analyzing LTE Downlink Signals

After setting up the R&S®FSQ-K100 for DL signals and performing a single measurement the result display shows "PVT" (power versus time) on screen A and "EVM versus Carrier" on screen B (illustrated in Figure 4-7).

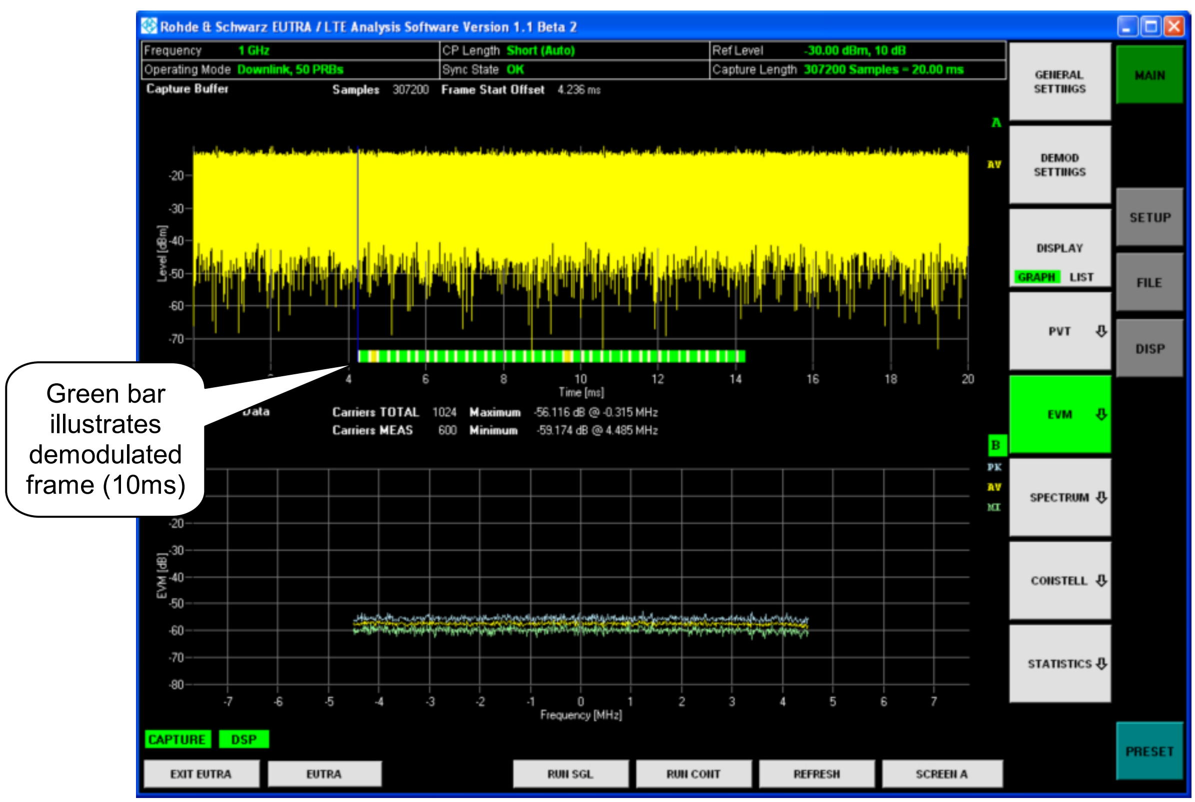


Figure 4-7 Analyzing EUTRA/LTE DL signals – Default result display

On the signal analysis side (DL) the following display options can be selected:

1. Power vs. Time (Figure 4-8)
2. EVM vs. Carrier (Figure 4-9: Screen A)
3. EVM vs. Symbol (Figure 4-9: Screen B)
4. Frequency Error vs. Symbol (Figure 4-10: Screen A)
5. EVM vs. Subframe (Figure 4-10: Screen B)
6. Spectrum: Flatness (Figure 4-11: Screen A)
7. Spectrum: Group Delay (Figure 4-11: Screen B)
8. Spectrum: Flatness Difference (Figure 4-12: Screen B)
9. Constellation Diagram (Figure 4-13)
10. Statistics: CCDF (Figure 4-14: Screen A)
11. Statistics: Signal Flow (Figure 4-14: Screen B)
12. Statistics: Allocation Summary (Figure 4-16)

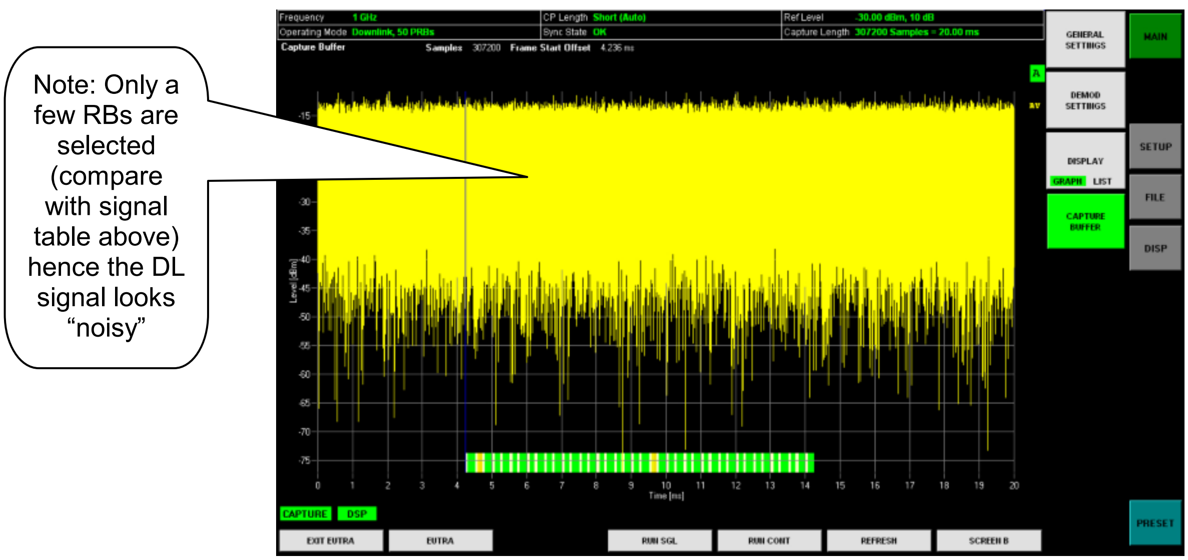


Figure 4-8 Analyzing EUTRA/LTE DL signals – Power vs. Time

Figure 4-9 Analyzing EUTRA/LTE DL signals – EVM vs. Carrier resp. vs. Symbol

Figure 4-10 Analyzing EUTRA/LTE DL signals – Freq. Error vs. Symbol & EVM vs. Subframe

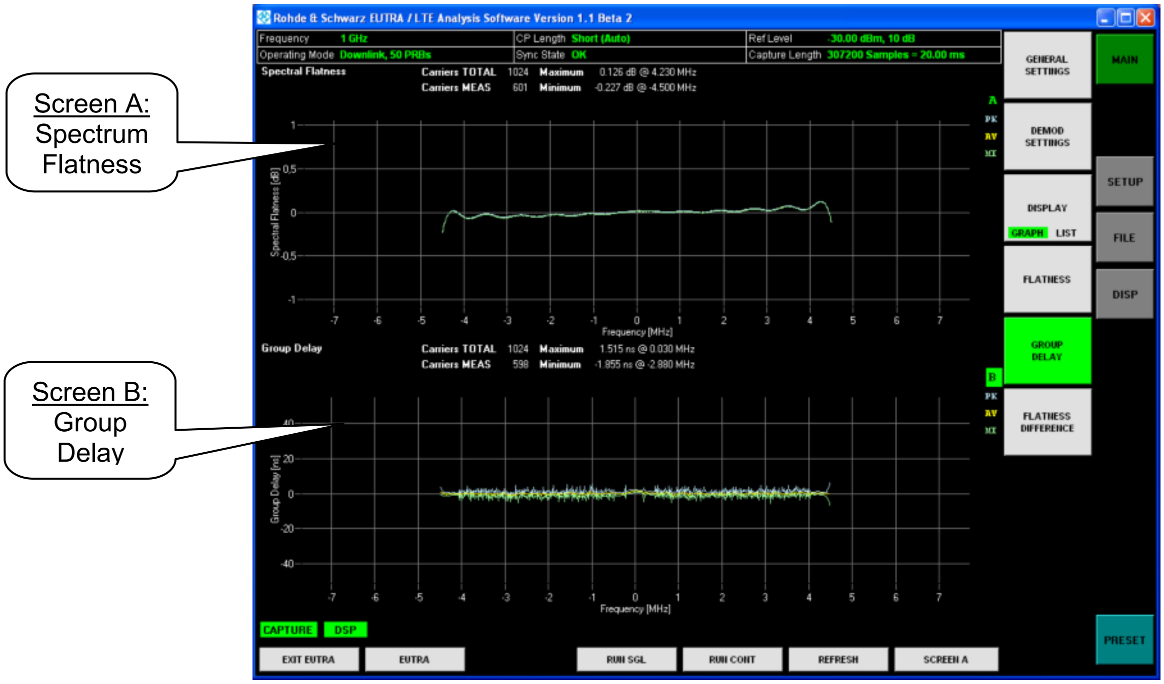


Figure 4-11 Analyzing EUTRA/LTE DL signals – Spectrum Flatness & Group Delay

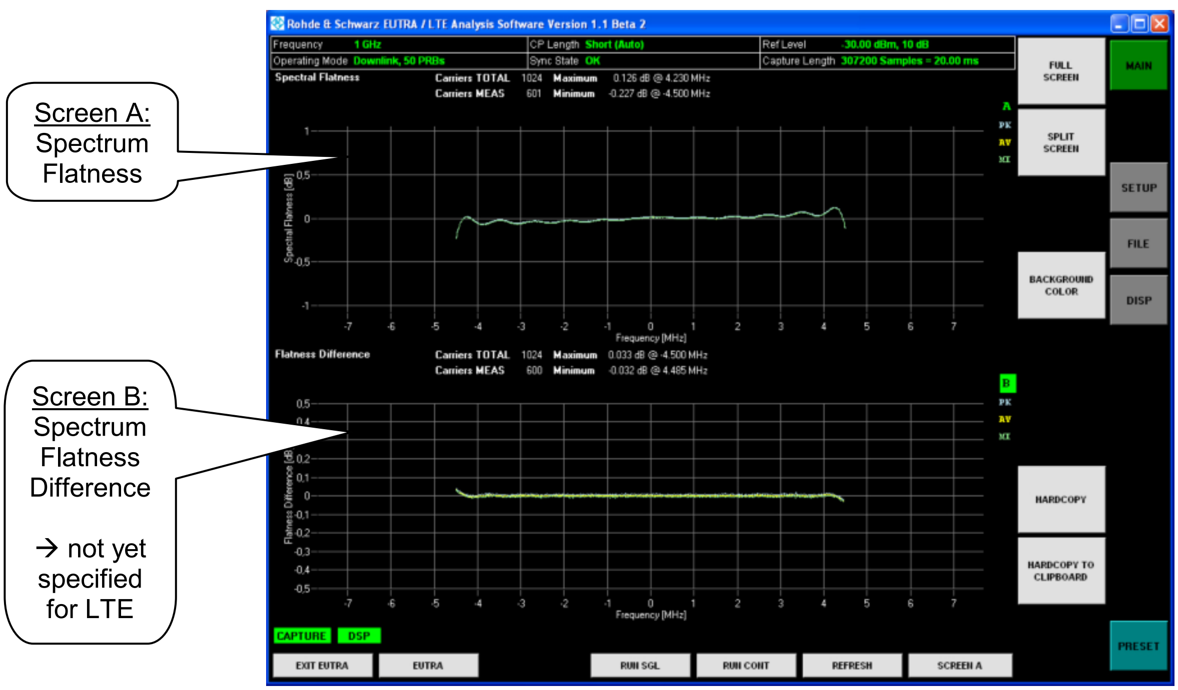


Figure 4-12 Analyzing EUTRA/LTE DL signals – Spectrum Flatness and Flatness Difference

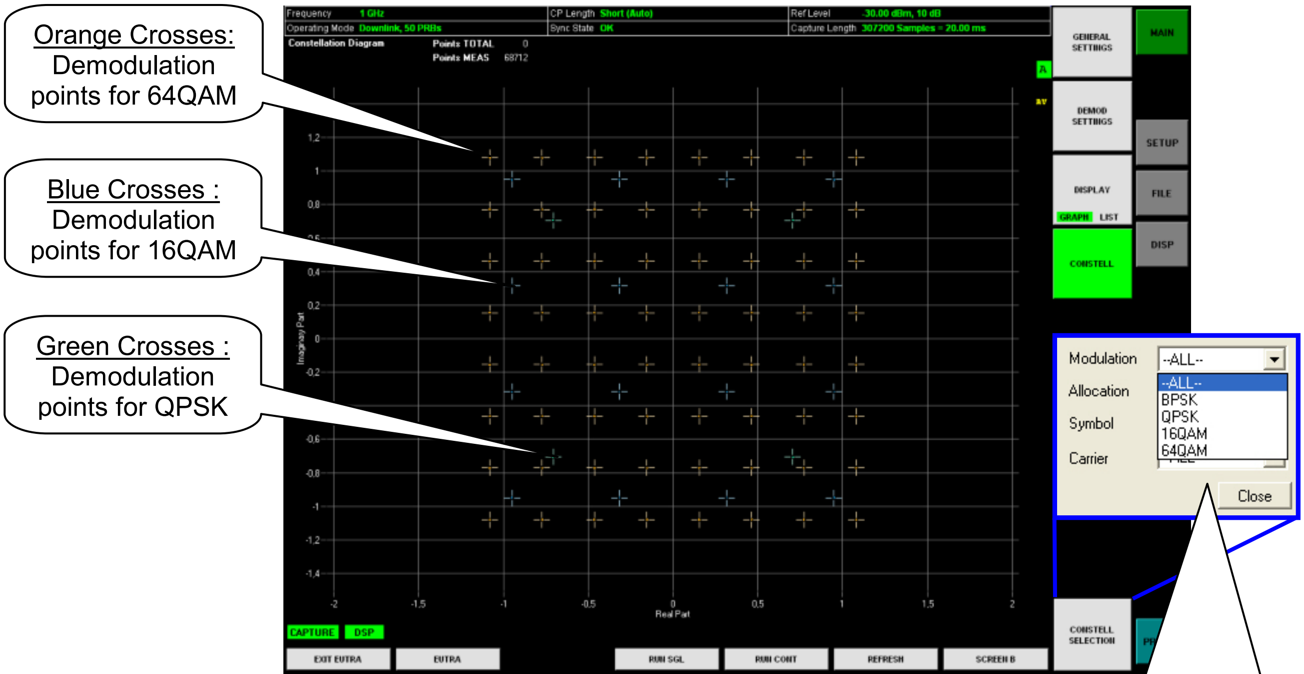


Figure 4-13 Analyzing EUTRA/LTE DL signals – Constellation Diagram

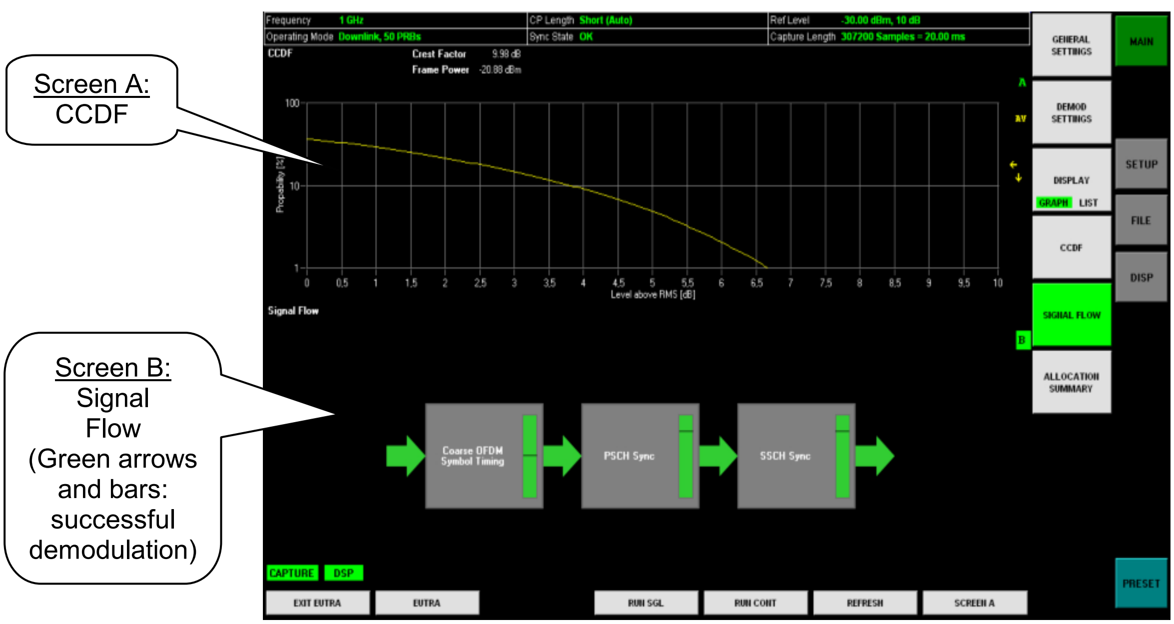


Figure 4-14 Analyzing EUTRA/LTE DL signals – CCDF and Signal Flow

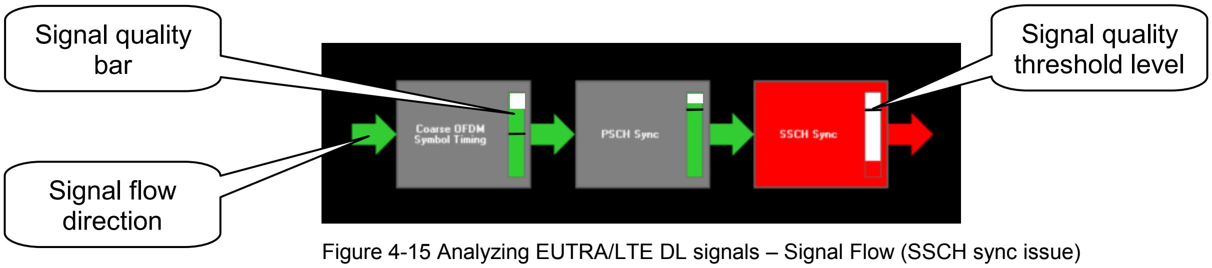


Figure 4-15 Analyzing EUTRA/LTE DL signals – Signal Flow (SSCH sync issue)

- If the signal quality is degraded due to fading for instance the effected block resp. the associated signal quality bar, e.g. PSCH Sync, can still be green but with a reduced level as shown in Figure 4-15 (compare with Figure 4-14, screen B).
- If the quality level is above the threshold, it´s coloured green, and demodulation resp. synchronization works. The indicator bar turns red if the quality bar is below threshold level (see SSCH sync block in Figure 4-15) and synchronization for example fails.

Figure 4-16 Analyzing EUTRA/LTE DL signals – Allocation Summary table

The allocation summary gives an overview of the demodulated signal containing allocation ID, number of resource blocks and offset, modulation type and corresponding EVM values for each subframe.

5 LTE Uplink

5.1 Generating LTE Uplink Signals

In order to setup a 3GPP EUTRA/LTE uplink (UL) signal with the R&S®SMU200A the following steps have to be performed:

a) Select "Baseband A" block in SMU diagram area (Figure 5-1),

b) Open BB configuration menu by pressing "config.." button

c) Select EUTRA/LTE

→ EUTRA/LTE software menu opens (Figure 5-2)

d) Select signal link direction: Uplink (Figure 5-2: Flag 5)

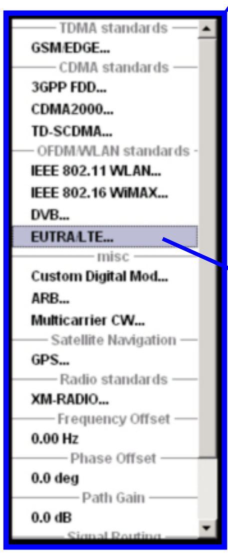
e) Make general UL settings (Figure 5-2: Flag 6)

f) Configure EUTRA/LTE frame (Figure 5-2: Flag 7)

g) Configure user equipment: CAZAC parameter (Figure 5-2: Flag 8)

h) Enable BB (Figure 5-2: Flag 1) and RF (Figure 5-7)

Subsequently the prior steps are illustrated and additional background information is given.



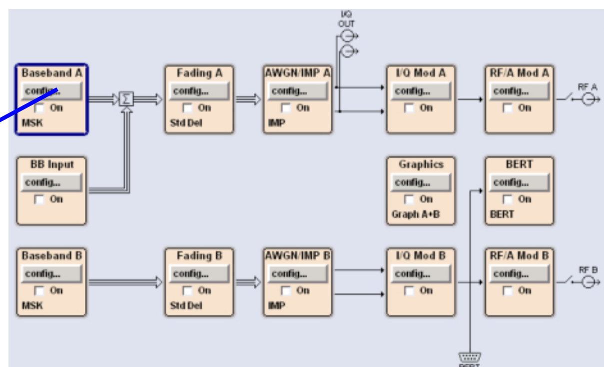


Figure 5-1 SMU200A – Diagram area

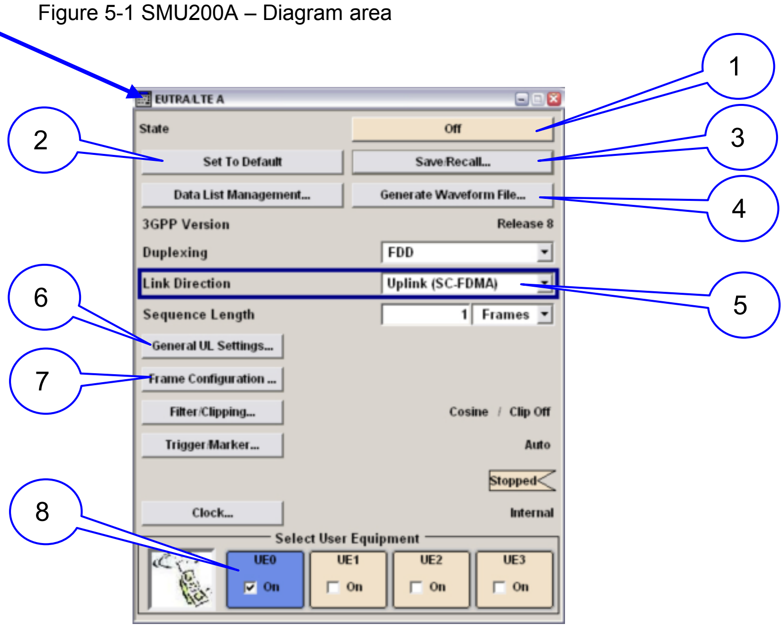


Figure 5-2 SMU EUTRA/LTE BB personality menu

①. Enable EUTRA/LTE BB → it´s recommended to enable baseband after configuring signal, otherwise signal calculations are triggered with any single modification

②. Set EUTRA/LTE menu to default settings

③. Save or recall EUTRA/LTE settings

④. Save datastream to ARB compatible *.wv file

⑤. Set signal link direction

⑥. Sub-menu for general UL signals (Figure 5-3)

⑦. Sub-menu for UL (resp. DL) frame configuration (Figure 5-4)

⑧. Configure user equipment, set CAZAC parameter (Figure 5-5)

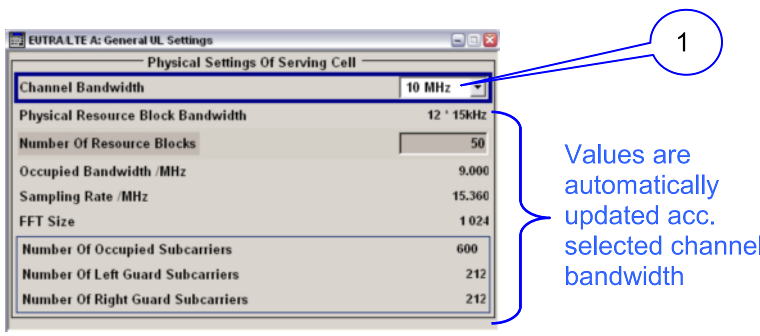


Figure 5-3 SMU EUTRA/LTE UL settings – General UL settings

①. Select channel bandwidth

In the following table some settings for a manually defined UL signal, 10 configurable subframes, are given:

Subframe	0	1	2	3	4	5	6	7	8	9
Cycle Prefix	Short	Short	Short	Short	Short	Short	Short	Short	Short	Short
Allocations	1	1	1	0	1	1		1	1	1
Content Type	PUSCH	PUSCH	PUSCH		PUSCH	PUSCH		PUSCH	PUSCH	PUSCH
Modulation / Resource Block (for allocation number 1..n)	16QAM/ 1	16QAM/ 1	16QAM/ 50		16QAM/ 35	16QAM/ 25		16QAM/ 50	16QAM/ 1	16QAM/ 1

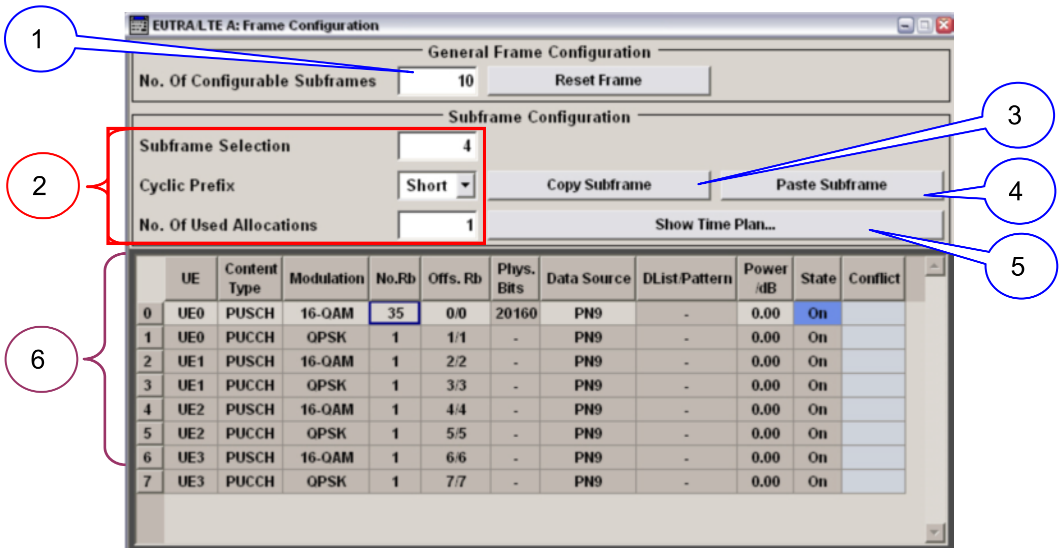


Figure 5-4 SMU EUTRA/LTE UL settings – Frame Configuration

①. Select the number of configurable subframes (1 .. 10)

②. Modify for each subframe (selected in 1) the cycle prefix and the number of used allocations

③. Take settings from the selected subframe (2) and copy to memory

④. Paste setting from memory to selected subframe (2)

⑤. Show timeplan (Figure 5-6) of configured signal

⑥. Configure each subframe individually (selected in 2)

- Content type
- Modulation type
- Number of used resource blocks

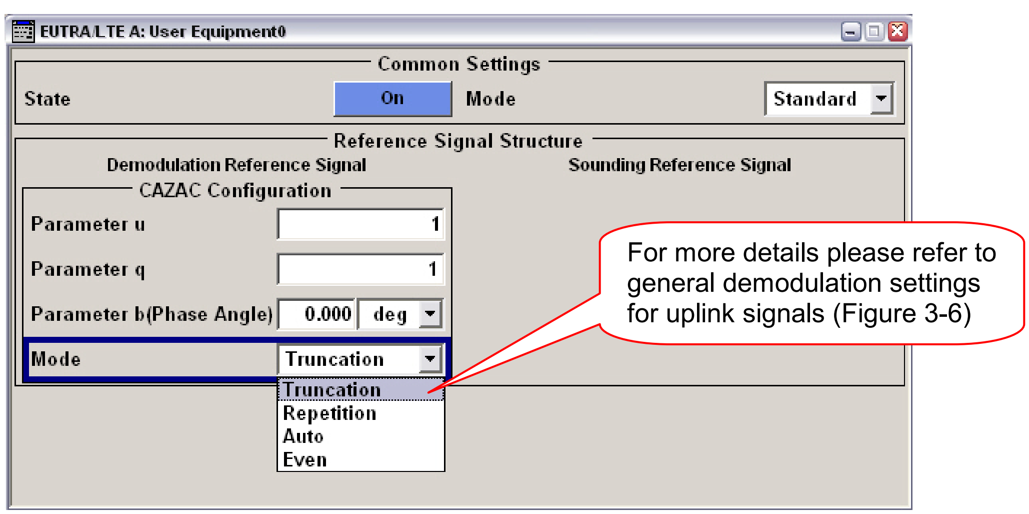


Figure 5-5 SMU EUTRA/LTE UL settings – Settings User Equipment (CAZAC Parameter)

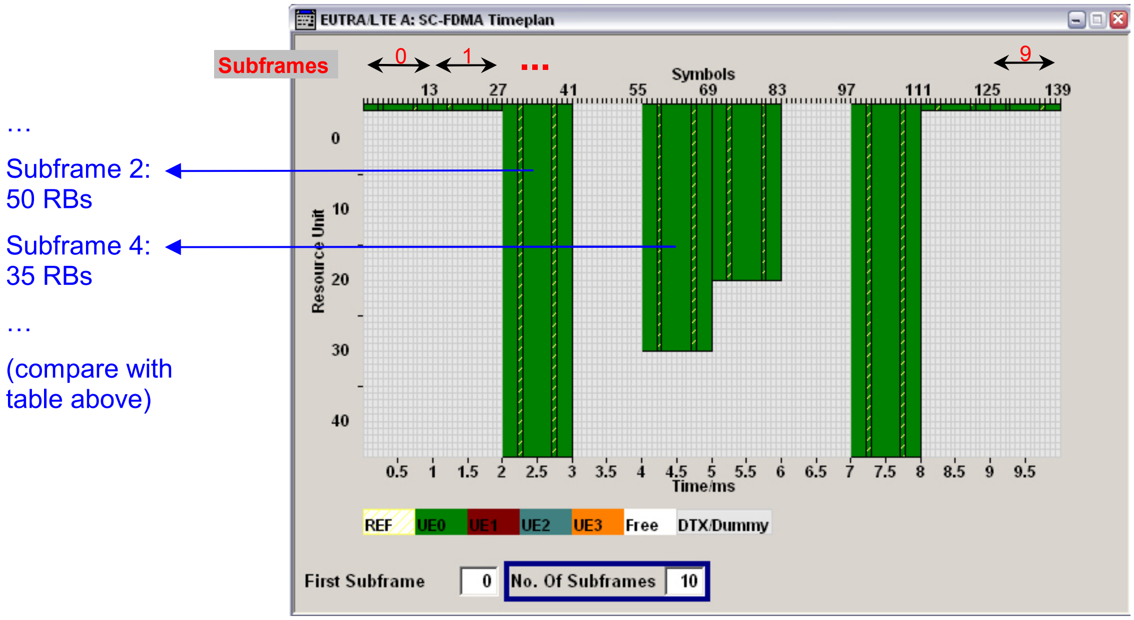


Figure 5-6 SMU EUTRA/LTE UL settings – Timeplan

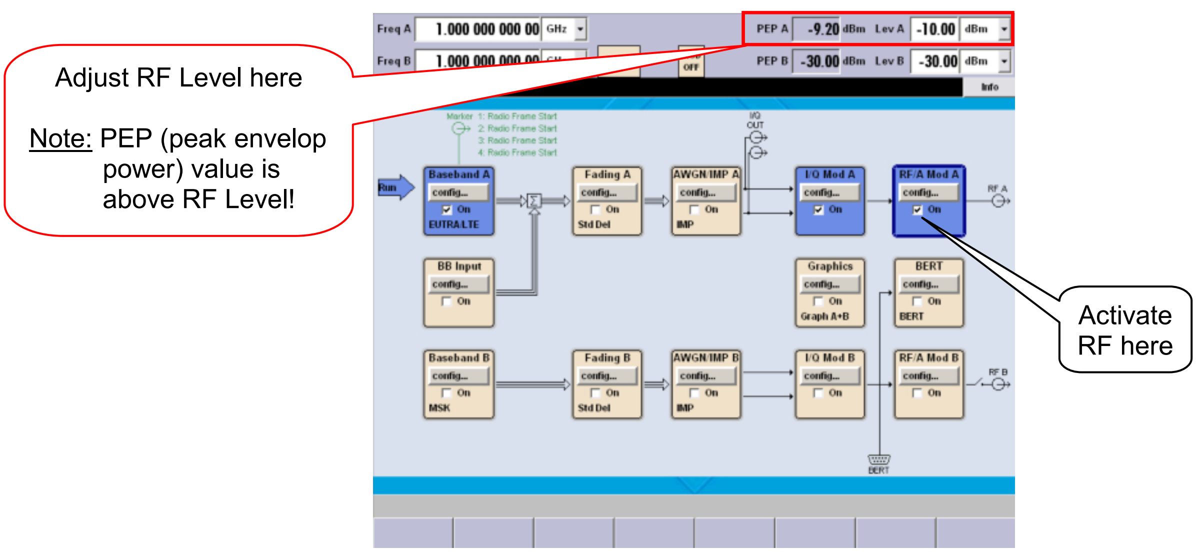


Figure 5-7 SMU EUTRA/LTE UL settings – BB and RF active

After setting up the EUTRA/LTE UL signal the BB has to be enabled by toggling the state button (Figure 5-2: Flag 1). Further, in order to generate a output signal, the SMU RF block has to be activated as well (Figure 5-7).

5.2 Analyzing LTE Uplink Signals

After setting up the FSQ-K101 for UL signals and performing a single measurement the result display shows “PVT” (power versus time) on screen A and “EVM versus Carrier” on screen B (illustrated in Figure 5-8).

Figure 5-8 Analyzing EUTRA/LTE UL signals – Default result display

On the signal analysis side (UL) the following display options can be selected:

1. Power vs. Time (Figure 5-9)
2. EVM vs. Carrier (Figure 5-11: Screen A)
3. EVM vs. Symbol (Figure 5-11: Screen B)
4. EVM vs. Slot (Figure 5-12: Screen B)
5. Spectrum: Flatness (Figure 5-13: Screen A)
6. Spectrum: Group Delay (Figure 5-13: Screen B)
7. Spectrum: Flatness Difference (Figure 5-14: Screen B)
8. Constellation Diagram (Figure 5-15)
9. Statistics: CCDF (Figure 5-17: Screen A)
10. Statistics: Allocation Summary (Figure 5-17: Screen B)

Figure 5-9 Analyzing EUTRA/LTE UL signals – Power vs. Time

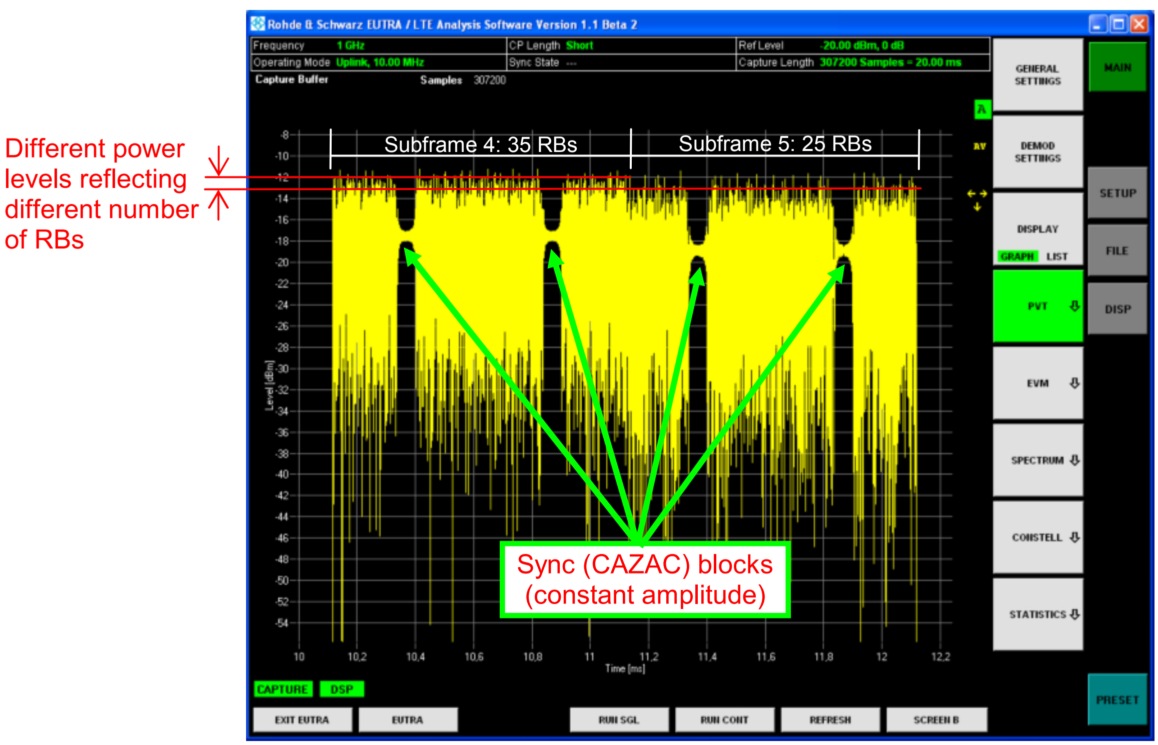


Figure 5-10 Analyzing EUTRA/LTE UL signals – Power vs. Time (focus subframe 4 & 5)

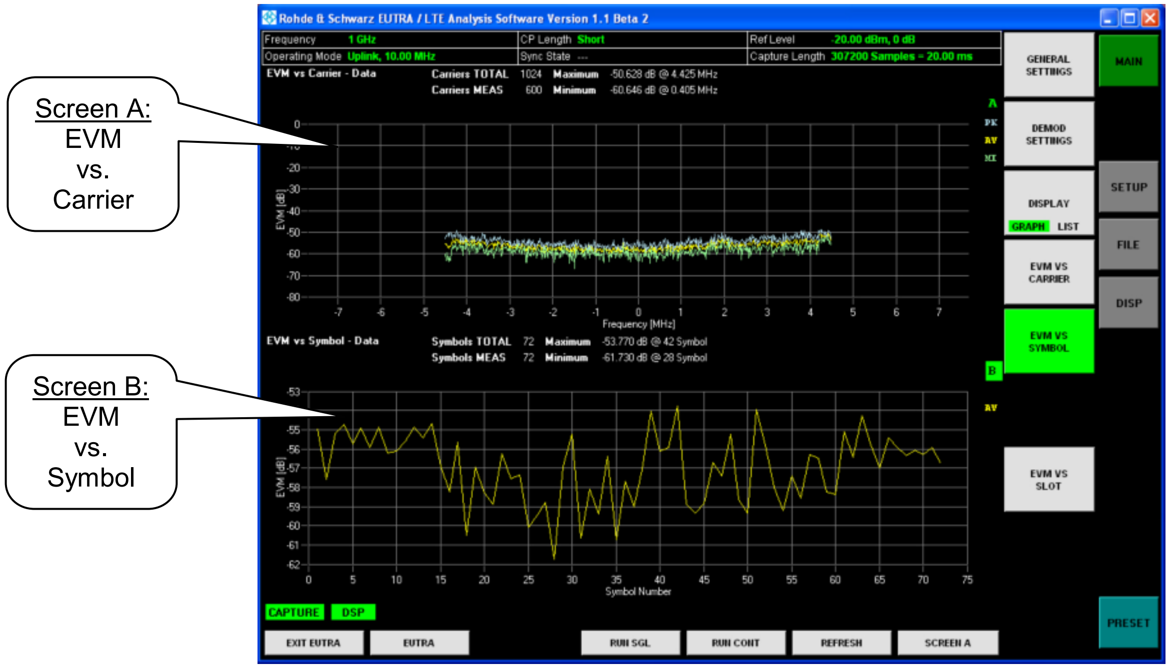


Figure 5-11 Analyzing EUTRA/LTE UL signals – EVM vs. Carrier resp. vs. Symbol

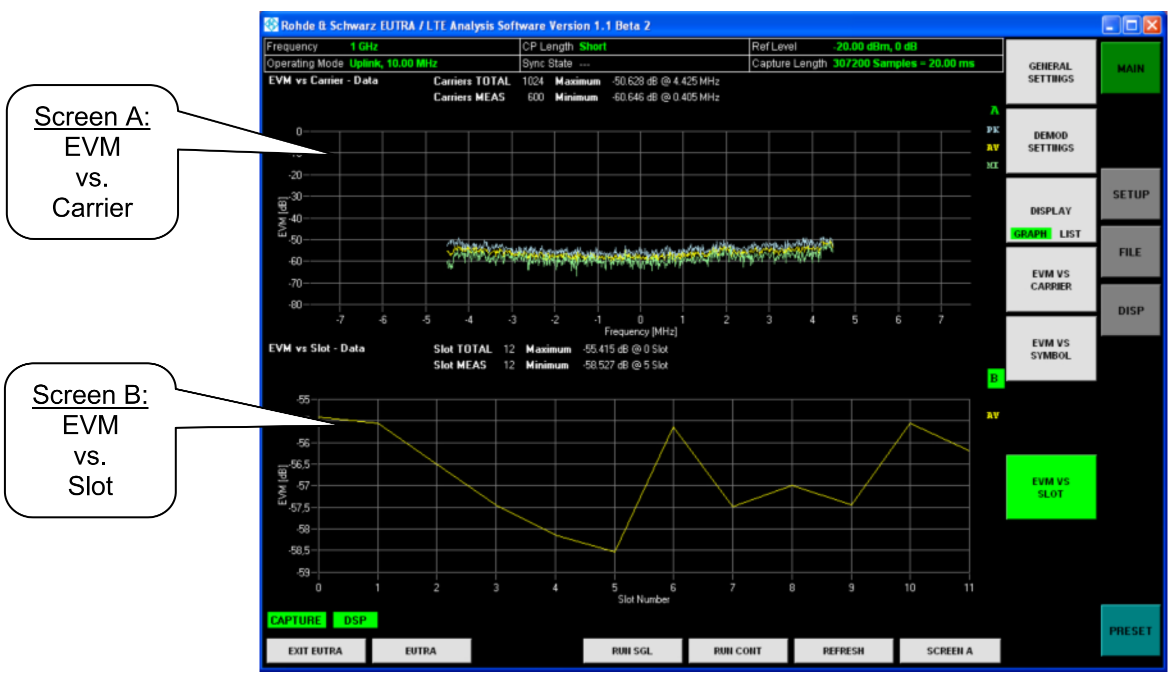


Figure 5-12 Analyzing EUTRA/LTE UL signals – EVM vs. Carrier resp. vs. Slot

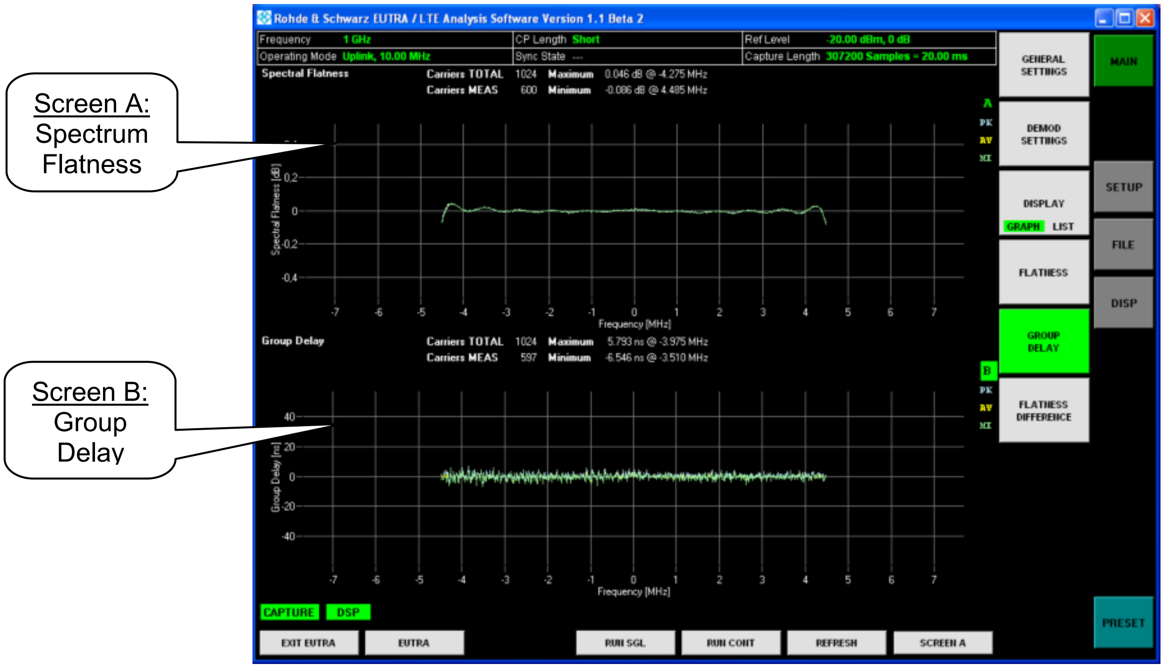


Figure 5-13 Analyzing EUTRA/LTE UL signals – Spectrum Flatness & Group Delay

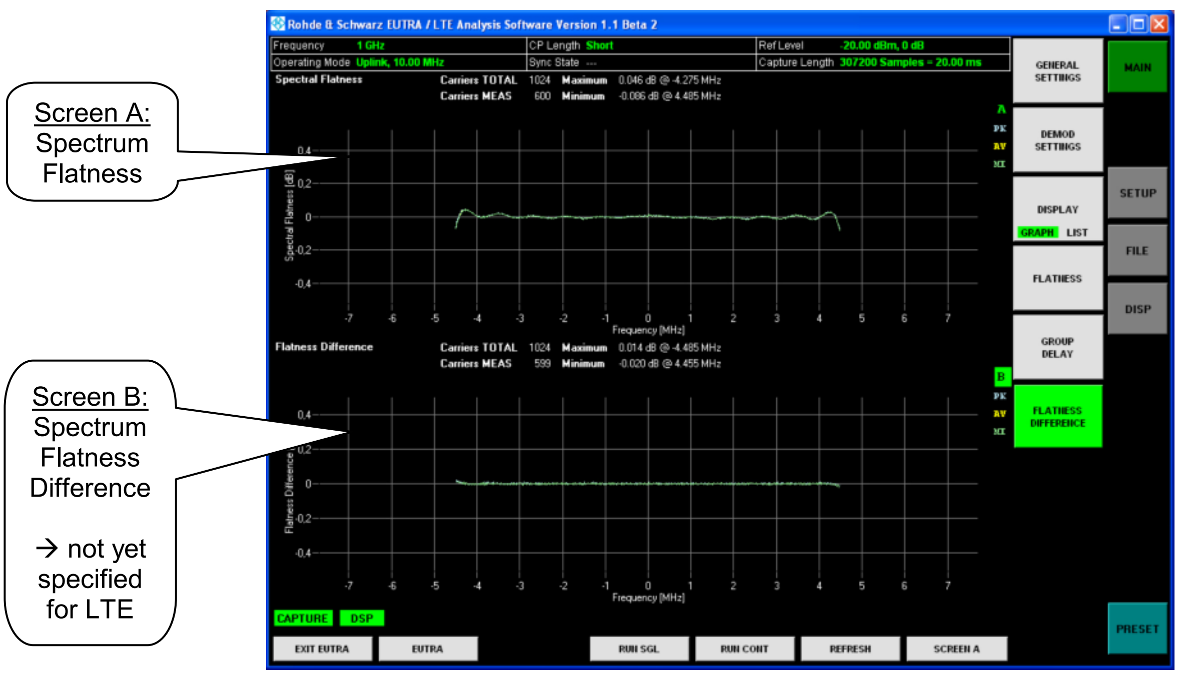


Figure 5-14 Analyzing EUTRA/LTE UL signals – Spectrum Flatness and Flatness Difference

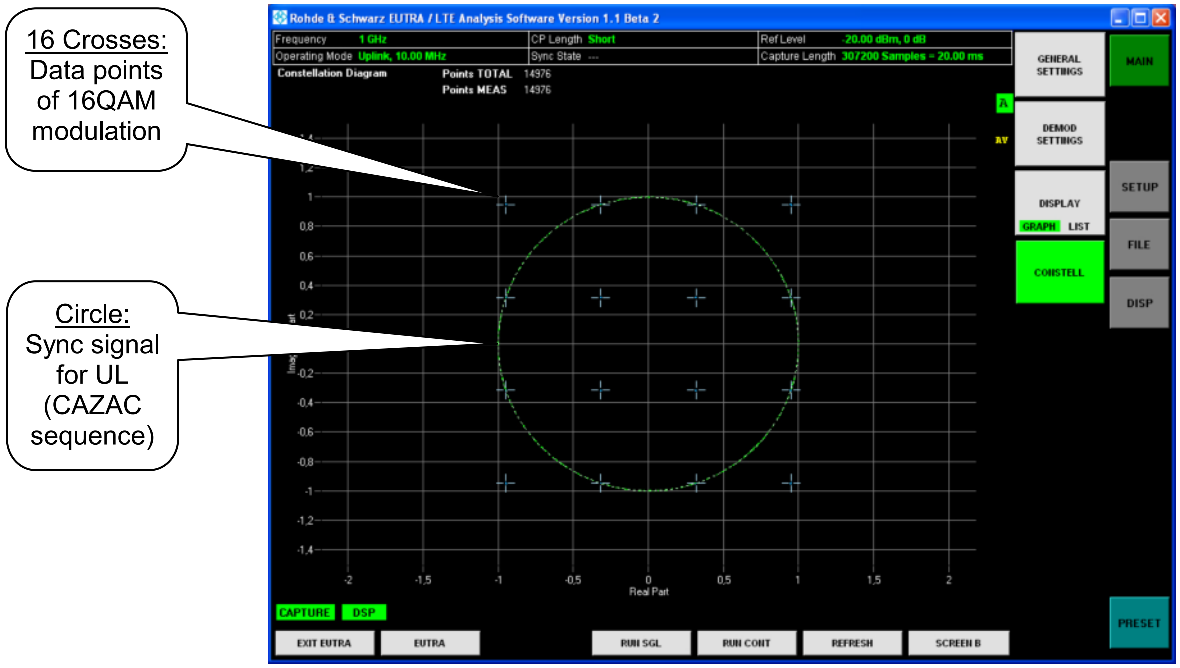


Figure 5-15 Analyzing EUTRA/LTE UL signals – Constellation Diagram

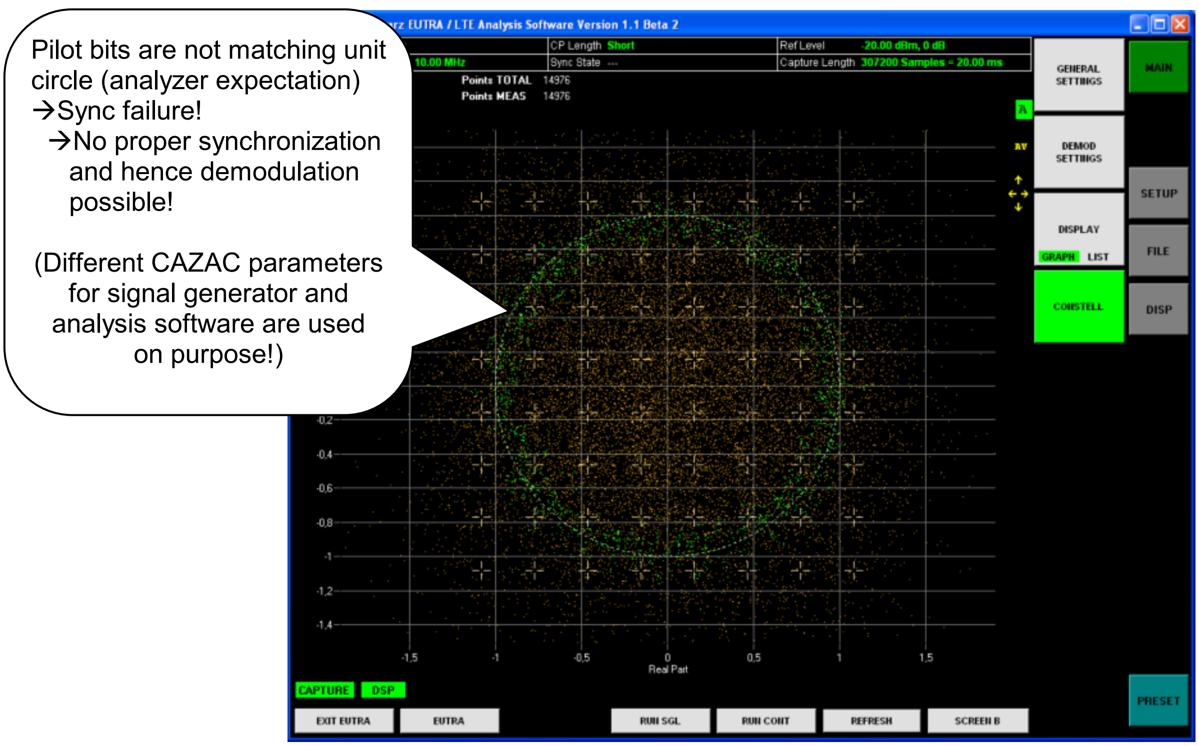


Figure 5-16 Analyzing EUTRA/LTE UL signals – Constellation Diagram with wrong CAZAC parameter

- Wrong CAZAC parameters are used for demonstration purpose
- Neither data nor pilot information is decoded correct (compare with Figure 5-15 - same input signal but correct CAZAC parameters)

Figure 5-17 Analyzing EUTRA/LTE UL signals – CCDF and Allocation Summary

6 Ordering information

Type of instrument

Signal Analyzer

Base Units

R&S® FSQ3	Frequency range 20 Hz to 3.6 GHz	1155.5001.03
R&S® FSQ8	Frequency range 20 Hz to 8 GHz	1155.5001.08
R&S® FSQ26	Frequency range 20 Hz to 26.5 GHz	1155.5001.26
R&S® FSQ40	Frequency range 20 Hz to 40 GHz	1155.5001.40
Analysis Applications		
R&S® FSQ-K100	Application Firmware 3GPP EUTRA/LTE Downlink	1308.9006.02
R&S® FSQ-K101	Application Firmware 3GPP EUTRA/LTE Uplink	*1308.9058.02

*ask local Rohde & Schwarz representative for further information

Signal Generator

R&S® SMU200A

Base Unit

R&S® SMU200A	Vector Signal Generator	1141.2005.02
RF Path A		
R&S® SMU-B102	Frequency range 100 kHz to 2.2 GHz	1141.8503.02
R&S® SMU-B103	Frequency range 100 kHz to 3 GHz	1141.8603.02
R&S® SMU-B104	Frequency range 100 kHz to 4 GHz	1141.8703.02
R&S® SMU-B106	Frequency range 100 kHz to 6 GHz	1141.8803.02
RF Path B		
R&S® SMU-B202	Frequency range 100 kHz to 2.2 GHz	1141.9400.02
R&S® SMU-B203	Frequency range 100 kHz to 3 GHz	1141.9500.02
Baseband		
R&S® SMU-B9	Baseband Generator with ARB (128 M Samples) and Digital Modulation (realtime)	1161.0766.02
R&S® SMU-B10	Baseband Generator with ARB (64 M Samples) and Digital Modulation (realtime)	1141.7007.02
R&S® SMU-B11	Baseband Generator with ARB (16 M Samples) and Digital Modulation (realtime)	1159.8411.02
R&S® SMU-B13	Baseband Main Module	1403.9109.02
R&S® SMU-K55	Digital Standard 3GPP EUTRA/LTE	1408.7310.02
R&S® SMU-K255	Digital Standard 3GPP EUTRA/LTE for WinIQSIM2™	1408.7362.02

R&S® SMJ100A

Base Unit

R&S® SMJ100A	Vector Signal Generator	1403.4507.02
R&S® SMJ-B103	Frequency range 100 kHz to 3 GHz	1403.8502.02
R&S® SMJ-B106	Frequency range 100 kHz to 6 GHz	1403.8702.02
Baseband		
R&S® SMJ-B9	Baseband Generator with ARB (128 M Samples) and Digital Modulation (realtime)	1404.1501.02
R&S® SMJ-B10	Baseband Generator with ARB (64 M Samples) and Digital Modulation (realtime)	1403.8902.02
R&S® SMJ-B11	Baseband Generator with ARB (16 M Samples) and Digital Modulation (realtime)	1403.9009.02
R&S® SMJ-B13	Baseband Main Module	1403.9109.02
R&S® SMJ-K55	Digital Standard 3GPP EUTRA/LTE	1409.2206.02
R&S® SMJ-K255	Digital Standard 3GPP EUTRA/LTE for WinIQSIM2™	1409.2258.02

R&S® SMATE200A

Base Unit		
R&S® SMATE200A	Vector Signal Generator	1400.7005.02
RF Path A		
R&S® SMATE-B103	Frequency range 100 kHz to 3 GHz	1401.1000.02
R&S® SMATE-B106	Frequency range 100 kHz to 6 GHz	1401.1200.02
RF Path B		
R&S® SMATE-B203	Frequency range 100 kHz to 3 GHz	1401.1400.02
R&S® SMATE-B206	Frequency range 100 kHz to 6 GHz	1401.1600.02
Baseband		
R&S® SMATE-B9	Baseband Generator with digital modulation (real time) and ARB (128 M samples)	1404.7500.02
R&S® SMATE-B10	Baseband Generator with digital modulation (realtime) and ARB (64MSamples)	1401.2707.02
R&S® SMATE-B11	Baseband Generator with digital modulation (realtime) and ARB (16MSamples)	1401.2807.02
R&S® SMATE-B13	Baseband Main Module	1401.2907.02
R&S® SMATE-K55	Digital Standard 3GPP EUTRA/LTE	1404.7851.02

R&S® AMU200A

Base Unit		
R&S® AMU200A	Baseband signal generator	1402.4090.02
Baseband		
R&S® AMU-B9	Baseband generator with digital modulation (realtime) and ARB (128 MSamples)	1402.8809.02
R&S® AMU-B10	Baseband generator with digital modulation (realtime) and ARB (64 MSamples)	1402.5300.02
R&S® AMU-B11	Baseband generator with digital modulation (realtime) and ARB (16 MSamples)	1402.5400.02
R&S® AMU-B13	Baseband main module	1402.5500.02
R&S® AMU-K55	Digital Standard 3GPP EUTRA/LTE	1402.9405.02
R&S® AMU-K255	Digital Standard 3GPP EUTRA/LTE for WinIQSIM2™	1402.9457.02

R&S® AFQ100A

Base Unit		
R&S® AFQ100A	IQ modulation generator	1401.3003.02
Baseband		
R&S® AFQ-B10	Waveform memory 256 Msamples	1401.5106.02
R&S® AFQ-B11	Waveform memory 1Gsamples	1401.5206.02
R&S® AFQ-K255	Digital Standard 3GPP EUTRA/LTE for WinIQSIM2™	1401.5906.02

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