WCDMA Base Station Performance Tests according to TS25.141

Application Note

Products:

- R&S®SMW200A
- R&S®SMU200A
- R&S®AMU200A
- R&S®SMATE200A

3GPP TS25.141 defines conformance tests for UTRA base stations (NodeB).

This application note describes how performance tests (TS25.141 Chapter 8) can be performed quickly and easily by using vector signal generators from Rohde & Schwarz.

Examples illustrate the manual operation. A free software program enables and demonstrates remote operation.

The WCDMA base station transmitter (Tx) tests (TS25.141 Chapter 6) are described in Application Note 1MA67.

The WCDMA base station receiver (Rx) tests (TS25.141 Chapter 7) are described in Application Note 1MA114.

Application Note
Schulz
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ROHDE&SCHWARZ

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The following abbreviations are used in this Application Note for Rohde & Schwarz test equipment:

- The R&S®SMW200A vector signal generator is referred to as the SMW.
- The R&S®SMATE200A vector signal generator is referred to as the SMATE.
- The R&S®SMU200A vector signal generator is referred to as the SMU.
- The R&S®AMU200A baseband signal generator and fading simulator is referred to as the AMU.
- The SMATE, SMU and SMW are referred to as the SMx.
- The software R&S®TSrun is referred to as the TSrun.

1 Introduction

The Wide band code division multiple access (W-CDMA) was first introduced in 3GPP Release 99/4 considering the growing demand for higher capacity and improved data rate. Since then, it has gone through a long process of evolution to ensure high quality experience for customers and maintain market competition.

Table 1-1 gives a brief overview of the evolution of W-CDMA with 3GPP releases.

Evolution of W-CDMA	
3GPP Release	**Main Features**
Rel-99/4	W-CDMA
Rel-5	HSDPA
Rel-6	HSUPA
Rel-7	▪ Downlink MIMO ▪ 16 QAM for Uplink and 64 QAM for Downlink
Rel-8	▪ Combination of MIMO and 64 QAM ▪ Dual cell HSDPA
Rel-9	▪ Dual cell HSUPA ▪ Dual band HSDPA ▪ Dual Cell HSDPA + MIMO
Rel-10	Four carrier HSDPA

Table 1-1: Evolution of W-CDMA from 3GPP release 99/4 to release 10

3GPP specification TS 25.141 describes the conformance tests for W-CDMA base stations operating in FDD mode. It includes transmitter (Tx), receiver (Rx) and performance (Px) tests.

The transmitter (Tx) tests (TS25.141 Chapter 6) are described in Application Note 1MA67 and the receiver (Rx) tests (TS25.141 Chapter 7) are covered in Application Note 1MA114.

In this application note the WCDMA Test Case Wizard is used. Please not that this Wizard supports the testcases according to release R99/R4 only.

Table 1-2 gives an overview of the performance tests defined in line with Chapter 8 of TS25.141. The tests can be carried out using instruments from Rohde & Schwarz. These tests are individually described in this application note.

Performance Requirement (Chapter 8) Release R99/R4		
Chapter (TS25.141)		**Test**
8.2.1 Demodulation of DCH in static propagation conditions		
	8.2.1	Demodulation of DCH
8.3 Demodulation of DCH in multipath fading conditions		
	8.3.1	Multipath fading Case 1
	8.3.2	Multipath fading Case 2
	8.3.3	Multipath fading Case 3
	8.3.4	Multipath fading Case 4
8.4 Demodulation of DCH in moving propagation conditions		
8.5 Demodulation of DCH in birth/death propagation conditions		
8.6 Verification of the internal BLER calculation		
8.8 RACH performance		
	8.8.1	RACH preamble detection in static propagation conditions
	8.8.2	RACH preamble detection in multipath fading case 3
	8.8.3	Demodulation of RACH message in static propagation conditions
	8.8.4	Demodulation of RACH message in multipath fading case 3

Table 1-2: Covered Tests according to Release R99/R4

2 General Performance Tests

2.1 Note

Very high power occurs on base stations! Be sure to use suitable attenuators in order to prevent damage to the test equipment.

2.2 Performance Test setup

Fig. 2-1 shows the general test setup for performance tests. A SMx is used to perform the test. The second RF path is used for diversity tests.

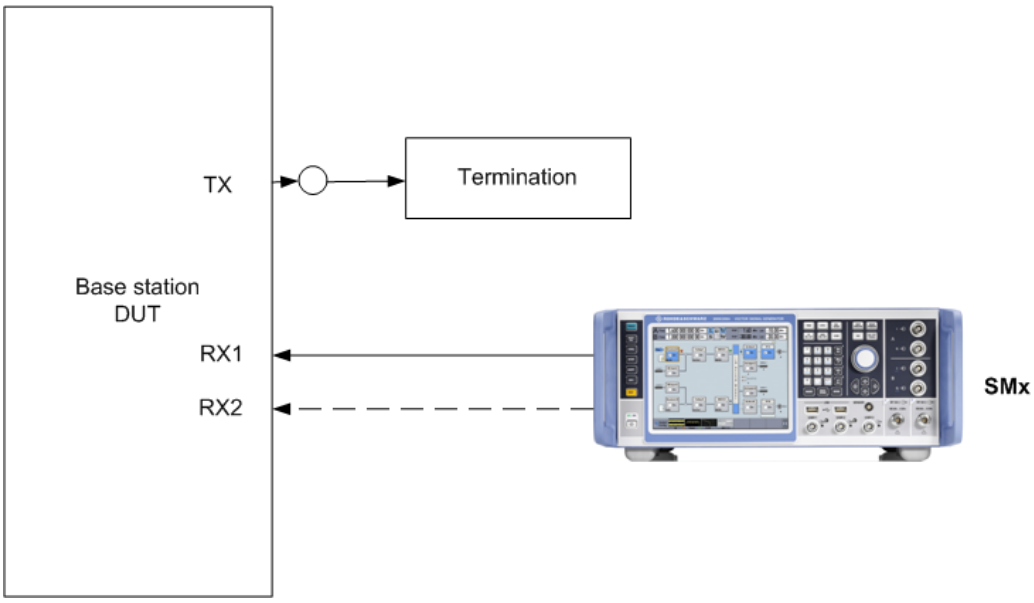


Fig. 2-1: Px Test Setup

2.3 Instruments and Software options

Several different vector signal generators can be used for the tests described here:

- SMW
- SMU
- SMATE + AMU

The W-CDMA **3GPP FDD** software option is available for each of the listed generators. The following are needed for the Px tests:

- SMx-K42 3GPP FDD

The instrument needs the following general options:

- SMx-B14 Fading
- SMx-K62 AWGN

For diversity tests the SMx need a second RF path.

3 Performance Tests (Chapter 8)

Performance tests are for the receiver of the basestation. The basestation typically measures the bit error rate (BER) or the block error rate (BLER on the DCH) or the ability to detect certain signals (RACH preamble) under static or multipath channel conditions.

Reference Measurement Channels (RMC)

For the performance tests RMC are defined. They contain W-CDMA channel parameters as bit rate, spreading factor etc. They are named according to [1], annex A and split in different subsets:

- RMC 12.2
- RMC 64
- RMC 144
- RMC 384

For more details refer to [1], annex A.

All RMCs are implemented as predefined settings in the signal generator family SMx.

Channels

According to [1] the channels to be tested are at the bottom (B), in the middle (M) and at the top (T) of the supported frequency range of the base station.

3.1 Basic operation

For most of the following measurements the first operating steps are the same. They are described only once.

The SMx simulates a UE and the channel with fading and noise (if applicable). Before starting with the described steps perform a preset of the device (green button in left upper corner). In principle four main parts are necessary:

- Signal routing
- W-CDMA settings for a UE in the baseband block
- Channel simulation / Fading
- AWGN / SNR

The SMx provides a **Test Case Wizard** which simplifies necessary settings according to TS25.141. All necessary settings (the four mentioned steps) are handled automatically according to the standard. In addition manual edition of certain parameters is possible.

3.1.1 General 3GPP FDD settings (Test Case Wizard)

1. In the block diagram click the **Baseband** block (typically A). Select **3GPP FDD…**

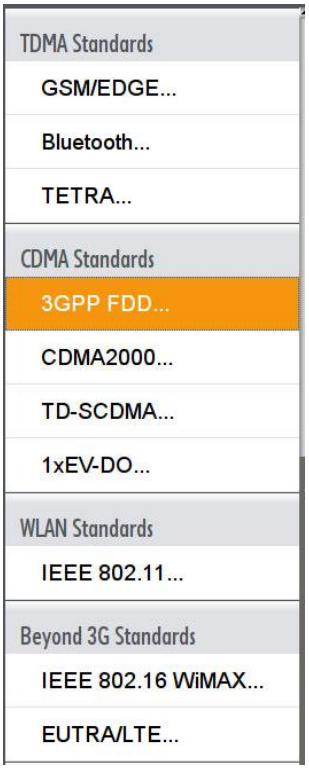


Fig. 3-1: Selecting of WCDMA (3GPP FDD) in the baseband

The 3GPP FFD A dialog opens (Fig. 3-2)

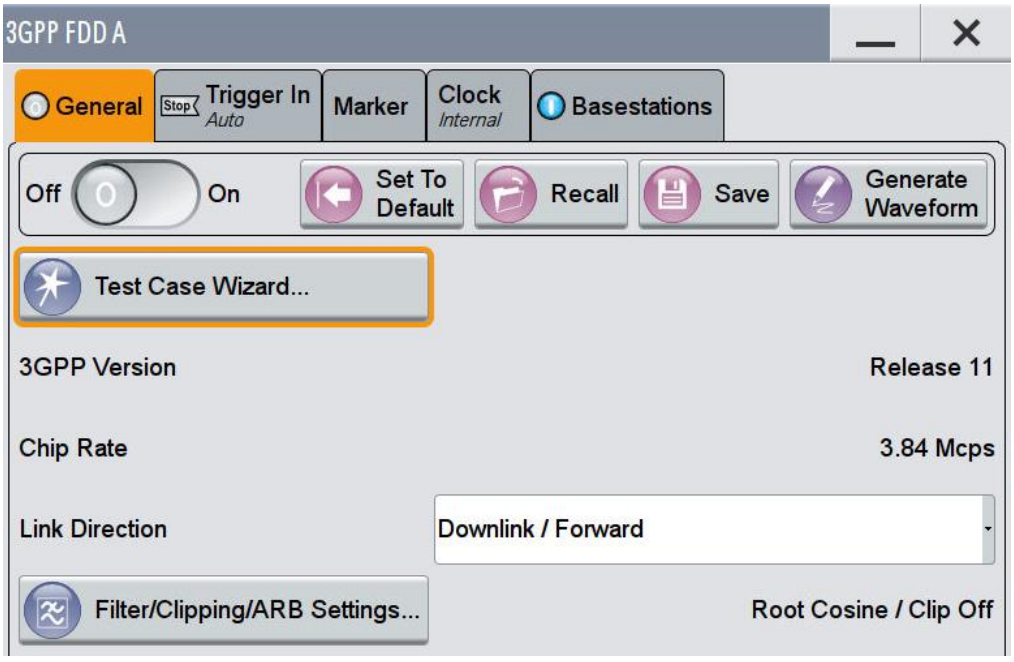


Fig. 3-2: 3GPP FDD main dialog. Use the Test Case Wizard-

2. Press **Test Case Wizard**.

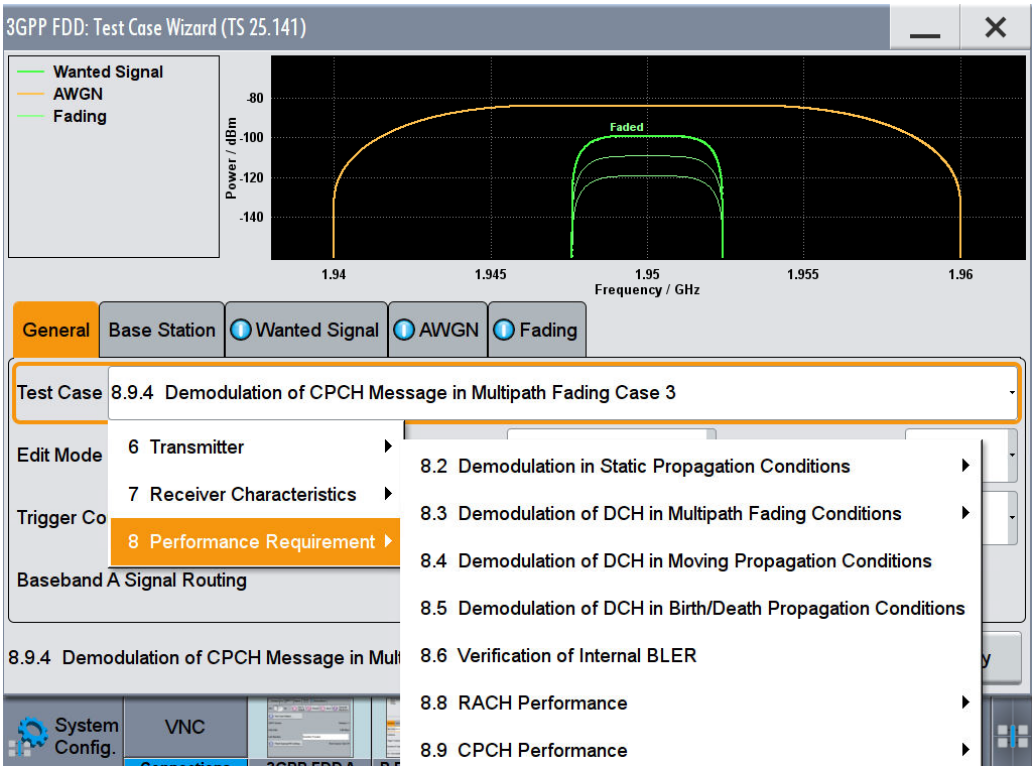
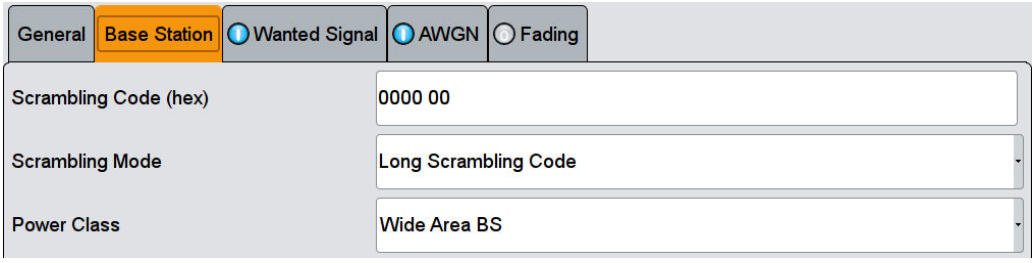


Fig. 3-3: The Test Case Wizard according to TS25.141: Available cases are shown under 8 Performance Requirement.

3. In the tab **Base Station**, set the **scrambling code** and **mode** and select the **Power Class**.



4. Press **Apply.**

5. Switch ON the RF paths.

Trigger

In default mode the SMx starts the WCDMA signal immediately.

6. To align the start of the LTE signal to the basestation under test, set **Trigger In Mode** to **Armed Auto**. (Fig. 3-4)

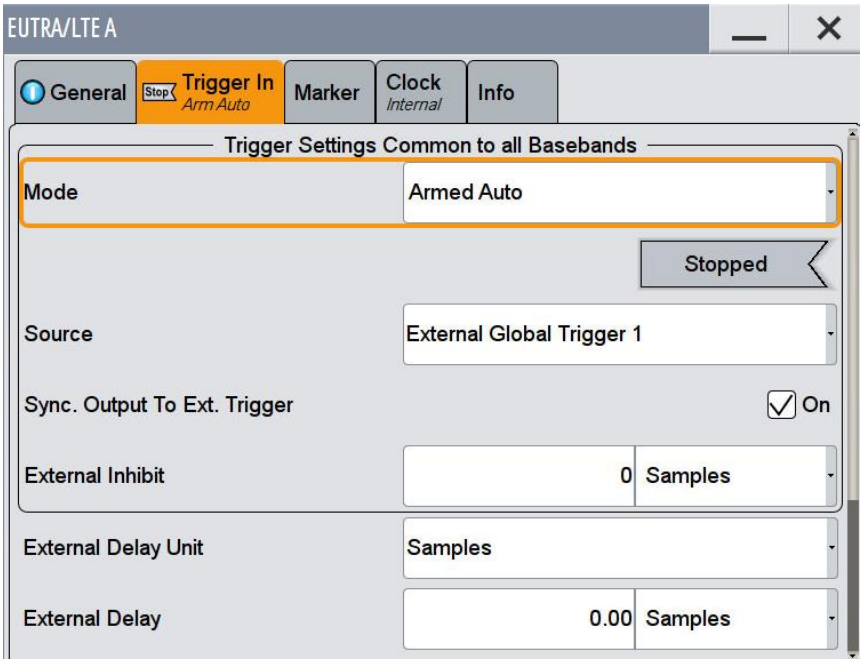


Fig. 3-4: Trigger In settings. The SMx waits for an external trigger signal to align the WCDMA signal.

3.1.2 General Fading settings

The SMx provides channels simulators in the baseband via the block **Fading**. It allows the fast and easy configuration with predefined settings according to the different mobile radio specifications (e.g. in WCDMA 3G CASE 3). Additionally individual fading settings can be applied.

The **Test Case Wizard** applies the correct fading settings automatically. To change settings:

1. Click on the block **Fading** and **Fading Settings (**Fig. 3-5)

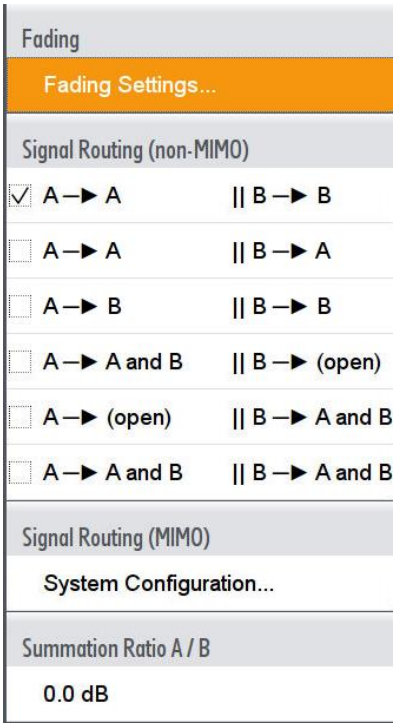


Fig. 3-5: Fading Settings

2. Select a profile via **Standard** (e.g. 3GPP Case 3 (UE/BS)) (Fig. 3-6 and Fig. 3-7)
3. Switch the fading block **On**. (Fig. 3-6)

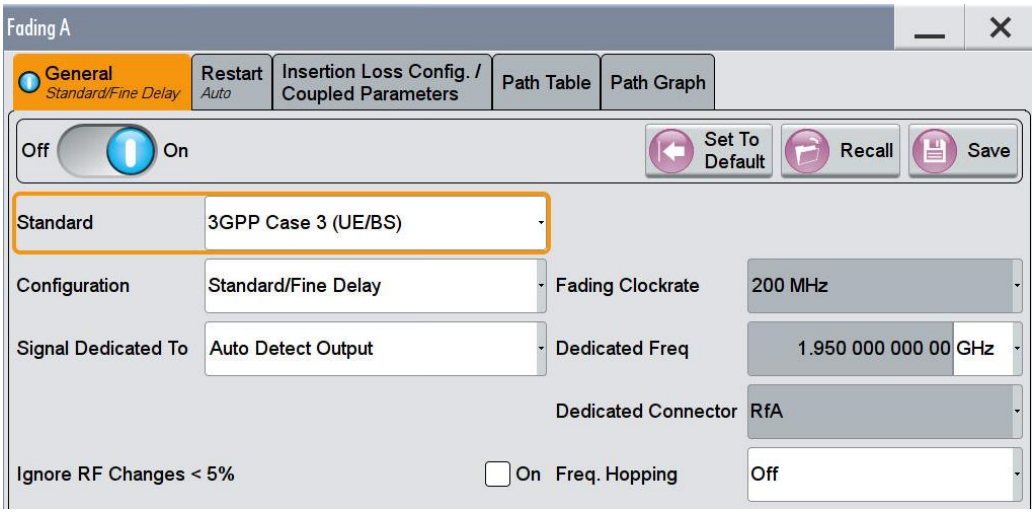


Fig. 3-6: Overview General Fading settings. Select a predefined setting in Standard

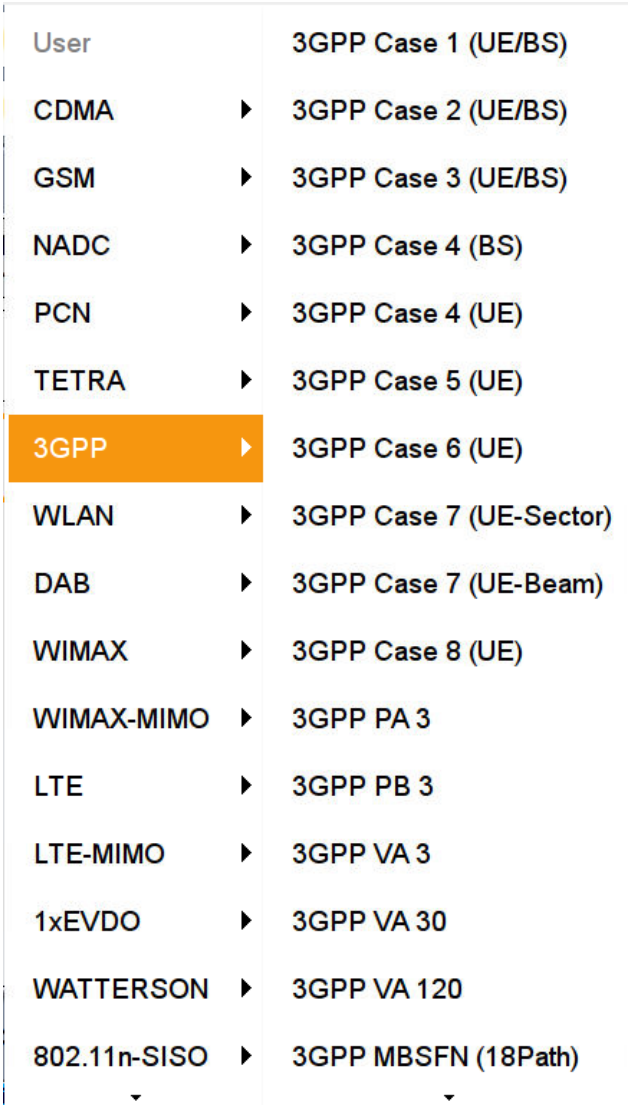


Fig. 3-7: Predefined Fading profiles for 3GPP

4. Repeat the settings in other paths. If special MIMO modes are used, this is done automatically

5. The path settings are shown as a table and as graph. Individual settings can be handled in the tables. (Fig. 3-8 and Fig. 3-9)

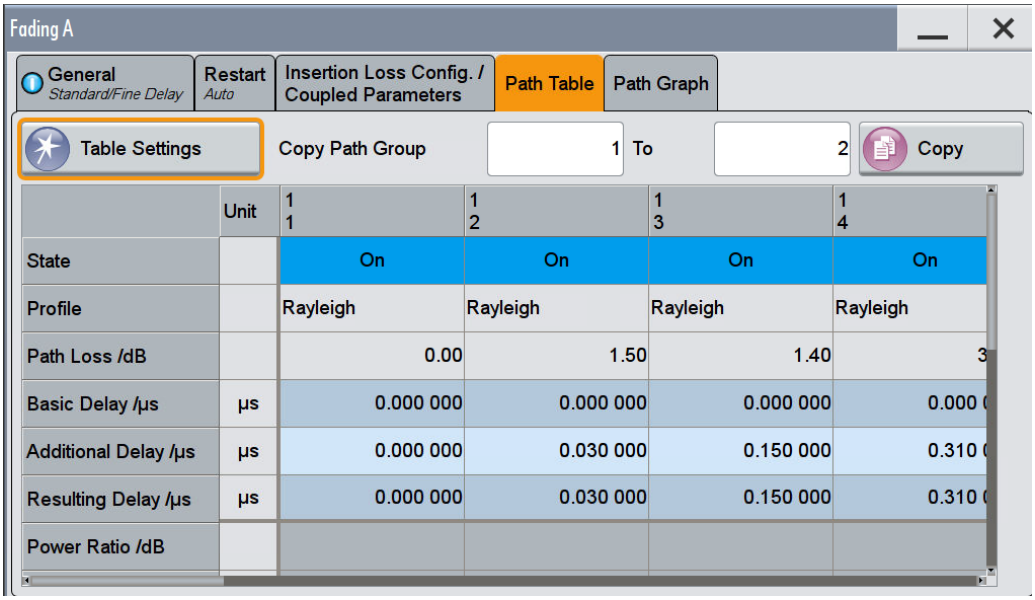


Fig. 3-8: Fading Path table

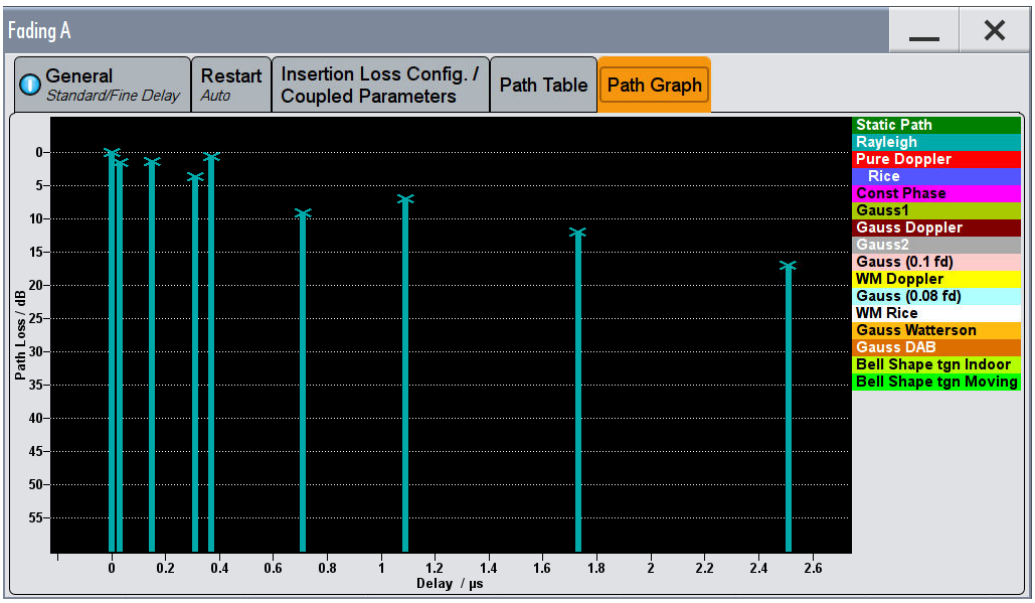


Fig. 3-9: Fading Path graph

3.1.3 General AWGN settings

The SMx provides noise via the block AWGN. The power levels in [1] are always set via a noise power and a relative signal-to-noise (SNR) requirement.

The **Test Case Wizard** applies the correct AWGN settings automatically. To change settings:

1. Click on the block **AWGN**
2. Switch the state **ON** and set the **Mode** to **Additive Noise**.(Fig. 3-10, Fig. 3-11)
3. Set the **System Bandwidth** to **3.840 MHz** (Fig. 3-10).
4. Set the **Ratio** to 2 (Fig. 3-10).

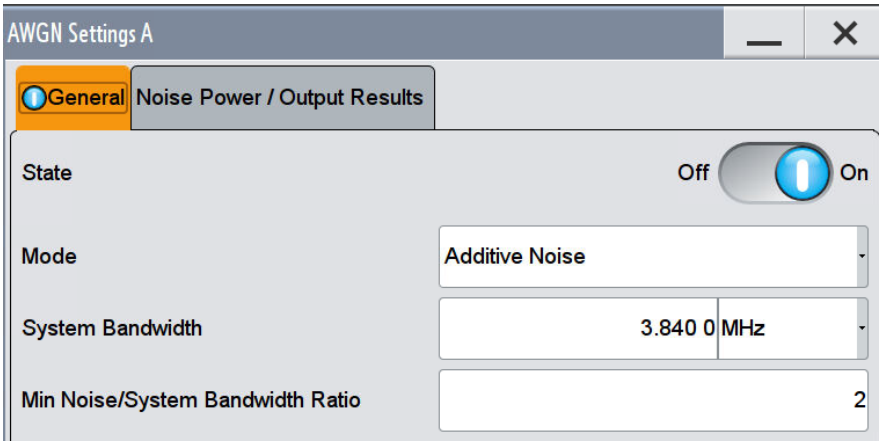


Fig. 3-10: General AWGN settings. The system bandwidth is 3.840 MHz.

5. Set the **Reference Mode** to **Noise**.
6. Set the **Noise Power** and the **Carrier to Noise Ratio** (SNR) (e.g. power = -80.5 dB, SNR = - 4 dB) (Fig. 3-11). Please note that for certain testcases an additional SNR correction factor applies.
7. For the SMU each AWGN block has to be set separately.
8. For the SMW the referenced RF port has to be set (e.g. RF A)

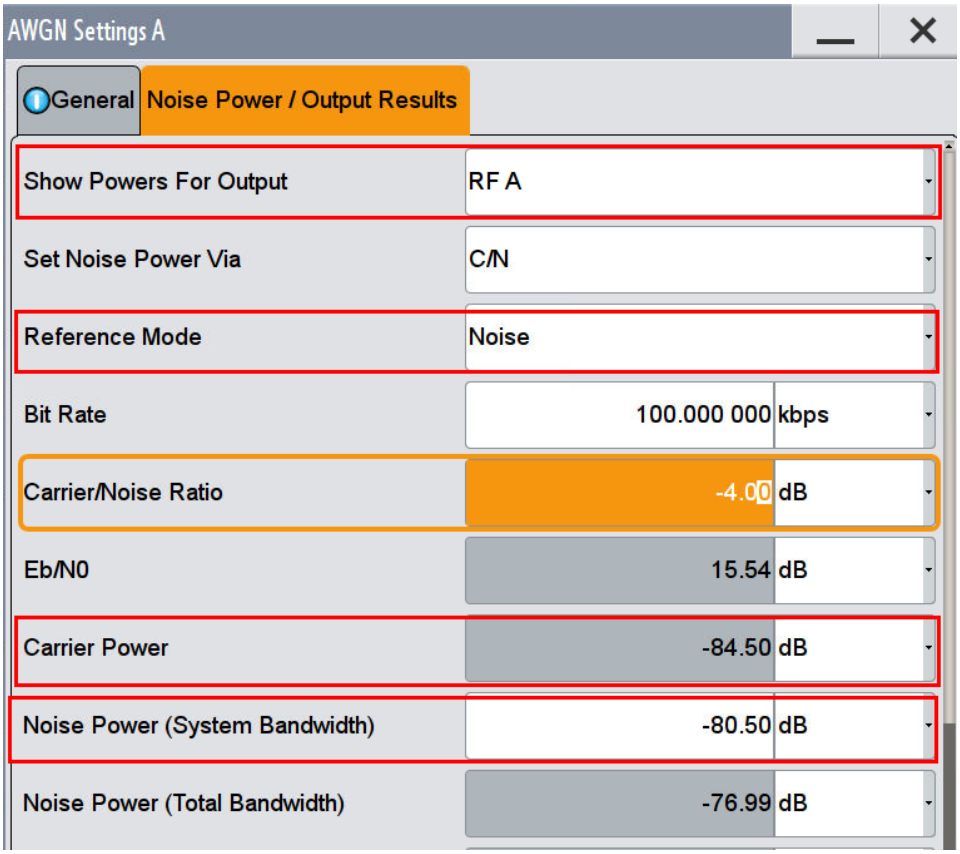


Fig. 3-11: AWGN settings. Set the noise power and the SNR. The effective Carrier Power is shown.

3.1.4 Demo Program R&S TSrun

This Application Note comes with a demonstration program module called **WCDMA BS Performance Tests** for the software **R&S TSrun** which is free of charge. The module covers all required tests (with the exceptions in Table 1-2).

The **WCDMA BS Performance Tests** module represents a so called test for the TSrun software. See Section 4.1 for some important points on the basic operation of TSrun.

Each test described in this application note can be executed quickly and easily using the module. Additional individual settings can be applied.

The program offers a straightforward user interface, and SCPI remote command sequence export functions for integrating the necessary SCPI commands into any user-specific test environment. A measurement report will be generated on each run. It can be saved to a file in different formats including PDF and HTML.

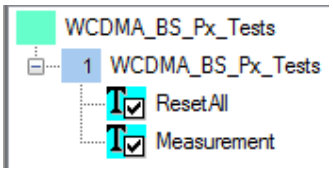
Following SCPI resources are needed:

- SMx

Getting started

This section describes only the module for the WCDMA BS Px tests. Double-click the test to open the window for entering parameters.

The test consists of two independent testcases:



- The testcase **ResetAll** resets all instruments (SMx)
- The testcase **Measurement** is the main part.

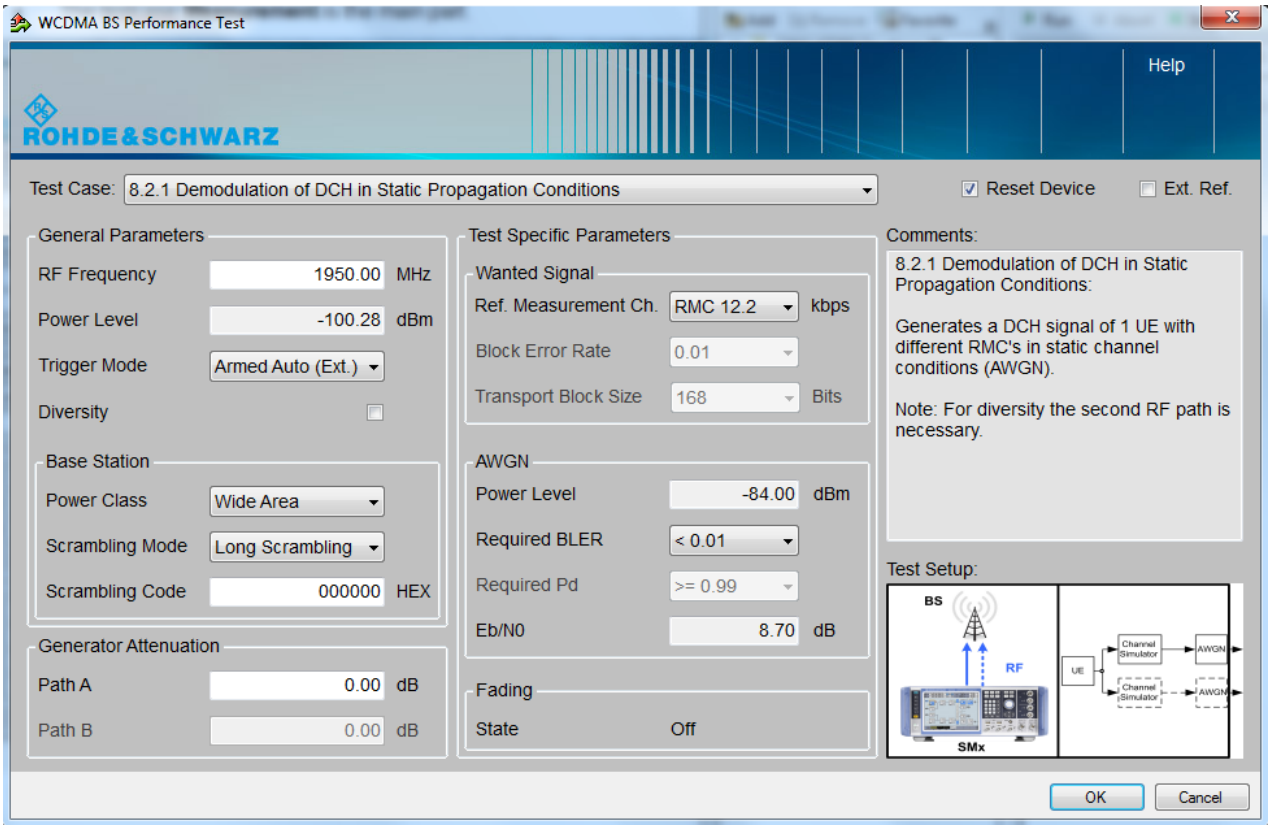


Fig. 3-12: Full overview: setting parameters for the WCDMA BS Performance tests.

General settings

The basic parameters are set at the top right:

- **Reset Devices**: Sends a reset command to all connected instruments
- **Ext. Ref**: Uses an external reference

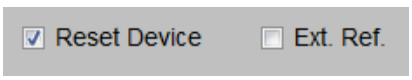


Fig. 3-13: General settings.

The **Attenuation** section is used to enter compensations for external path attenuations.

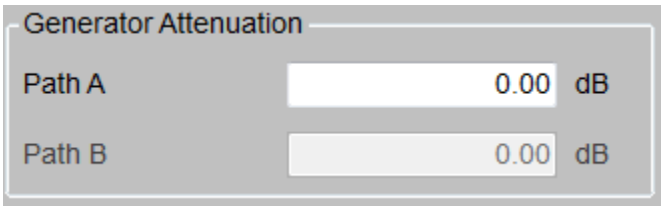


Fig. 3-14: Attenuation settings.

Test cases

This is the main parameter. Select the wanted test case here. All other remaining parameters in the window are grayed out or set active based on the requirements for the selected test case. These parameters are described in detail in the individual sections below.

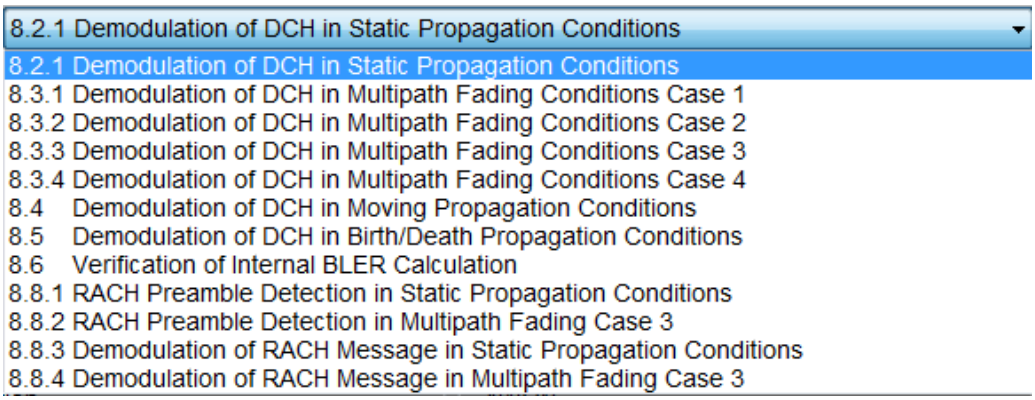


Fig. 3-15: Available test cases.

Based on the selected test case, helpful hints are provided in the Comments section and an illustration of the basic test setup is displayed.

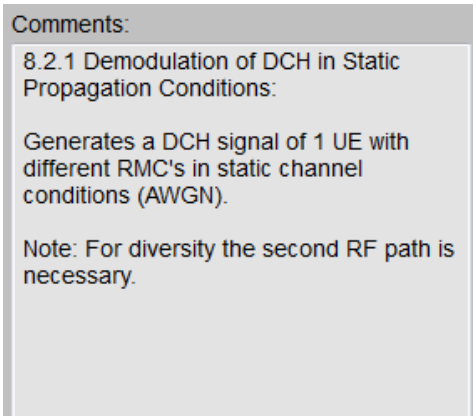


Fig. 3-16: Brief notes are provided in the Comments **section (top right) based on the selected test case.**

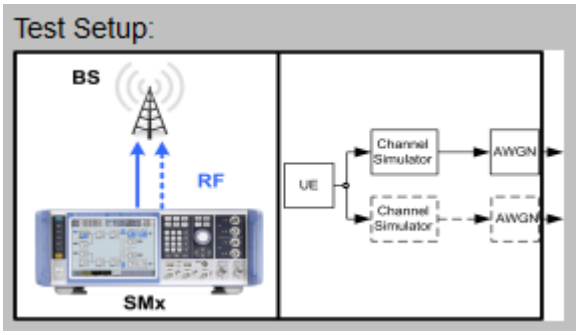


Fig. 3-17: The Test Setup **section (bottom right) displays a basic setup for the selected test case.**

General settings for the signal

Use this section to define the basic parameters for the LTE signal:

- **RF Frequency** for the center frequency
- **Power Level:** the wanted level
- **Trigger Mode:** typically External trigger provided by the basestation under test
- **Diversity:** switches on the RX diversity
- The section **Base Station** defines the general BS settings:
  - Power Class
  - Scrambling Mode
  - Scrambling Code

More advanced settings for specific tests cases are described in the corresponding sections below.

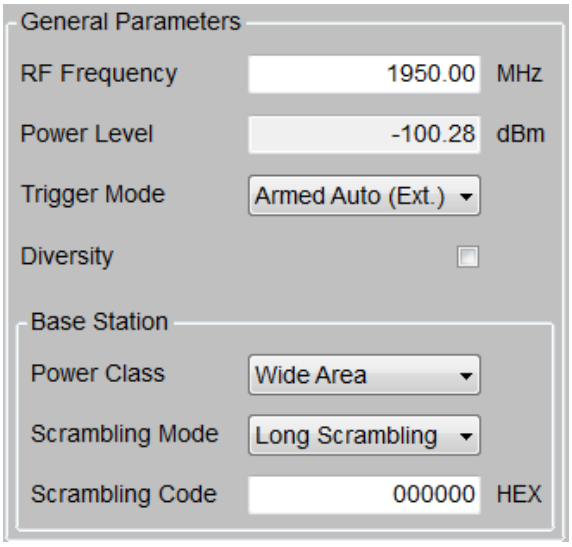


Fig. 3-18: Main parameter settings.

3.2 Demodulation of DCH

The Dedicated Channel (DCH) is a transport channel for dedicated user and control data. For reproducible testing, so called Reference Measurement Channels (RMC) has been defined in the specification.

The performance requirement for DCH is determined by the maximum Block Error Ratio (BLER) allowed when the receiver input signal is at a specified E_b/N_0 limit. The BLER is calculated for each of the measurement channels supported by the base station [1].

If external BLER measurement is not used then the internal BLER calculation shall be used instead. When internal BLER calculation is used, the requirements of the verification test according to 8.6 shall be met in advance [1].

DCH tests and data rates				
Reference Measurement Channel data rate (kbit/s)	**8.2**	**8.3**	**8.4**	**8.5**
12.2	☑	☑	☑	☑
64	☑	☑	☑	☑
144	☑	☑	-	-
384	☑	☑	-	-

Table 3-1: different data rates in DCH tests

The AWGN is for all DCH tests:

AWGN settings	
Base Station	**AWGN (dBm)**
Wide Area	- 84
Medium Range	- 74
Local Area / Home BS	- 70

Table 3-2: AWGN settings for DCH tests

The resulting RF level is calculated:

$$Level = AWGN + 10 \times log_{10} \frac{RMC}{3.84 \times 10^6} + \frac{E_b}{N_0}$$

Example for a wide area BS with a RMC of 64 kbit/s and Eb/N0 of 5.5 dB:

Level = -84 dBm – 17.78 dB + 5.5 dB = -96.28 dBm.

3.2.1 Demodulation of DCH in static propagation conditions (Clause 8.2.1)

In this test the BLER is determined in static propagation conditions (AWGN) at certain $E_b/N_{0.}$

The test shall verify the receiver's ability to receive the test signal under static propagation conditions with a BLER not exceeding a specified limit [1].

Requirements for DCH in AWGN channel			
Measurement channel (kbit/s)	**BLER**	**E_b/N_0 With Rx Diversity (dB)**	**E_b/N_0 Without Rx Diversity (dB)**
12.2	0.1	n.a.	n.a.
	0.01	5.5	8.7
64	0.1	1.9	5.1
	0.01	2.1	5.2
144	0.1	1.2	4.2
	0.01	1.3	4.4
384	0.1	1.3	4.4
	0.01	1.4	4.5

Table 3-3: Requirements for 8.2.1

Test Setup

Fig. 3-19 shows the test setup.

For diversity the wanted signal generated by SMx baseband A is split up in two paths. AWGN is added.

The SMU needs an external trigger at input TRIGGER1, the SMW at USER3.

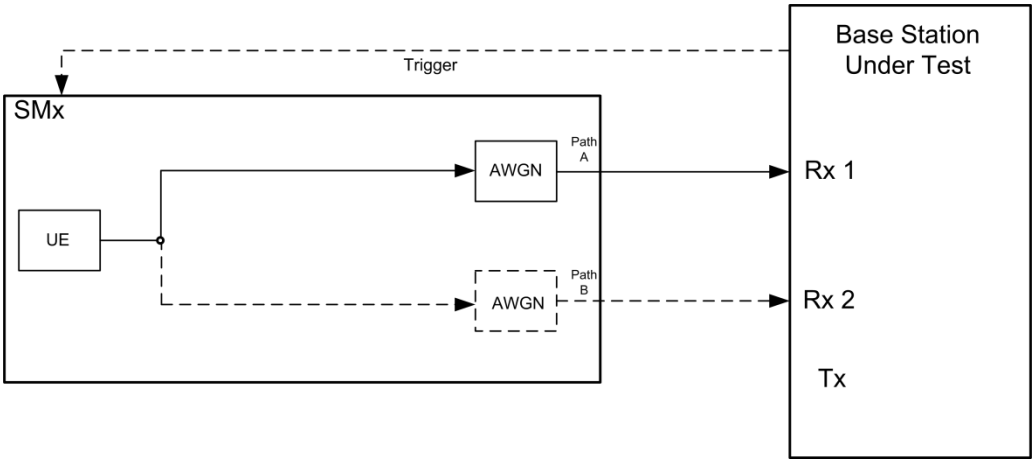
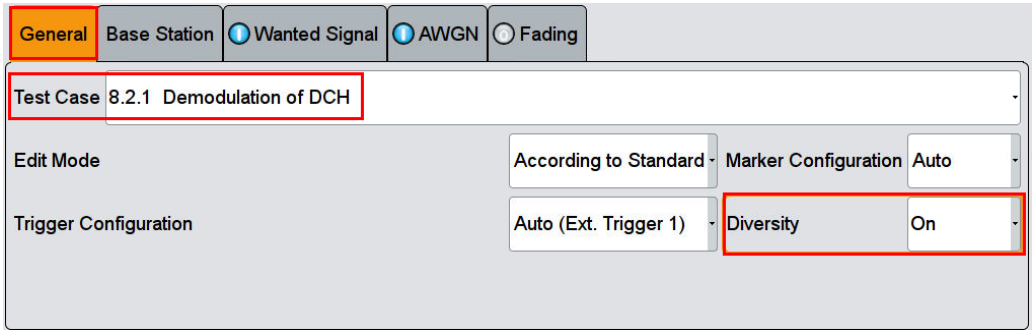


Fig. 3-19: Test setup for DCH test 8.2.1

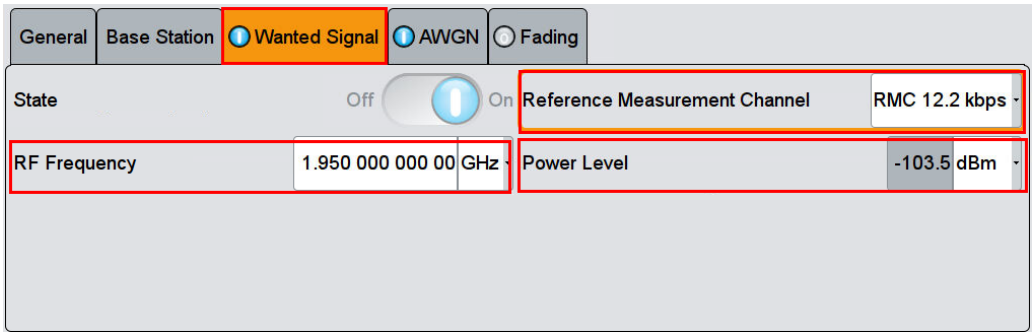
Test Procedure

As an example the settings for diversity, wide area BS and a BLER of 0.01 are shown.

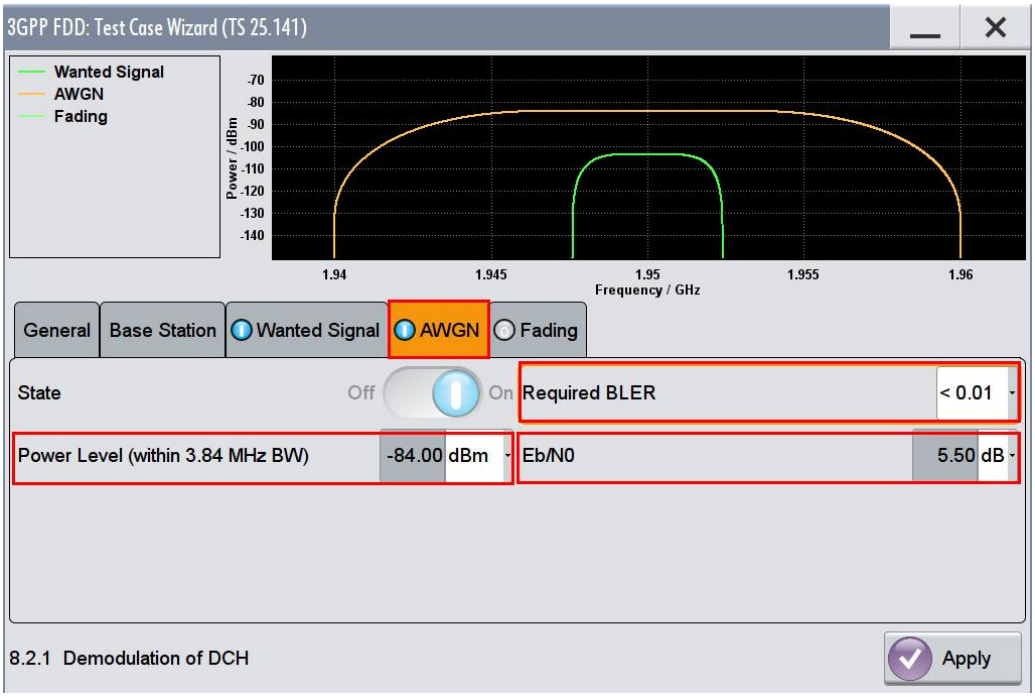
1. For the basic steps see section 3.1.1.
2. Select **8.2.1 Demodulation of DCH** and switch **Diversity ON.** (both in tab **General**)



3. Select the **Reference Measurement Channel** and set the **RF Frequency**. In addition the resulting **Power Level** is displayed. (example: RMC 12.2 kbps, 1.95 GHz)



4. Set the required **BLER** (example **0.01**). In addition the **AWGN level** (depends on the Base station power class) and the **Eb/No** is displayed



5. Measure the BLER at the base station.

Demo Program

Fig. 3-20 shows the parameters of the test. Select the wanted **Ref Measurement Ch.** and the **Required BLER**. When selecting a particular test all settings are default according to the specification. The setting of the **Eb/N0** depends on the RMC and the required BLER and diversity. The level depends also on the base station power class. For this test the fading is Off.

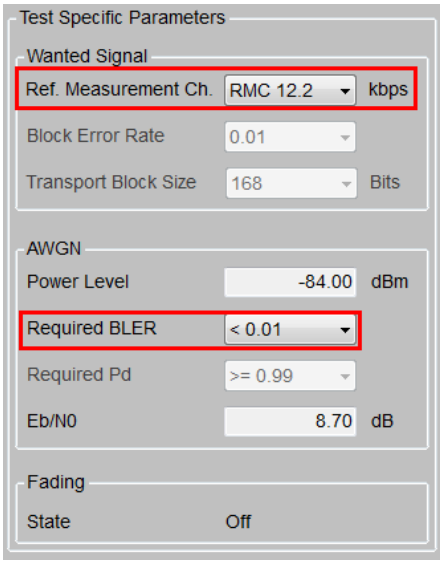


Fig. 3-20: Parameter for DCH test 8.2.1

Fig. 3-21 shows the report.

WCDMA Base Station Performance Test

Test Case: 8.2.1 Demodulation of DCH in Static Propagation Conditions

Generator Settings:
Trigger Configuration: Armed Auto (Ext.)
Diversity: On
Attenuation (Path A): 1.23 dB
Attenuation (Path B): 2.34 dB
Base Station Configuration:
Power Class: Wide Area
Scrambling Mode: Long Scrambling
Scrambling Code: 000000 HEX

Settings Item and Configuration			Value	Unit	Status
Wanted Signal					
RF Frequency	---	---	1950.00	MHz	
Power Level	---	---	-103.48	dBm	
Reference Measurement Channel	---	---	RMC 12.2	kbps	
AWGN					
Power Level *within 3.84 MHz BW*	---	---	-84.00	dBm	
Required BLER	---	---	< 0.01	-/-	
Eb/N0	---	---	5.50	dB	
Fading					
State	---	---	Off	-/-	

Settings in compliance with TS 25.141!

Fig. 3-21: Report 8.2.1

3.2.2 Demodulation of DCH in multipath fading conditions (Clause 8.3)

In this test the BLER is determined in multipath fading conditions and additional AWGN at certain E_b/N_0.

The test is split in four different tests with different fading conditions. Pleas also note the applicability for the different BS power classes:

Test	Fading	BS class
8.3.1	Case 1	All
8.3.2	Case 2	Not Home BS
8.3.3	Case 3	Not Home BS
8.3.4	Case 4	Wide Area only

Table 3-4: Four tests with different fading conditions for 8.3

The tests shall verify the receiver's ability to receive the test signal

- under slow multipath fading propagation conditions (8.3.1)
- that has a large time dispersion (8.3.2)
- under fast fading propagation conditions (8.3.3 and 8.3.4)

with a BLER not exceeding a specified limit [1].

The tables Table 3-5 to Table 3-8 show the different test requirements.

Requirements for DCH in multipath case 1 channel (8.3.1)			
Measurement channel (kbit/s)	**BLER**	**E_b/N_0 With Rx Diversity (dB)**	**E_b/N_0 Without Rx Diversity (dB)**
12.2	0.1	n.a.	n.a.
	0.01	12.5	19.7
64	0.1	6.8	12.2
	0.01	9.8	16.5
144	0.1	6.0	11.4
	0.01	9.0	15.6
384	0.1	6.4	11.8
	0.01	9.4	16.1

Table 3-5: Requirements for 8.3.1

Requirements for DCH in multipath case 2 channel (8.3.2)			
Measurement channel (kbit/s)	**BLER**	**E_b/N_0 With Rx Diversity (dB)**	**E_b/N_0 Without Rx Diversity (dB)**
12.2	0.1	n.a.	n.a.
	0.01	9.6	15.6
64	0.1	4.9	9.8
	0.01	7.0	12.9
144	0.1	4.3	8.8
	0.01	6.2	12.1
384	0.1	4.7	9.3
	0.01	6.7	12.7

Table 3-6: Requirements for 8.3.2

Requirements for DCH in multipath case 3 channel (8.3.3)			
Measurement channel (kbit/s)	**BLER**	**E_b/N_0 With Rx Diversity (dB)**	**E_b/N_0 Without Rx Diversity (dB)**
12.2	0.1	n.a.	n.a.
	0.01	7.8	11.4
	0.001	8.6	12.3
64	0.1	4.0	7.7
	0.01	4.4	8.3
	0.001	4.7	9.1
144	0.1	3.4	6.6
	0.01	3.8	7.3
	0.001	4.2	7.8
384	0.1	3.8	7.1
	0.01	4.2	7.8
	0.001	4.8	8.5

Table 3-7: Requirements for 8.3.3

Requirements for DCH in multipath case 4 channel (8.3.4)			
Measurement channel (kbit/s)	**BLER**	**E_b/N_0 With Rx Diversity (dB)**	**E_b/N_0 Without Rx Diversity (dB)**
12.2	0.1	n.a.	n.a.
	0.01	10.8	14.4
	0.001	11.6	15.3
64	0.1	7.0	10.7
	0.01	7.4	8.3
	0.001	7.7	12.1
144	0.1	6.4	9.6
	0.01	6.8	10.3
	0.001	7.2	10.8
384	0.1	6.8	10.1
	0.01	7.2	10.8
	0.001	7.8	11.5

Table 3-8: Requirements for 8.3.4

Test Setup

Fig. 3-22 shows the test setup.

For diversity the wanted signal generated by SMx baseband A is split up in two paths. The channel is simulated and AWGN is added.

The SMU needs an external trigger at input TRIGGER1, the SMW at USER3.

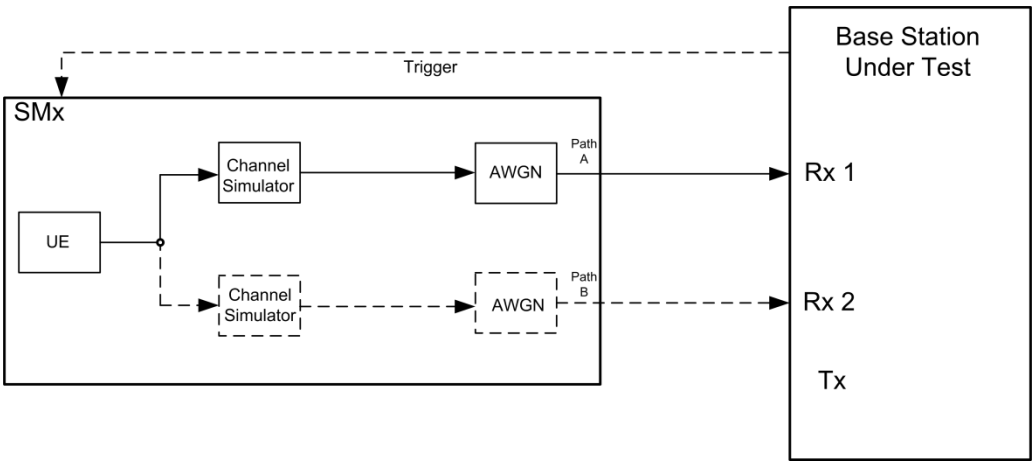
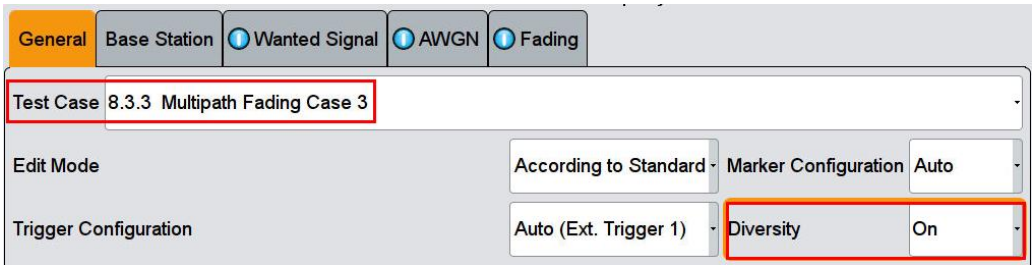


Fig. 3-22: Test setup for DCH test 8.3

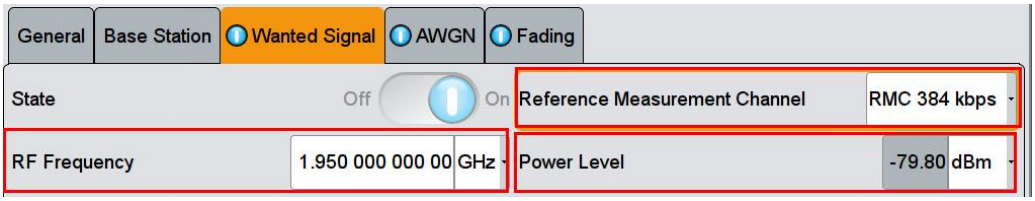
Test Procedure

As an example the settings for diversity, Medium Range BS , RMC 384 and a BLER of 0.001 for fading case 3 are shown.

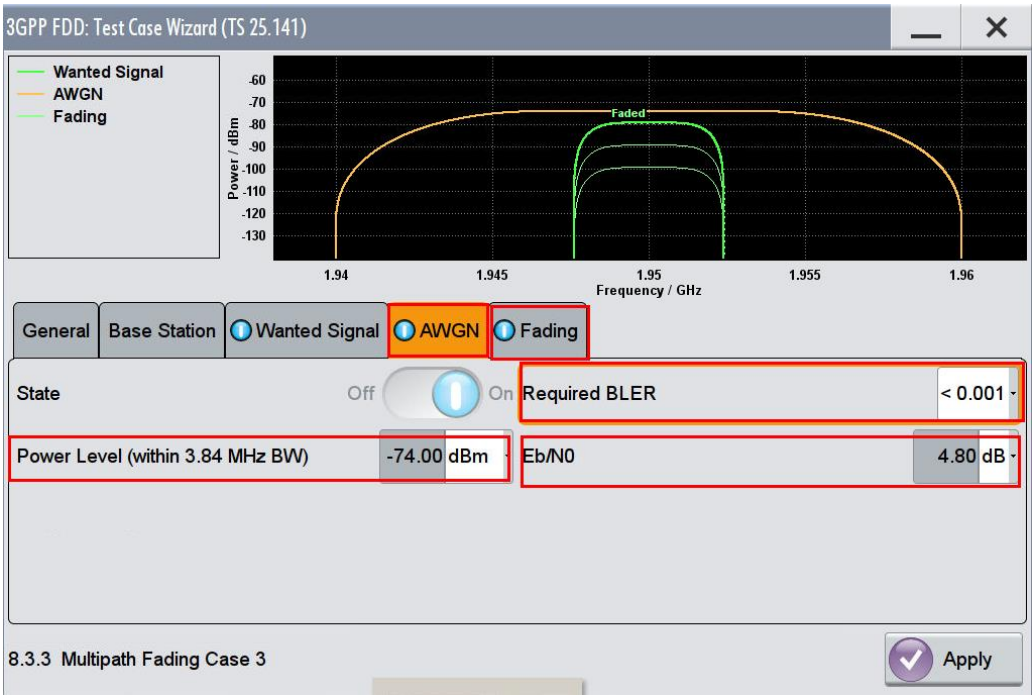
1. For the basic steps see section 3.1.1.
2. Select **8.3.3 Demodulation of DCH** and switch **Diversity ON.** (both in tab **General**)



3. Select the **Reference Measurement Channel** and set the **RF Frequency**. In addition the resulting **Power Level** is displayed. (example: RMC 384 kbps, 1.95 GHz)



4. Set the required **BLER** (example **0.001**). In addition the **AWGN level** (depends on the Base station power class) and the **Eb/No** is displayed. Note that **Fading** is switched On.



5. Measure the BLER at the base station.

Demo Program

Fig. 3-23 shows the parameters of the test. Select the wanted **Ref Measurement Ch.** and the **Required BLER**. When selecting a particular test all settings are default according to the specification. The setting of the **Eb/N0** depends on the RMC and the required BLER and diversity. The level depends also on the base station power class. For this test the fading is **On**, the settings depend on the testcase (case 1…4).

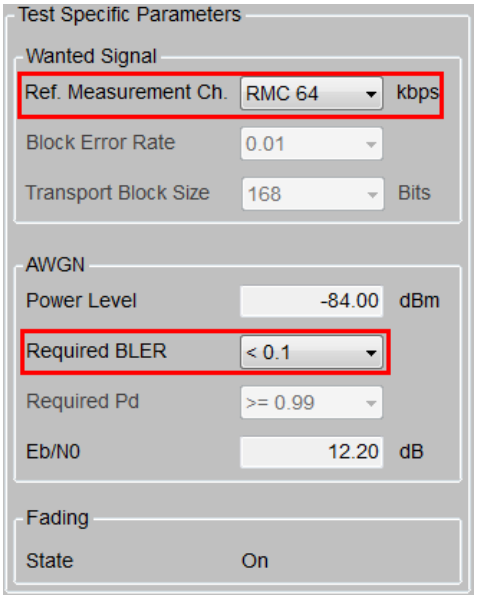


Fig. 3-23: Parameter for DCH test 8.3.1

Fig. 3-24 shows the report.

WCDMA Base Station Performance Test

Test Case: 8.3.1 Demodulation of DCH in Multipath Fading Conditions Case 1

Generator Settings:
Trigger Configuration: Armed Auto (Ext.)
Diversity: Off
Attenuation (Path A): 1.23 dB
Base Station Configuration:
Power Class: Wide Area
Scrambling Mode: Long Scrambling
Scrambling Code: 000000 HEX

Settings Item and Configuration			Value	Unit	Status
Wanted Signal					
RF Frequency	---	---	1950.00	MHz	
Power Level	---	---	-89.58	dBm	
Reference Measurement Channel	---	---	RMC 64	kbps	
AWGN					
Power Level *within 3.84 MHz BW*	---	---	-84.00	dBm	
Required BLER	---	---	< 0.1	-/-	
Eb/N0	---	---	12.20	dB	
Fading					
State	---	---	On	-/-	

Settings in compliance with TS 25.141!

Fig. 3-24: Report 8.3.1

3.2.3 Demodulation of DCH in moving propagation conditions (Clause 8.4)

In this test the BLER is determined in moving propagation conditions and additional AWGN at certain E_b/N_0.

The test shall verify the receiver's ability to receive and track the test signal with a BLER not exceeding a specified limit [1].

Requirements for DCH in moving channel			
Measurement channel (kbit/s)	**BLER**	**E_b/N_0 With Rx Diversity (dB)**	**E_b/N_0 Without Rx Diversity (dB)**
12.2	0.1	n.a.	n.a.
	0.01	6.3	9.3
64	0.1	2.7	5.9
	0.01	2.8	6.1

Table 3-9: Requirements for 8.4

Test Setup

Fig. 3-25 shows the test setup.

For diversity the wanted signal generated by SMx baseband A is split up in two paths. AWGN is added.

The SMU needs an external trigger at input TRIGGER1, the SMW at USER3.

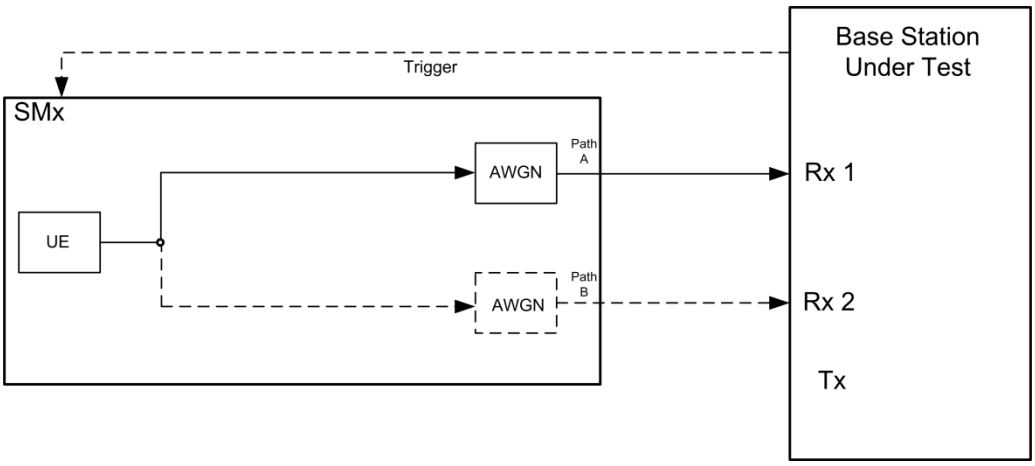
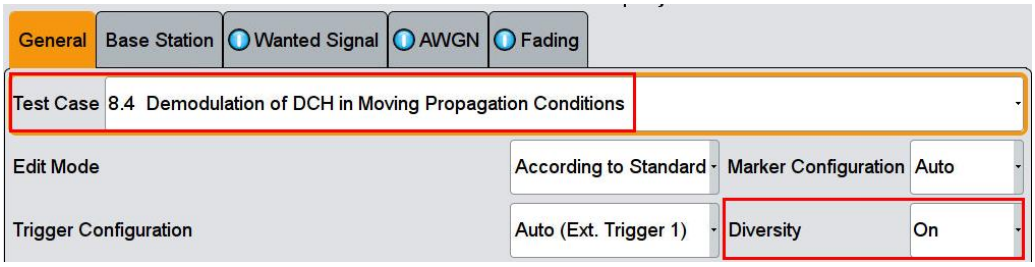


Fig. 3-25: Test setup for DCH test 8.4

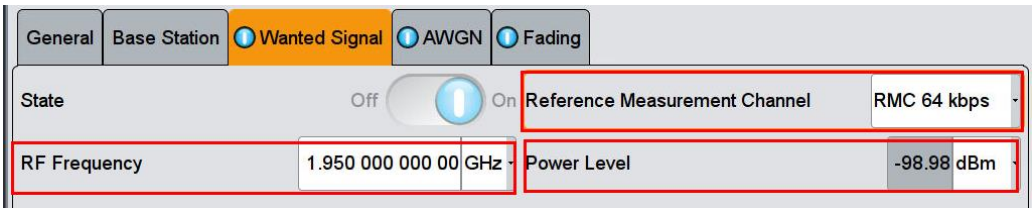
Test Procedure

As an example the settings for diversity, wide area BS, RMC 64 and a BLER of 0.01 are shown.

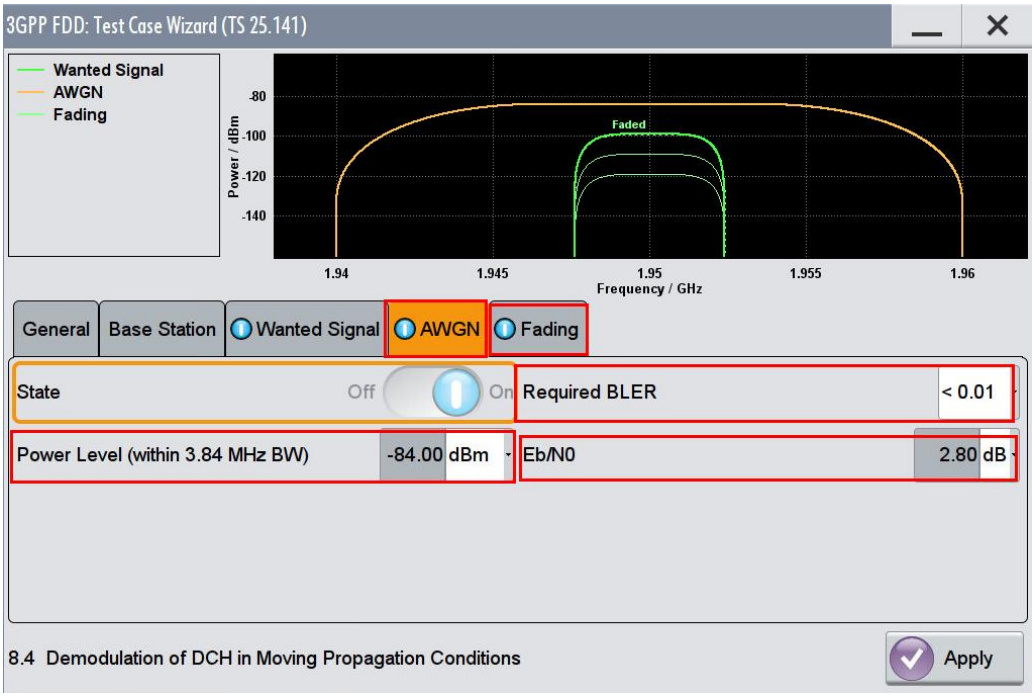
1. For the basic steps see section 3.1.1.
2. Select **8.4 Demodulation of DCH in Moving Propagation Conditions** and switch **Diversity ON.** (both in tab **General**)



3. Select the **Reference Measurement Channel** and set the **RF Frequency**. In addition the resulting **Power Level** is displayed. (example: RMC 64 kbps, 1.95 GHz)



4. Set the required **BLER** (example **0.01**). In addition the **AWGN level** (depends on the Base station power class) and the **Eb/No** is displayed. Note that **Fading** is switched On.



5. Measure the BLER at the base station.

Demo Program

Fig. 3-26 shows the parameters of the test. Select the wanted **Ref Measurement Ch.** and the **Required BLER**. When selecting a particular test all settings are default according to the specification. The setting of the **Eb/N0** depends on the RMC and the required BLER and diversity. The level depends also on the base station power class. For this test the fading is **On**, the settings are moving propagation.

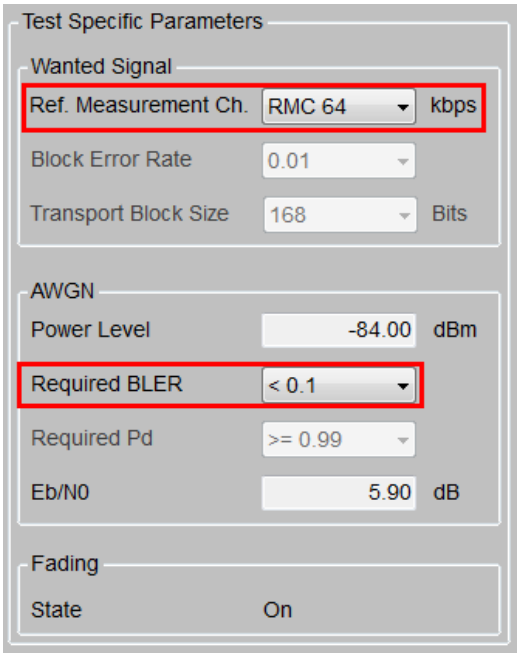


Fig. 3-26: Parameter for DCH test 8.4

Fig. 3-27 shows the report.

WCDMA Base Station Performance Test

Test Case: 8.4 Demodulation of DCH in Moving Propagation Conditions

Generator Settings:
Trigger Configuration: Armed Auto (Ext.)
Diversity: Off
Attenuation (Path A): 1.23 dB
Base Station Configuration:
Power Class: Wide Area
Scrambling Mode: Long Scrambling
Scrambling Code: 000000 HEX

Settings Item and Configuration			Value	Unit	Status
Wanted Signal					
RF Frequency	---	---	1950.00	MHz	
Power Level	---	---	-95.88	dBm	
Reference Measurement Channel	---	---	RMC 64	kbps	
AWGN					
Power Level *within 3.84 MHz BW*	---	---	-84.00	dBm	
Required BLER	---	---	< 0.1	-/-	
Eb/N0	---	---	5.90	dB	
Fading					
State	---	---	On	-/-	

Settings in compliance with TS 25.141!

Fig. 3-27: Report 8.4

3.2.4 Demodulation of DCH in birth/death propagation conditions (Clause 8.5)

In this test the BLER is determined in birth/death propagation conditions and additional AWGN at certain E_b/N_0.

The test shall verify the receiver's ability to receive the test signal to find new multi path components with a BLER not exceeding a specified limit [1].

Requirements for DCH in birth/death channel			
Measurement channel (kbit/s)	**BLER**	**E_b/N_0 With Rx Diversity (dB)**	**E_b/N_0 Without Rx Diversity (dB)**
12.2	0.1	n.a.	n.a.
	0.01	8.3	11.4
64	0.1	4.7	8.0
	0.01	4.8	8.1

Table 3-10: Requirements for 8.5

Test Setup

Fig. 3-28 shows the test setup.

For diversity the wanted signal generated by SMx baseband A is split up in two paths. AWGN is added.

The SMU needs an external trigger at input TRIGGER1, the SMW at USER3.

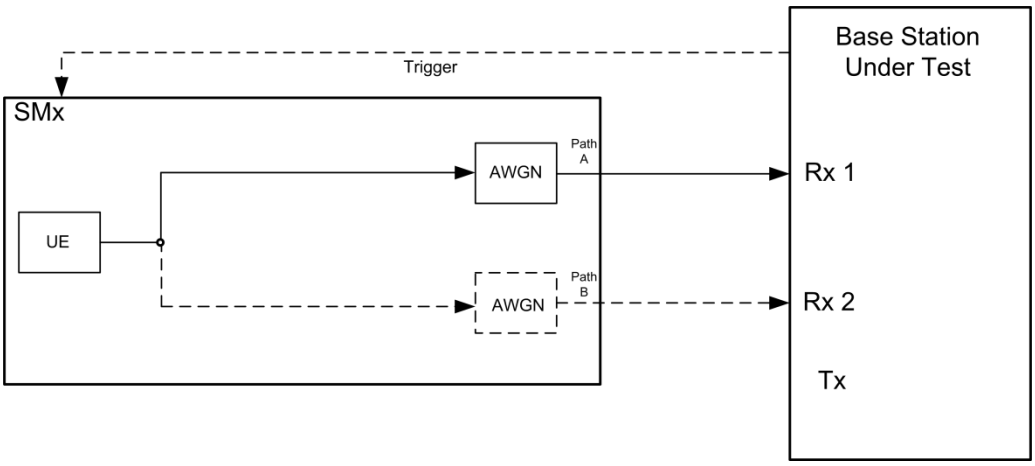
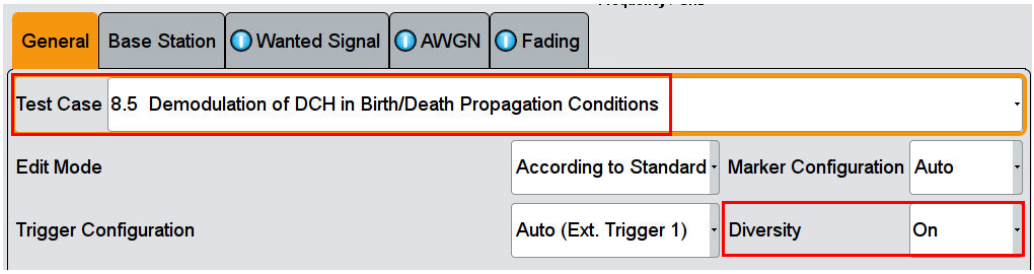


Fig. 3-28: Test setup for DCH test 8.5

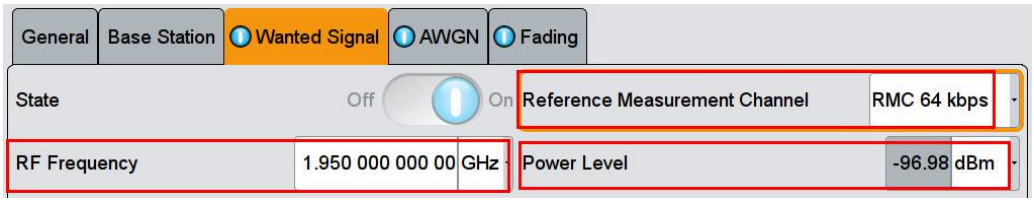
Test Procedure

As an example the settings for diversity, wide area BS, RMC 64 and a BLER of 0.01 are shown.

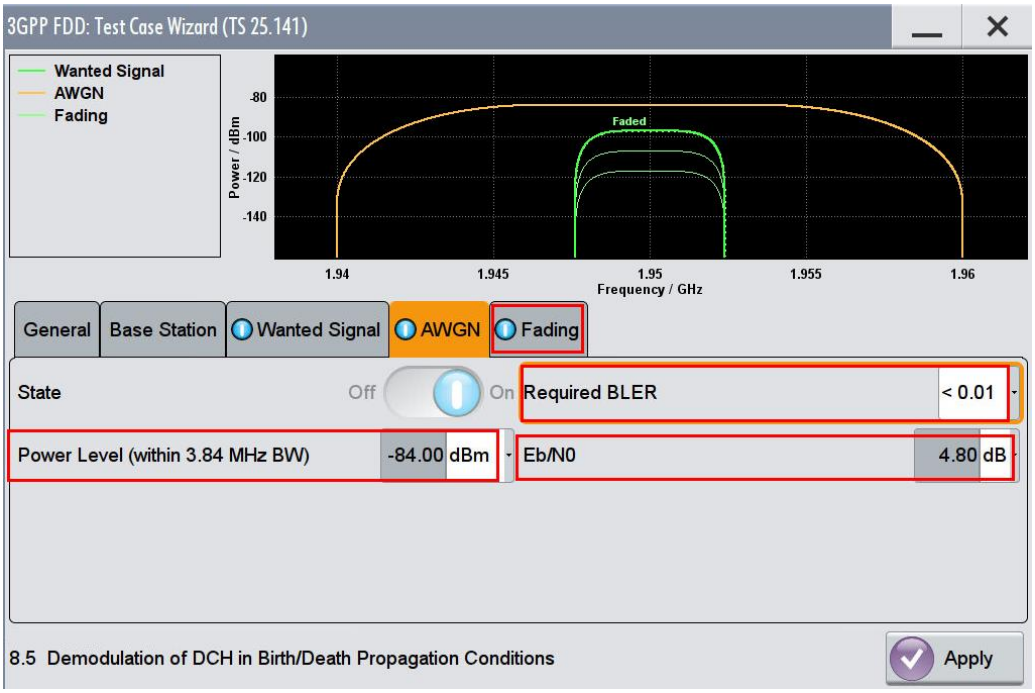
1. For the basic steps see section 3.1.1.
2. Select **8.5 Demodulation of DCH in Birth/Death Propagation Conditions** and switch **Diversity ON.** (both in tab **General**)



3. Select the **Reference Measurement Channel** and set the **RF Frequency**. In addition the resulting **Power Level** is displayed. (example: RMC 64 kbps, 1.95 GHz)



4. Set the required **BLER** (example **0.01**). In addition the **AWGN level** (depends on the Base station power class) and the **Eb/No** is displayed. Note that **Fading** is switched On.



5. Measure the BLER at the base station.

Demo Program

Fig. 3-29 shows the parameters of the test. Select the wanted **Ref Measurement Ch.** and the **Required BLER**. When selecting a particular test all settings are default according to the specification. The setting of the **Eb/N0** depends on the RMC and the required BLER and diversity. The level depends also on the base station power class. For this test the fading is **On**, the settings are birth/death propagation.

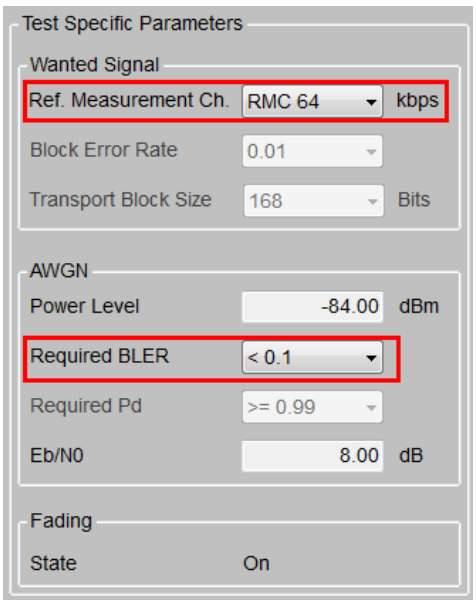


Fig. 3-29: Parameter for DCH test 8.5

Fig. 3-30 shows the report.

WCDMA Base Station Performance Test

Test Case: 8.5 Demodulation of DCH in Birth/Death Propagation Conditions

Generator Settings:
Trigger Configuration: Armed Auto (Ext.)
Diversity: Off
Attenuation (Path A): 1.23 dB
Base Station Configuration:
Power Class: Wide Area
Scrambling Mode: Long Scrambling
Scrambling Code: 000000 HEX

Settings Item and Configuration			Value	Unit	Status
Wanted Signal					
RF Frequency	---	---	1950.00	MHz	
Power Level	---	---	-93.78	dBm	
Reference Measurement Channel	---	---	RMC 64	kbps	
AWGN					
Power Level *within 3.84 MHz BW*	---	---	-84.00	dBm	
Required BLER	---	---	< 0.1	-/-	
Eb/N0	---	---	8.00	dB	
Fading					
State	---	---	On	-/-	

Settings in compliance with TS 25.141!

Fig. 3-30: Report 8.5

3.3 Verification of the internal BLER calculation (Clause 8.6)

Base Station System with internal BLER calculates block error rate from the CRC blocks of the received. This test is performed only if Base Station System has this kind of feature. All data rates which are used in clause 8 Performance requirement testing shall be used in verification testing. This test is performed by feeding measurement signal with known BLER to the input of the receiver. Locations of the erroneous blocks shall be randomly distributed within a frame. Erroneous blocks shall be inserted into the UL signal as shown in figure Fig. 3-31 [1].

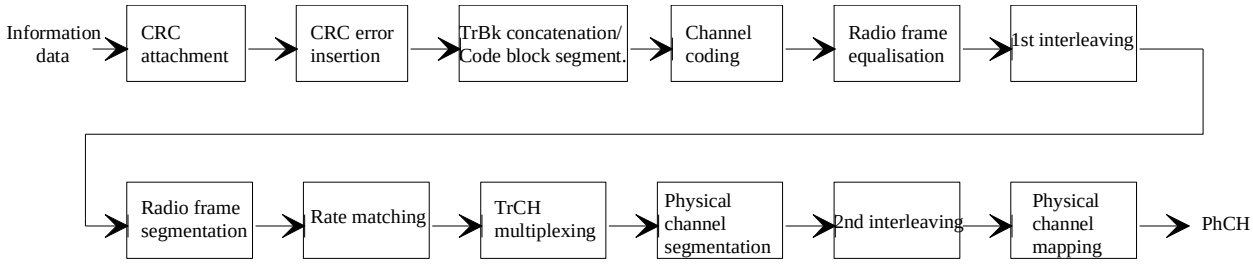


Fig. 3-31: BLER insertion into the information data [1]

The aim of this test is to verify that the internal BER calculation accuracy shall meet requirements for conformance testing. BLER indicated by the base station system shall be within ±10% of the BLER generated by the RF signal source for the measurement signals specified in Table 3-11.

Measurement signal requirements		
Transport channel combination	**Data rate**	**BER**
DPCH	12.2 kbps	0.01
DPCH	64 kbps	0.01
DPCH	144 kbps	0.01
DPCH	384 kbps	0.01

Table 3-11: Measurement signals requirements for internal BER calculation

Signal source parameters should be set according Table 3-12

Uplink levels					
Parameters	**Uplink Level (dBm/3.84 MHz)**				
UL signal level	**BS Class**	**12.2**	**64**	**144**	**484**
	Wide Area BS	- 111	- 107	- 104	- 100
	Medium Range BS	- 101	- 97	- 94	- 90
	Local Area BS / Home BS	- 97	- 93	- 90	- 86
Data sequence	PN9 or longer				

Table 3-12: Parameters for signal source

Test Setup

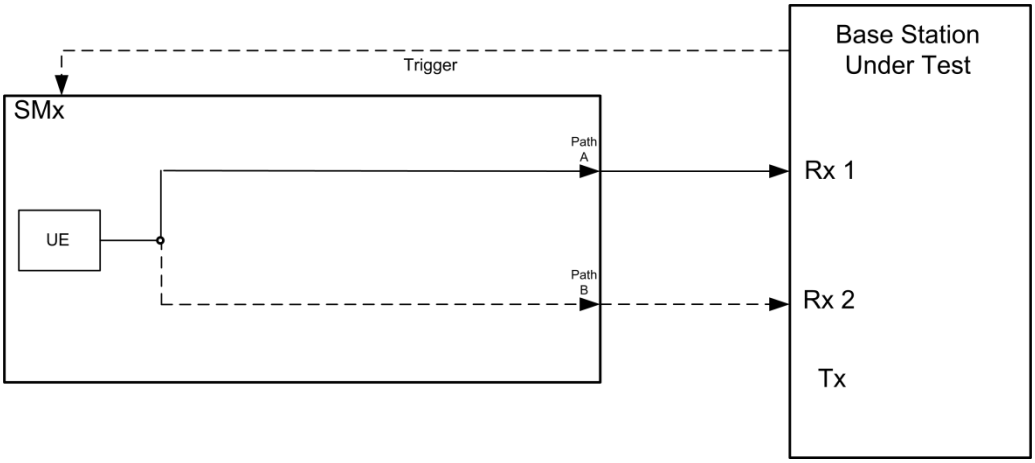
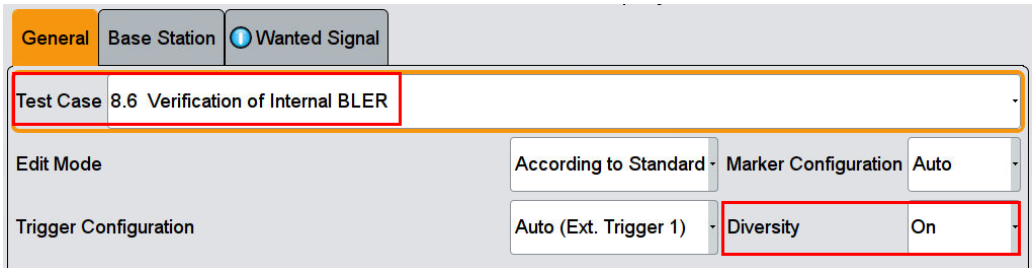


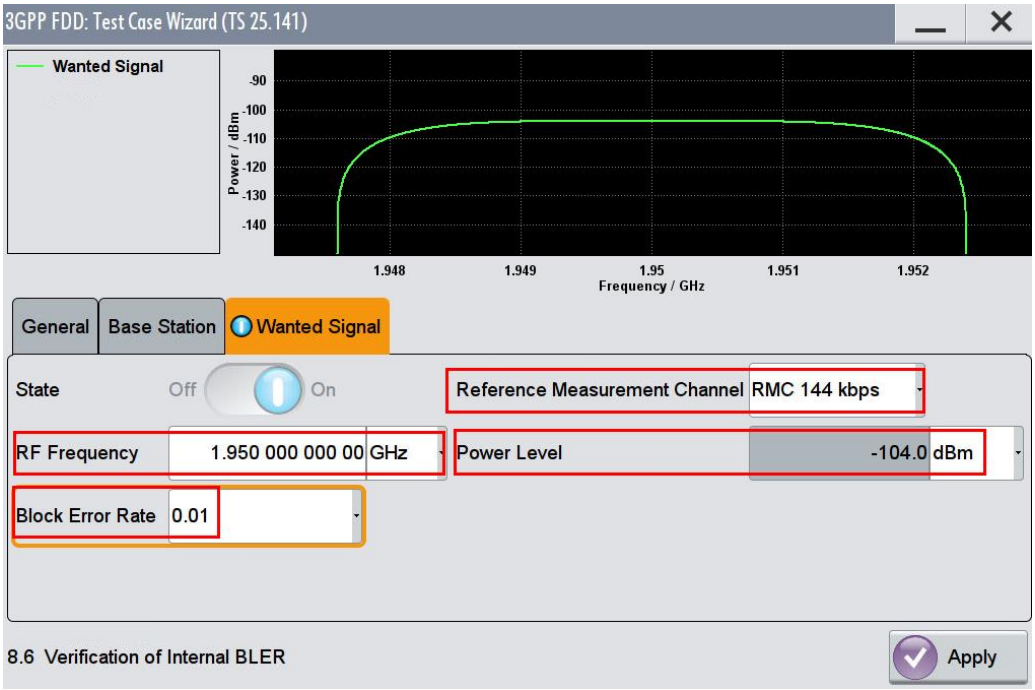
Fig. 3-32: Verification of the internal LBER calculation test setup (8.6). The SMx generates the W-CDMA uplink reference measurement channel.

As an example the settings for diversity, wide area BS, RMC 64 and a BLER of 0.01 are shown.

1. For the basic steps see section 3.1.1.
2. Select **8.6 Verification of internal BLER** and switch **Diversity ON.** (both in tab **General**)



3. Select the **Reference Measurement Channel** , the **RF Frequency** and the **Block Error Rate** to **0.01**. In addition the resulting **Power Level** is displayed. (example: RMC 64 kbps, 1.95 GHz)



4. Measure the BLER at the base station at least over 50000 blocks.

Demo Program

Fig. 3-33 shows the parameters of the test. Select the wanted **Ref Measurement Ch.** and the **Bock Error Rate**. When selecting a particular test all settings are default according to the specification. The level depends also on the base station power class.

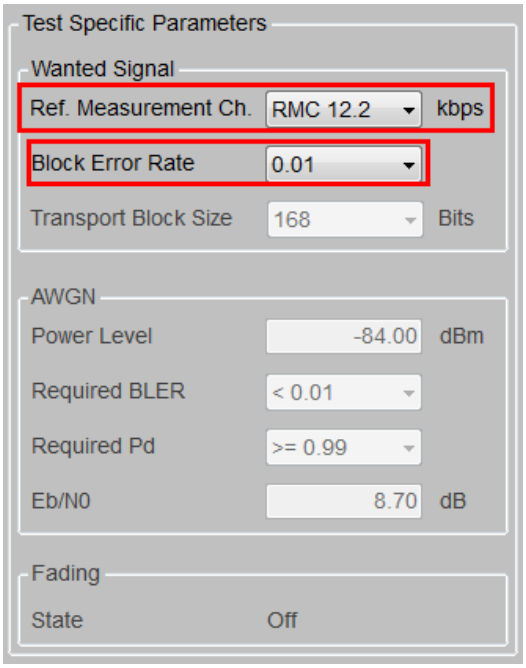


Fig. 3-33: Parameter for BLER verification test 8.6

Fig. 3-34 shows the report.

WCDMA Base Station Performance Test

Test Case: 8.6 Verification of Internal BLER Calculation

Generator Settings:
Trigger Configuration: Armed Auto (Ext.)
Diversity: Off
Attenuation (Path A): 1.23 dB
Base Station Configuration:
Power Class: Wide Area
Scrambling Mode: Long Scrambling
Scrambling Code: 000000 HEX

Settings Item and Configuration			Value	Unit	Status
Wanted Signal					
RF Frequency	---	---	1950.00	MHz	
Power Level	---	---	-107.00	dBm	
Reference Measurement Channel	---	---	RMC 64	kbps	
Block Error Rate	---	---	0.01	-/-	

Settings in compliance with TS 25.141!

Fig. 3-34: Report 8.6

3.4 RACH performance (Clause 8.8)

The Random Access Channel (RACH) is used by the UE for initial access to the radio interface. The UE transmits RACH with preambles until it receives a confirmation by the network (via AICH). Then the UE sends a RACH with a message part. Both receiving cases (preamble and message) are tested in the next sections.

The AWGN is for all RACH tests:

AWGN settings	
Base Station	**AWGN (dBm)**
Wide Area	- 84
Medium Range	- 74
Local Area / Home BS	- 70

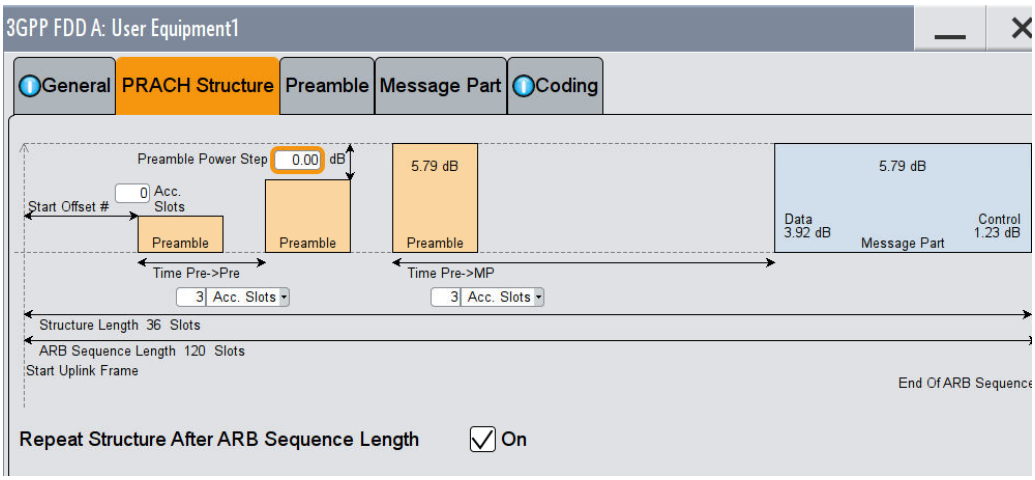
Table 3-13: AWGN settings for RACH tests

The test is split in four different tests with different fading conditions. Please also note the applicability for the different BS power classes:

Test	Purpose	Channel	BS class
8.8.1	Preamble	AWGN	All
8.8.2		AWGN + Case 3	Not Home BS
8.8.3	Message	AWGN	All
8.8.4		AWGN + Case 4	Not Home BS

Table 3-14: Four tests for RACH 8.8

Please note, that for RACH tests the power level is offset by 5.79 dB. That means the shown level at the SMx is 5.79 dB lower than the wanted level in the wizard.



3.4.1 RACH preamble detection in static propagation conditions (Clause 8.8.1)

The test shall verify the receiver's ability to detect RACH preambles under static propagation conditions [1].

The performance requirement is determined by the two parameters probability of false detection of the preamble (Pfa) and the probability of detection of preamble (Pd). Only one signature is used and it is known by the receiver [1].

The preamble is repeated.

Preamble Preamble • • •

Requirements for RACH in AWGN channel			
Pfa ≤	**Pd ≥**	**E_b/N_0 With Rx Diversity (dB)**	**E_b/N_0 Without Rx Diversity (dB)**
0.001	0.99	- 20.1	- 17.2
	0.999	- 19.7	-16.4

Table 3-15: Requirements for 8.8.1

Test Setup

Fig. 3-35 shows the test setup.

For diversity the wanted signal generated by SMx baseband A is split up in two paths. AWGN is added.

The SMU needs an external trigger at input TRIGGER1, the SMW at USER3.

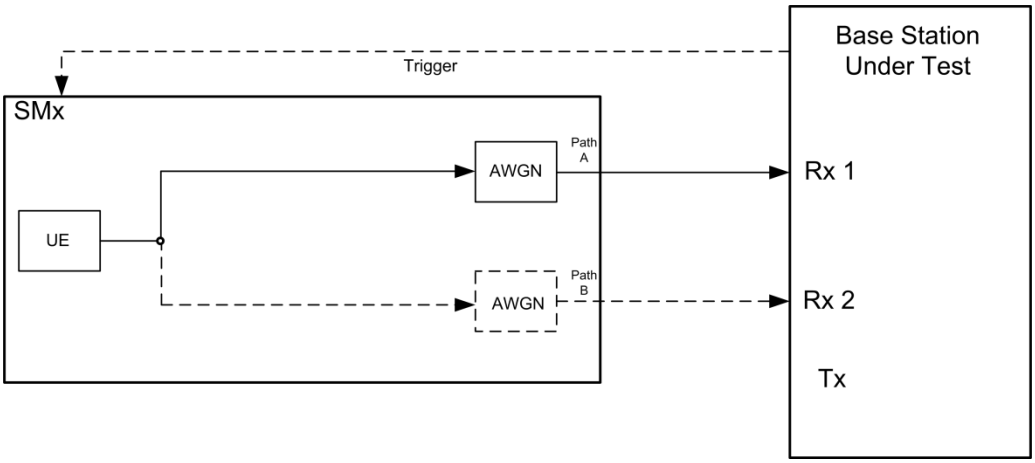
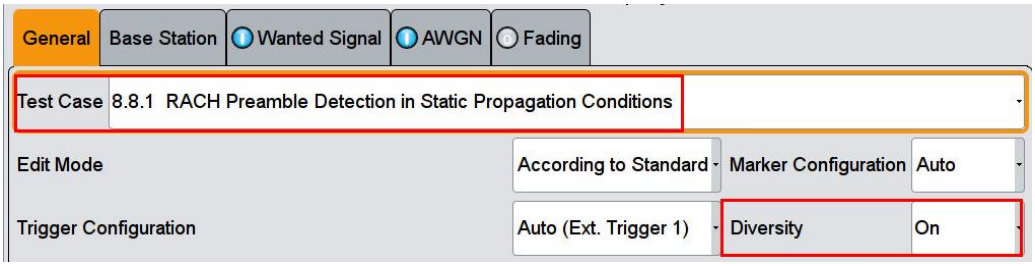


Fig. 3-35: Test setup for RACH test 8.8.1

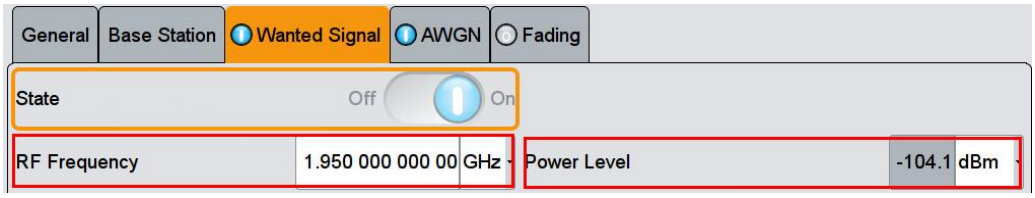
Test Procedure

As an example the settings for diversity, wide area BS and a Pd of 0.999 are shown.

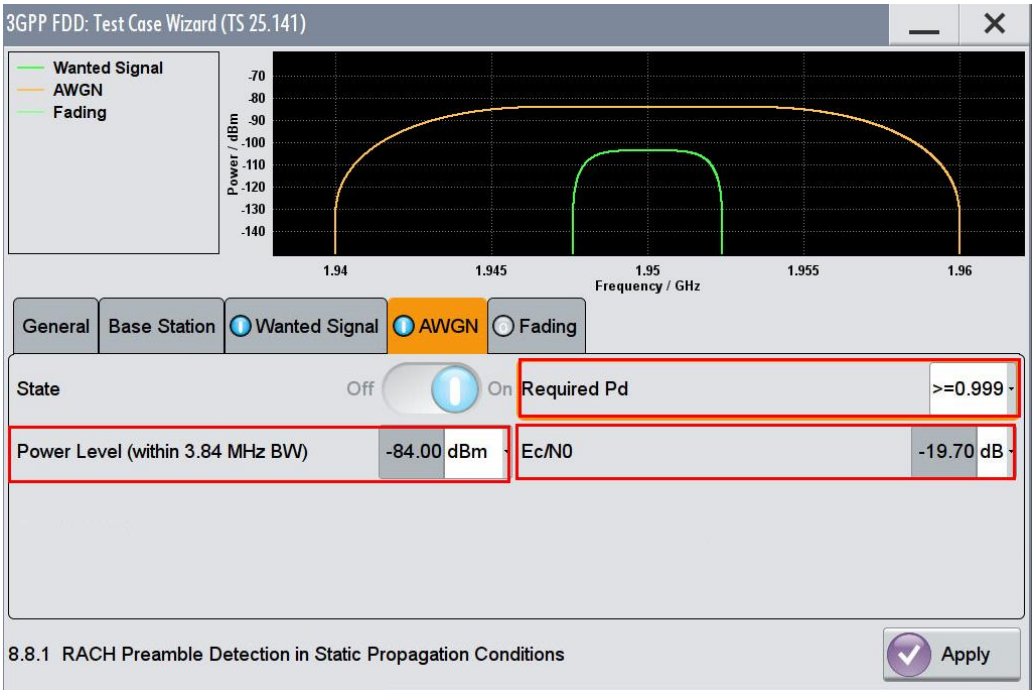
1. For the basic steps see section 3.1.1.
2. Select **8.8.1 RACH Preamble Detection in Static Propagation Conditions** and switch **Diversity ON.** (both in tab **General**)



3. Set the **RF Frequency**. In addition the resulting **Power Level** is displayed. (example: 1.95 GHz)



4. Set the **required Pd** (example **0.999**). In addition the **AWGN level** (depends on the Base station power class) and the **Ec/N0** is displayed



5. Measure the probabilities at the base station.

Demo Program

Fig. 3-36 shows the parameters of the test. Select the wanted **Required Pd**. When selecting a particular test all settings are default according to the specification. The setting of the **Ec/N0** depends on the required Pd and diversity. The level depends also on the base station power class. For this test the fading is **Off.**

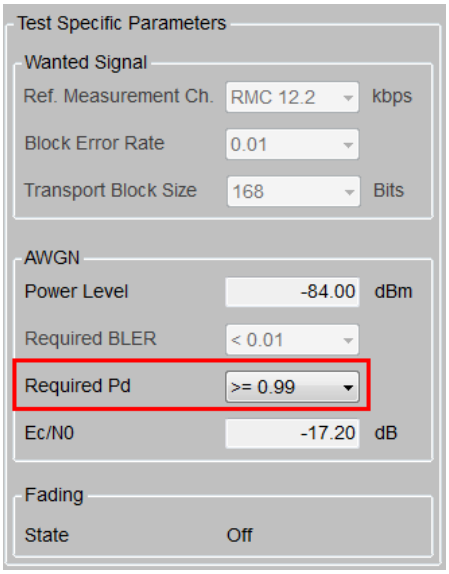


Fig. 3-36: Parameter for RACH test 8.8.1

Fig. 3-37 shows the report.

WCDMA Base Station Performance Test

Test Case: 8.8.1 RACH Preamble Detection in Static Propagation Conditions

Generator Settings:
Trigger Configuration: Armed Auto (Ext.)
Diversity: Off
Attenuation (Path A): 0.00 dB
Base Station Configuration:
Power Class: Wide Area
Scrambling Mode: Long Scrambling
Scrambling Code: 000000 HEX

Settings Item and Configuration			Value	Unit	Status
Wanted Signal					
RF Frequency	---	---	1950.00	MHz	
Power Level	---	---	-101.20	dBm	
AWGN					
Power Level *within 3.84 MHz BW*	---	---	-84.00	dBm	
Required Pd	---	---	>= 0.99	-/-	
Ec/N0	---	---	-17.20	dB	
Fading					
State	---	---	Off	-/-	

Settings in compliance with TS 25.141!

Fig. 3-37: Report 8.8.1

3.4.2 RACH preamble detection in multipath fading case 3 (Clause 8.8.2)

The test shall verify the receiver's ability to detect RACH preambles under multipath fading case 3 propagation conditions [1].

The performance requirement is determined by the two parameters probability of false detection of the preamble (Pfa) and the probability of detection of preamble (Pd). Only one signature is used and it is known by the receiver [1].

The requirement shall not be applied to Home BS.

The preamble is repeated.

Requirements for RACH in AWGN channel			
Pfa ≤	**Pd ≥**	**E_b/N_0 With Rx Diversity (dB)**	**E_b/N_0 Without Rx Diversity (dB)**
0.001	0.99	- 14.9	- 8.8
	0.999	- 12.8	- 5.8

Table 3-16: Requirements for 8.8.2

Test Setup

Fig. 3-38shows the test setup.

For diversity the wanted signal generated by SMx baseband A is split up in two paths. The channel is simulated and AWGN is added.

The SMU needs an external trigger at input TRIGGER1, the SMW at USER3.

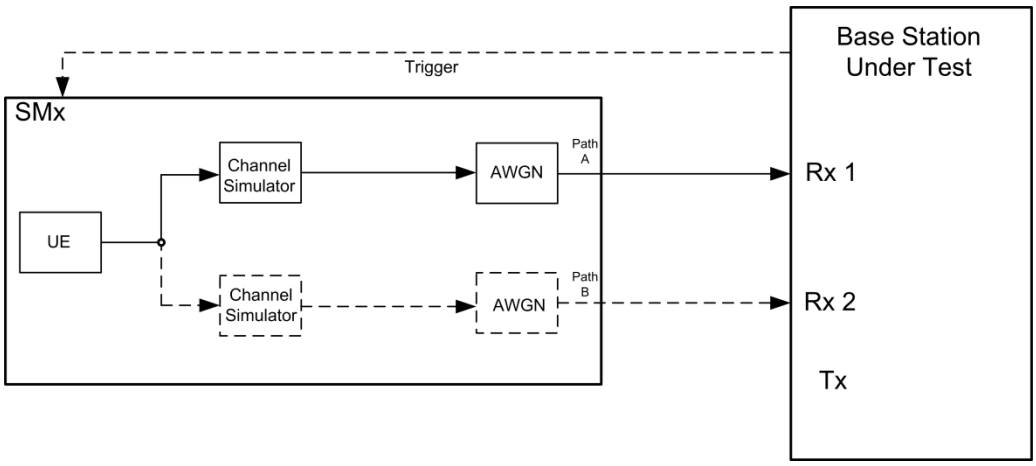


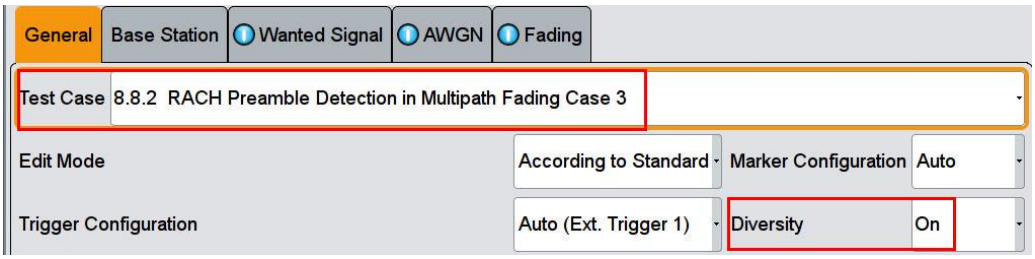
Fig. 3-38: Test setup for DCH test 8.8.2

Test Procedure

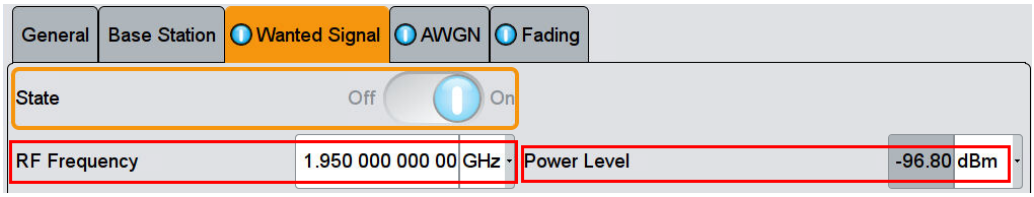
As an example the settings for diversity, wide area BS and a Pd of 0.999 are shown.

1. For the basic steps see section 3.1.1.

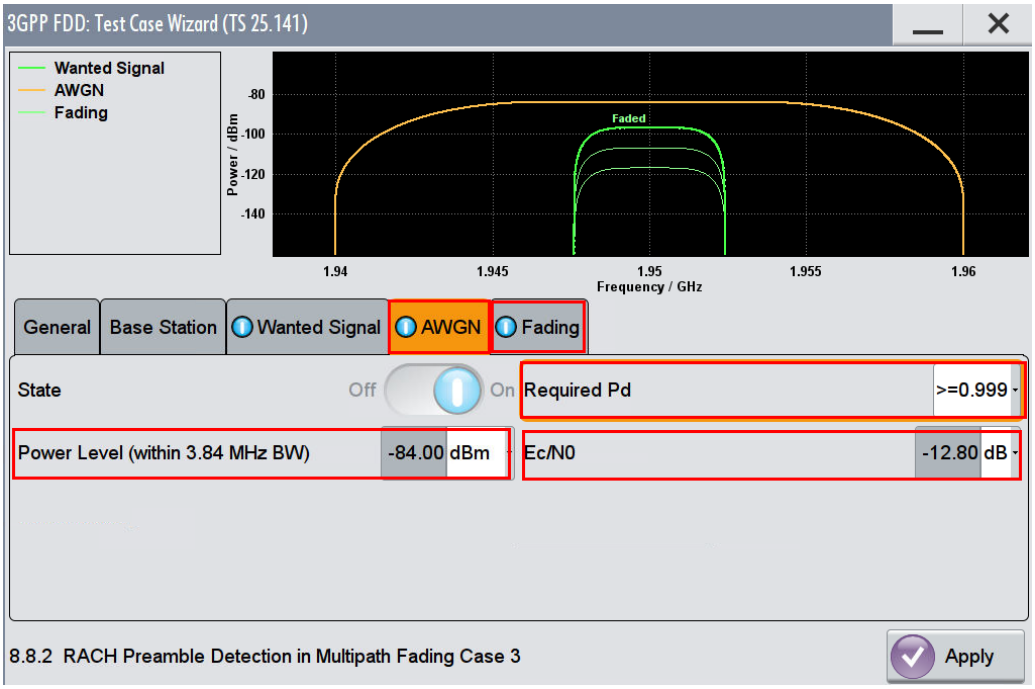
2. Select **8.8.2 RACH Preamble Detection in Multipath Fading Case 3 Conditions** and switch **Diversity ON.** (both in tab **General**)



3. Set the **RF Frequency**. In addition the resulting **Power Level** is displayed. (example: 1.95 GHz)



4. Set the **required Pd** (example **0.999**). In addition the **AWGN level** (depends on the Base station power class) and the **Ec/N0** is displayed. Note that **Fading** is switched On.



5. Measure the probabilities at the base station.

Demo Program

Fig. 3-39 shows the parameters of the test. Select the wanted **Required Pd**. When selecting a particular test all settings are default according to the specification. The

setting of the **Ec/N0** depends on the required Pd and diversity. The level depends also on the base station power class. For this test the fading is **ON,** the setting is multipath case 3.

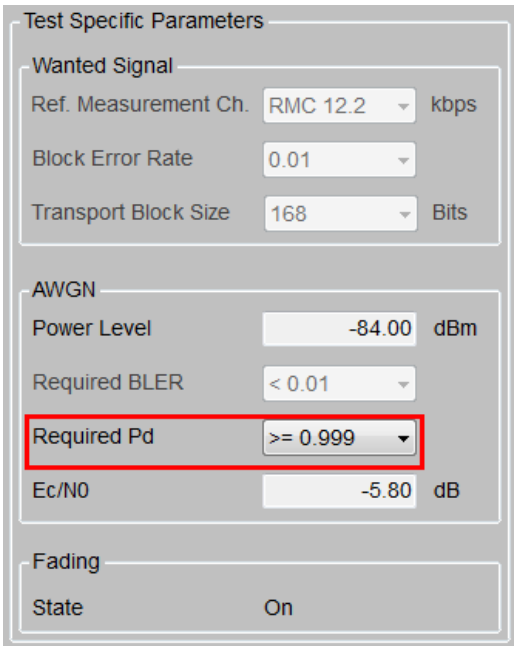


Fig. 3-39: Parameter for RACH test 8.8.2

Fig. 3-40 shows the report.

WCDMA Base Station Performance Test

Test Case: 8.8.2 RACH Preamble Detection in Multipath Fading Case 3

Generator Settings:
Trigger Configuration: Armed Auto (Ext.)
Diversity: Off
Attenuation (Path A): 0.00 dB
Base Station Configuration:
Power Class: Wide Area
Scrambling Mode: Long Scrambling
Scrambling Code: 000000 HEX

Settings Item and Configuration			Value	Unit	Status
Wanted Signal					
RF Frequency	---	---	1950.00	MHz	
Power Level	---	---	-89.80	dBm	
AWGN					
Power Level *within 3.84 MHz BW*	---	---	-84.00	dBm	
Required Pd	---	---	>= 0.999	-/-	
Ec/N0	---	---	-5.80	dB	
Fading					
State	---	---	On	-/-	

Settings in compliance with TS 25.141!

Fig. 3-40: Report 8.8.2

3.4.3 Demodulation of RACH message in static propagation conditions (Clause 8.8.3)

The test shall verify the receiver's ability to receive the message part of the RAC under static propagation conditions [1].

In this test the BLER of the RACH message is determined in multipath fading conditions and additional AWGN at certain E_b/N_0.

The receiver tries to detect the preamble and the message. The block error rate is calculated for the messages that have been decoded. Messages following undetected preambles shall not be taken into account in the BLER measurement [1].

The RACH pattern is repeated.

Requirements for RACH in AWGN channel, TTI = 20 ms				
	TB size 168 bits		TB size 360 bits	
BLER	E_b/N_0 With Rx Diversity (dB)	E_b/N_0 Without Rx Diversity (dB)	E_b/N_0 With Rx Diversity (dB)	E_b/N_0 Without Rx Diversity (dB)
0.1	4.5	7.6	4.3	7.3
0.01	5.4	8.5	5.2	8.2

Table 3-17: Requirements for 8.8.3

The resulting RF level is calculated:

$$Level = AWGN + 10 \times log_{10} \frac{TB}{TTI \times 3.84 \times 10^6} + \frac{E_b}{N_0}$$

Test Setup

Fig. 3-41 shows the test setup.

For diversity the wanted signal generated by SMx baseband A is split up in two paths. AWGN is added.

The SMU needs an external trigger at input TRIGGER1, the SMW at USER3.

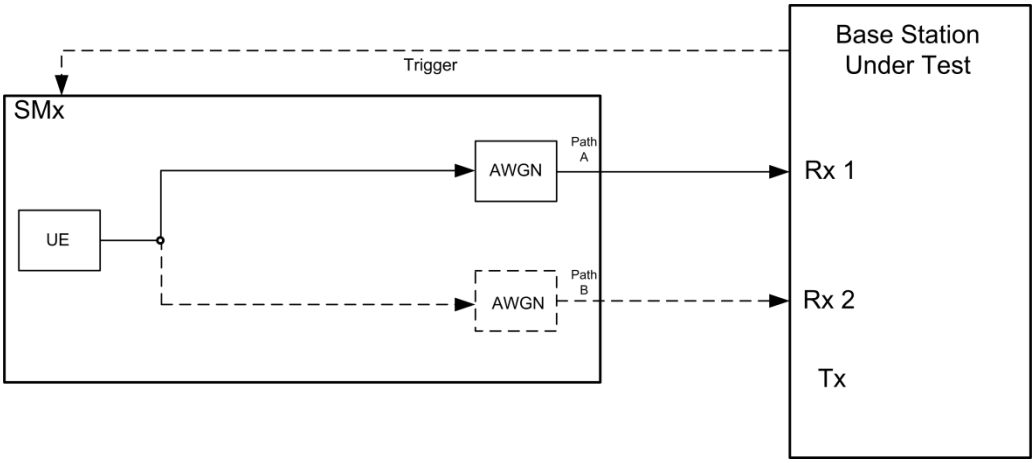
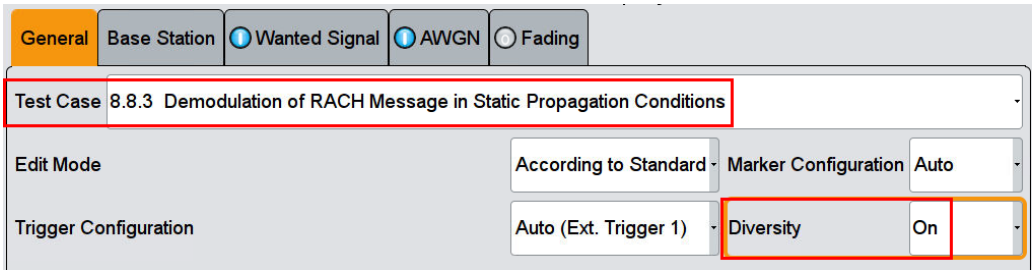


Fig. 3-41: Test setup for RACH test 8.8.3

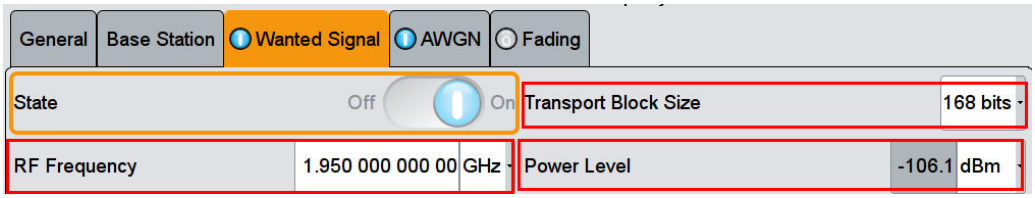
Test Procedure

As an example the settings for diversity, wide area BS, TB of 183 bits and a BLER of 0.01 are shown.

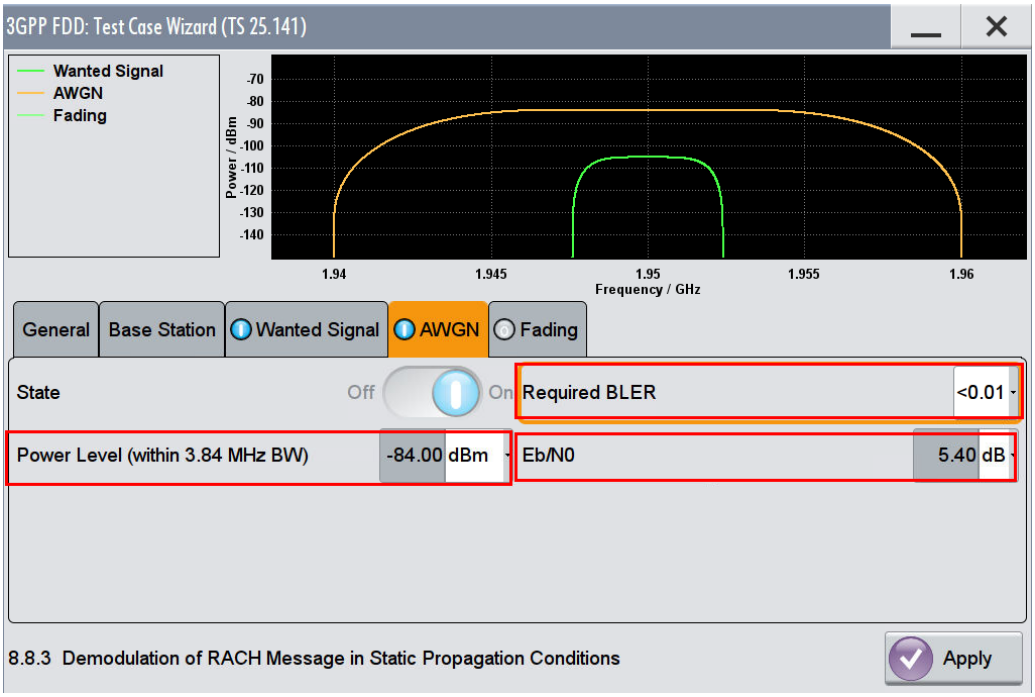
1. For the basic steps see section 3.1.1.
2. Select **8.8.3 Demodulation of RACH Message in Static Propagation Conditions** and switch **Diversity ON.** (both in tab **General**)



3. Select the **Transport Block Size**, the **RF Frequency**. In addition the resulting **Power Level** is displayed. (example: 168 bits, 1.95 GHz)



4. Set the required **BLER** (example **0.01**). In addition the **AWGN level** (depends on the Base station power class) and the **Eb/No** is displayed.



5. Measure the BLER at the base station.

Demo Program

Fig. 3-42 shows the parameters of the test. Select the wanted **Transport Block Size** and the **Required BLER**. When selecting a particular test all settings are default according to the specification. The setting of the **Eb/N0** depends on the Transport Block size, required BLER and diversity. The level depends also on the base station power class. For this test the fading is **Off.**

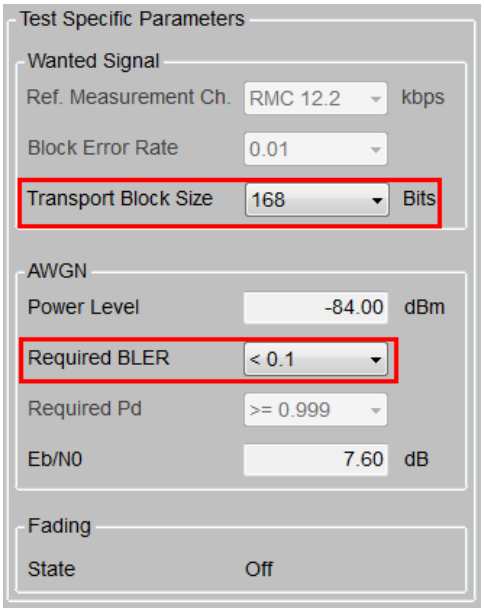


Fig. 3-42: Parameter for RACH test 8.8.3

Fig. 3-43 shows the report.

WCDMA Base Station Performance Test

Test Case: 8.8.3 Demodulation of RACH Message in Static Propagation Conditions

Generator Settings:
Trigger Configuration: Armed Auto (Ext.)
Diversity: Off
Attenuation (Path A): 0.00 dB
Base Station Configuration:
Power Class: Wide Area
Scrambling Mode: Long Scrambling
Scrambling Code: 000000 HEX

Settings and Configuration			Value	Unit	Status
Wanted Signal					
RF Frequency	---	---	1950.00	MHz	
Power Level	---	---	-103.00	dBm	
Transport Block Size	---	---	168	Bits	
AWGN					
Power Level *within 3.84 MHz BW*	---	---	-84.00	dBm	
Required BLER	---	---	< 0.1	-/-	
Eb/N0	---	---	7.60	dB	
Fading					
State	---	---	Off	-/-	

Settings in compliance with TS 25.141!

Fig. 3-43: Report 8.8.3

3.4.4 Demodulation of RACH message in multipath fading case 3 (Clause 8.8.4)

The test shall verify the receiver's ability to receive the test signal under multipath fading case 3 propagation conditions with a BLER not exceeding a specified limit [1].

In this test the BLER of the RACH message is determined in multipath fading conditions and additional AWGN at certain $E_b/N_{0.}$

The receiver tries to detect the preamble and the message. The block error rate is calculated for the messages that have been decoded. Messages following undetected preambles shall not be taken into account in the BLER measurement [1].

Only one signature is used and it is known by the receiver [1].

The requirement shall not be applied to Home BS.

The preamble is repeated.

Requirements for RACH in fading case 3 channel, TTI = 20 ms				
	TB size 168 bits		TB size 360 bits	
BLER	E_b/N_0 With Rx Diversity (dB)	E_b/N_0 Without Rx Diversity (dB)	E_b/N_0 With Rx Diversity (dB)	E_b/N_0 Without Rx Diversity (dB)
0.1	8.0	11.7	7.9	11.6
0.01	9.1	13.0	8.9	12.7

Table 3-18: Requirements for 8.8.4

The resulting RF level is calculated:

$$Level = AWGN + 10 \times log_{10} \frac{TB}{TTI \times 3.84 \times 10^6} + \frac{E_b}{N_0}$$

Test Setup

Fig. 3-44 shows the test setup.

For diversity the wanted signal generated by SMx baseband A is split up in two paths. The channel is simulated and AWGN is added.

The SMU needs an external trigger at input TRIGGER1, the SMW at USER3.

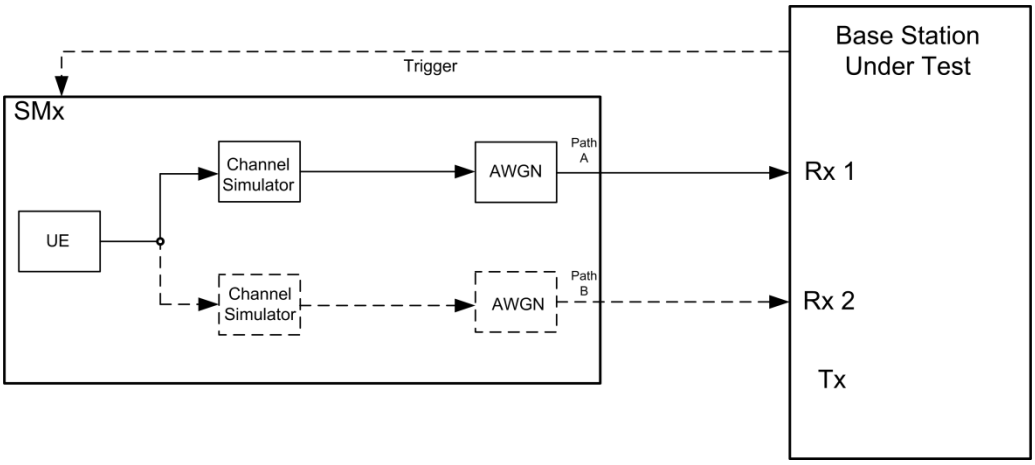


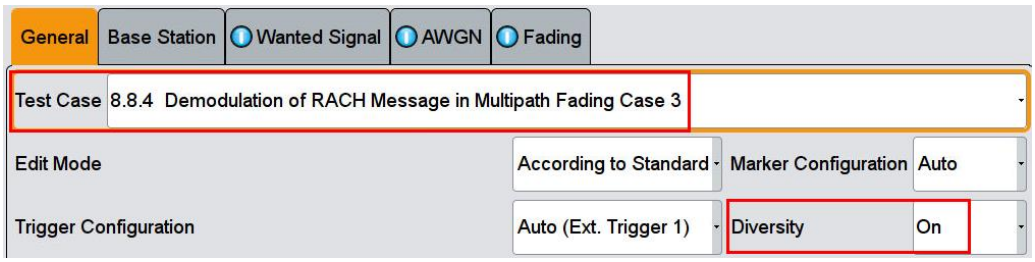
Fig. 3-44: Test setup for DCH test 8.8.4

Test Procedure

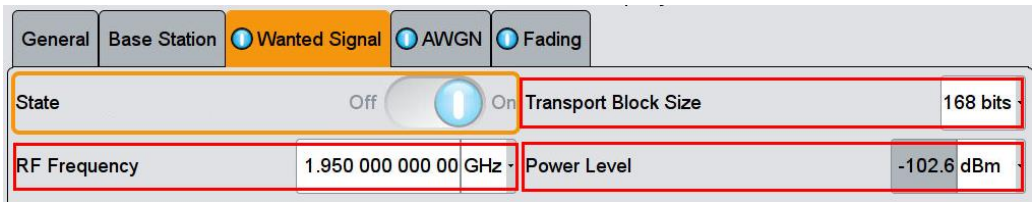
As an example the settings for diversity, wide area BS, a TB of 183 bits and a BLER of 0.01 are shown.

1. For the basic steps see section 3.1.1.

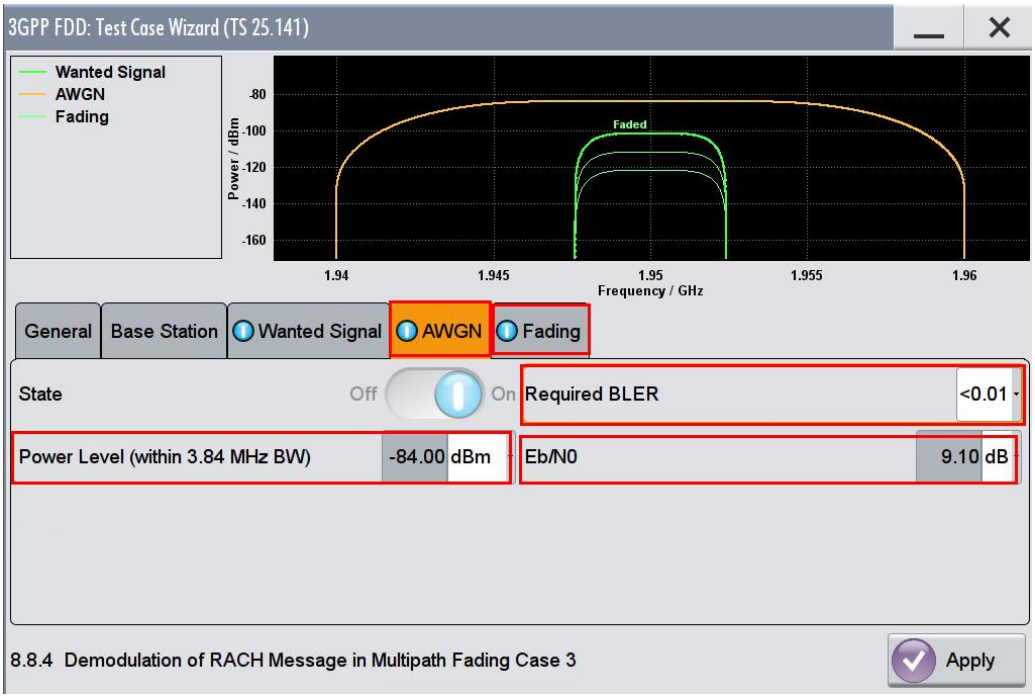
2. Select **8.8.4 Demodulation of RACH Message in Multipath Fading Case 3** and switch **Diversity ON.** (both in tab **General**)



3. Select the **Transport Block Size**, the **RF Frequency**. In addition the resulting **Power Level** is displayed. (example: 168 bits, 1.95 GHz)



4. Set the required **BLER** (example **0.01**). In addition the **AWGN level** (depends on the Base station power class) and the **Eb/No** is displayed. Note that **Fading** is switched On.



5. Measure the BLER at the base station.

Demo Program

Fig. 3-45 shows the parameters of the test. Select the wanted **Transport Block Size** and the **Required BLER**. When selecting a particular test all settings are default according to the specification. The setting of the **Eb/N0** depends on the Transport Block size, required BLER and diversity. The level depends also on the base station power class. For this test the fading is **ON,** the setting is multipath case 3.

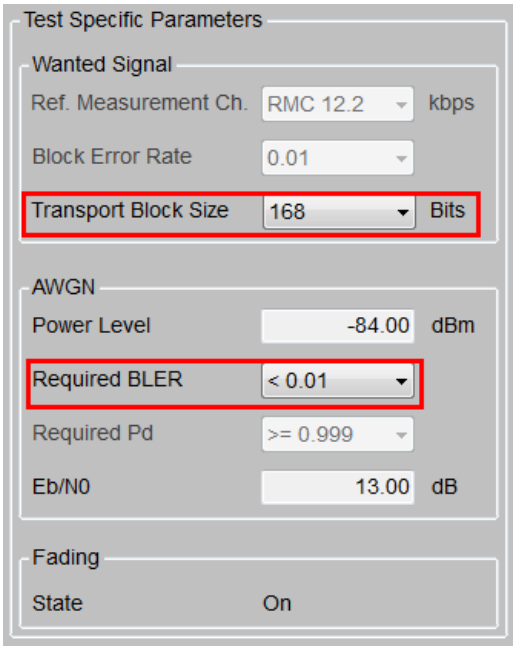


Fig. 3-45: Parameter for RACH test 8.8.4

Fig. 3-46 shows the report.

WCDMA Base Station Performance Test

Test Case: 8.8.4 Demodulation of RACH Message in Multipath Fading Case 3

Generator Settings:
Trigger Configuration: Armed Auto (Ext.)
Diversity: Off
Attenuation (Path A): 0.00 dB
Base Station Configuration:
Power Class: Wide Area
Scrambling Mode: Long Scrambling
Scrambling Code: 000000 HEX

Settings and Configuration			Value	Unit	Status
Wanted Signal					
RF Frequency	---	---	1950.00	MHz	
Power Level	---	---	-97.60	dBm	
Transport Block Size	---	---	168	Bits	
AWGN					
Power Level *within 3.84 MHz BW*	---	---	-84.00	dBm	
Required BLER	---	---	< 0.01	-/-	
Eb/N0	---	---	13.00	dB	
Fading					
State	---	---	On	-/-	

Settings in compliance with TS 25.141!

Fig. 3-46: Report 8.8.4

4 Appendix

4.1 R&S TSrun Program

The TSrun software application makes it possible to combine tests (modules) provided by Rohde & Schwarz into test plans to allow rapid and easy remote control of test instruments. This program is available free of charge from our website.

Requirements

Operating system:

- Microsoft Windows XP / Vista / Windows 7 / Windows 8
- NET framework V4.0 or higher

General PC requirements:

- Pentium 1 GHz or faster
- 1 Gbyte RAM
- 100 Mbyte space harddisk
- XGA monitor (1024x768)

Remote control interface:

- National Instruments VISA
- GPIB card

Or

- LAN connection. AfterTSrun is launched, the following splash screen appears:

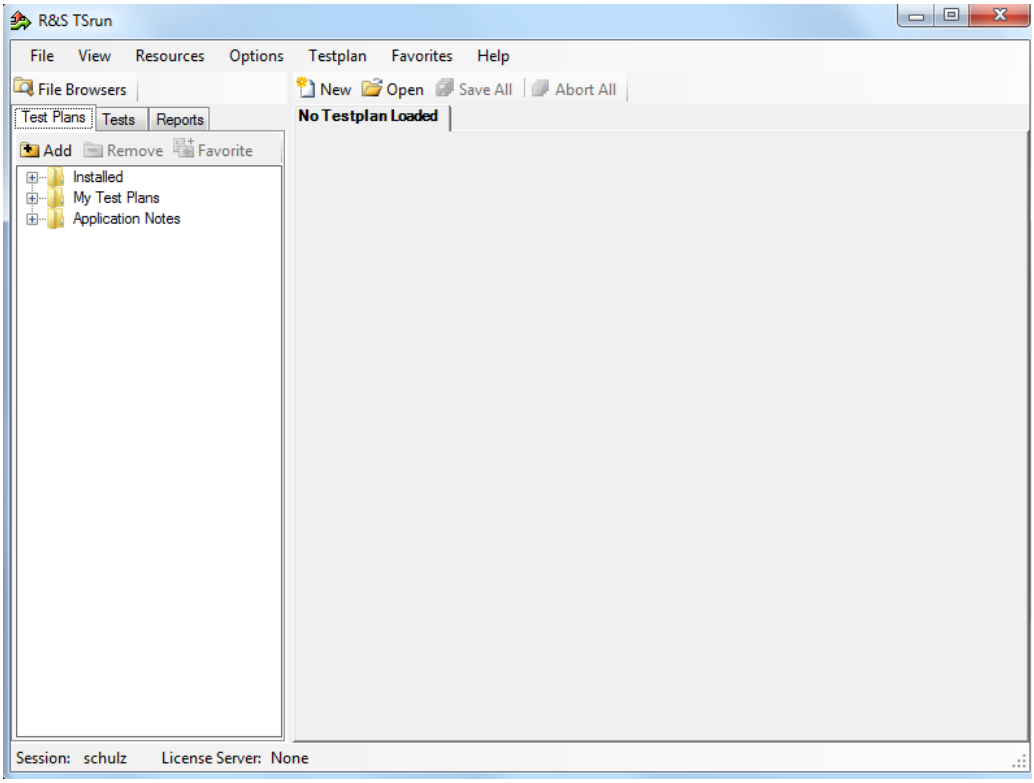


Fig. 4-1: Overview TSrun

Tests and test plans

Tests are separate, closed modules for TSrun. A test plan can consist of one or more tests.

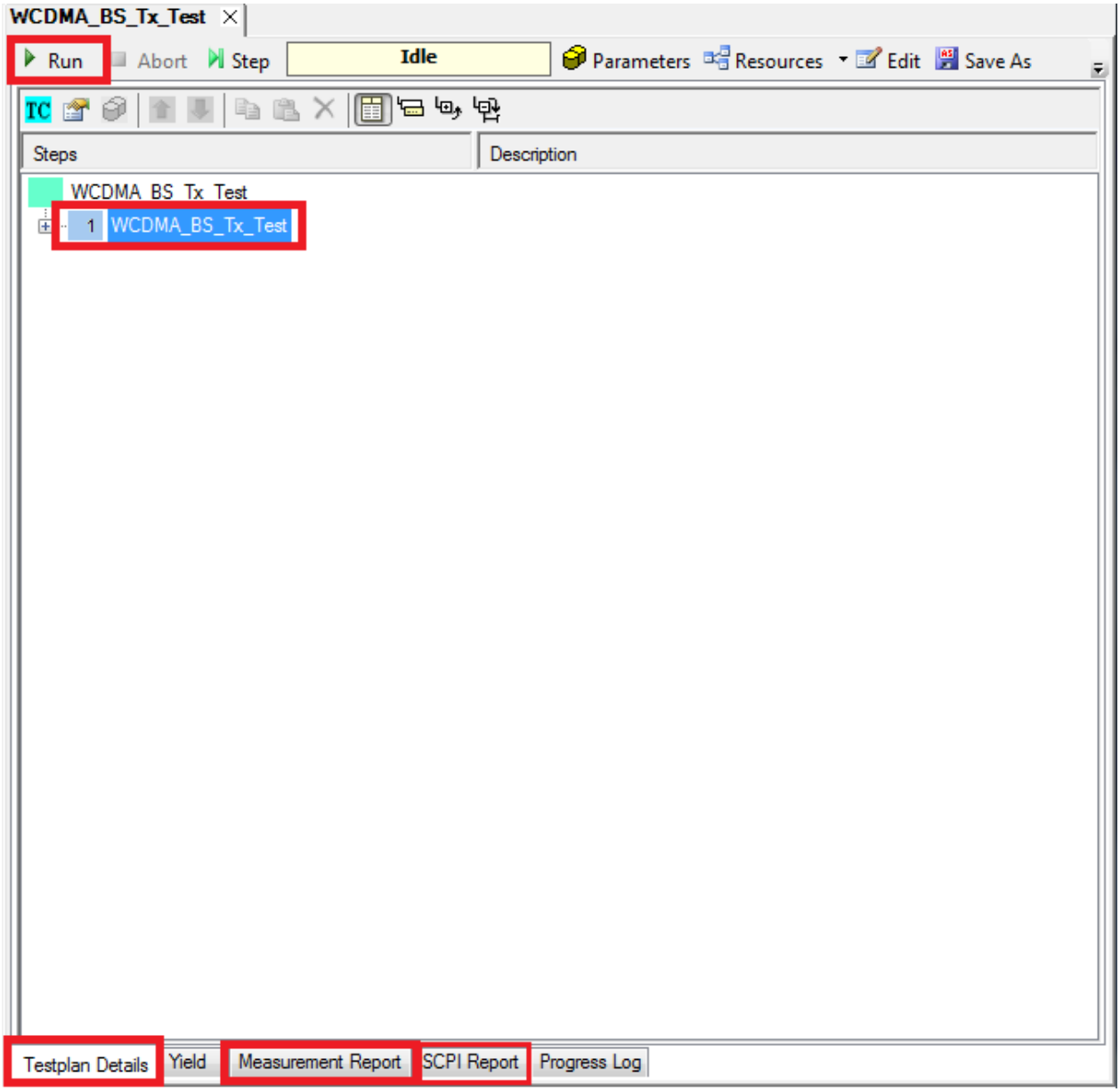


Fig. 4-2: Overview of a test plan in TSrun. The test plan in the example contains only one test (WCDMA BS Tx Test). After the test is completed, the bar along the bottom can be used to display the measurement and SCPI reports.

The WCDMA BS tests can be found under Tests/ApplicationNotes.

Click **RUN** to start the current test plan.

SCPI connections

Under **Resources|SCPI Connections**, you can add all required instruments for remote control.

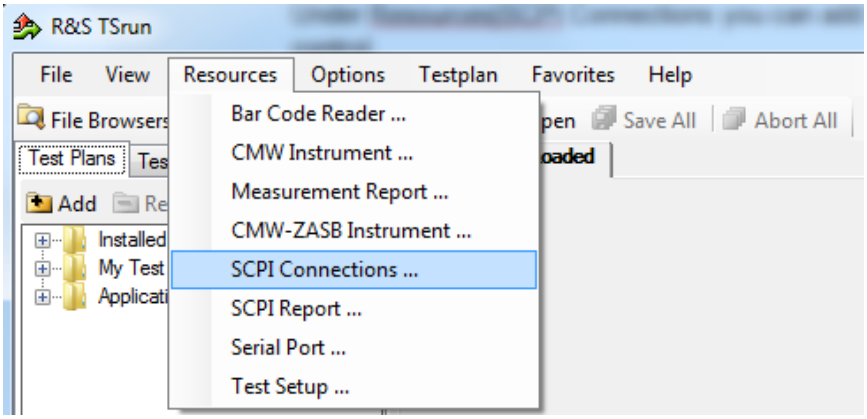


Fig. 4-3: Setting the SCPI connections.

Use **Configure…** to open a wizard for entering the VISA parameters (Fig. 4-4). Use the **Test Connection** button to test the connection to the instrument. When the **Demo Mode** button is enabled, no instruments need to be connected because TSrun runs in demo mode and output a fictitious test report.

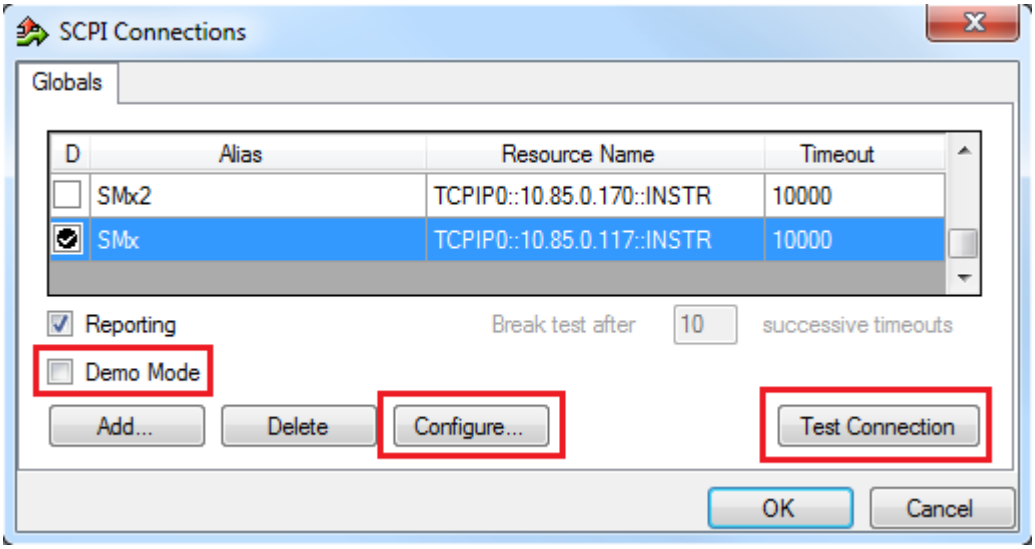


Fig. 4-4: SCPI connections.

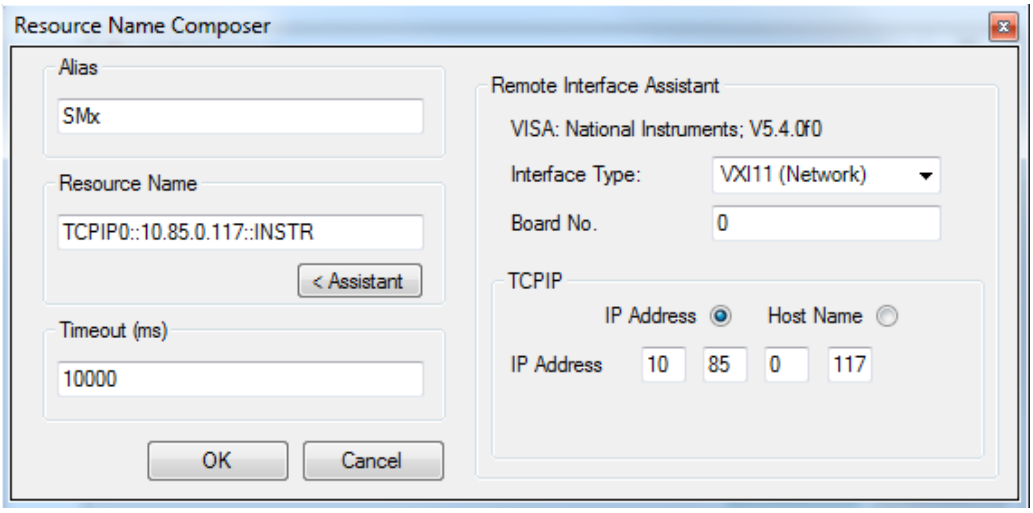


Fig. 4-5: Wizard for entering VISA parameters. Both the IP address and a host name can be entered directly.

Reports: Measurement and SCPI

After the test is completed, TSrun automatically generates both a **Measurement Report** and a **SCPI Report**.

The measurement report shows the actual results and the selected settings.

The SCPI report returns a LOG file of all transmitted SCPI commands. These can then be copied and easily used in separate applications.

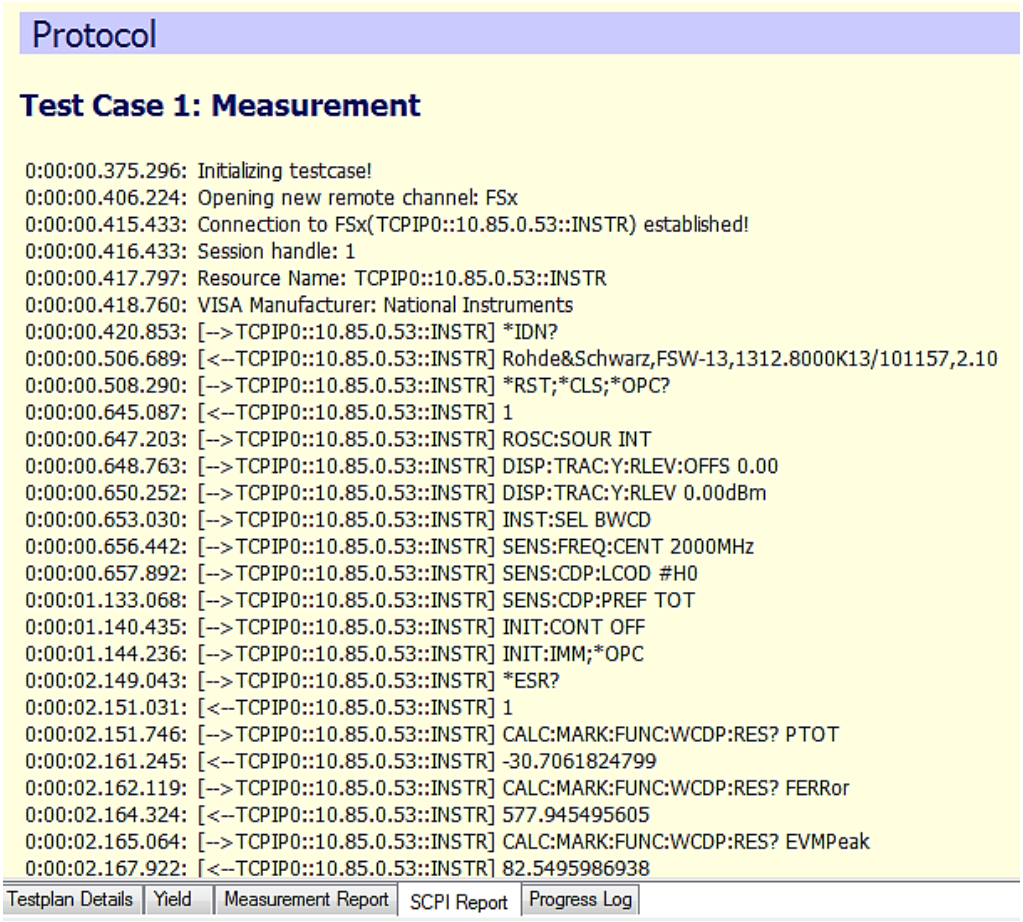


Fig. 4-6: SCPI report.

4.2 References

1] Technical Specification Group Radio Access Network**; Base station conformance testing (FDD)**, **Release 10; 3GPP TS 25.141,** V 10.11.0, September 2014

[2] Rohde & Schwarz: **W-CDMA Base Station Receiver Tests according to TS 25.141 Rel. 10,** Application Note 1MA114, October 2014

[2] Rohde & Schwarz: **W-CDMA Base Station Transmitter Tests according to TS 25.141 Rel. 10,** Application Note 1MA67, October 2014

4.3 Additional Information

Please send your comments and suggestions regarding this white paper to

TM-Applications@rohde-schwarz.com

4.4 Ordering Information

Ordering Information for Signal Generators		
Vector Signal Generator		
Product Description	**Type**	**Ordering No.**
Vector Signal Generator	**SMW200A**	**1412.0000.02**
Baseband Generator	SMW-B10	1413.1200.02
Baseband Generator	SMW-B11	1159.8411.02
Baseband Main Module	SMW-B13	1141.8003.04
Fading Simulator	SMW-B14	1413.1500.02
1st RF path	SMW-B10x	
2nd RF path	SMW-B20x	
AWGN	SMW-K62	1413.3484.02
Digital Standard **3GPP FDD**	SMW-K42	1413.3784.02

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.

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Environmental commitment

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

Certified Quality System
ISO 9001

PAD-T-M: 3573.7380.02/02.00/CI/1/EN/

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