



Rohde & Schwarz products: WCDMA BS Test Set R&S<sup>®</sup> FSMU-W, Signal Analyzer R&S<sup>®</sup> FSQ, Vector Signal Generator R&S<sup>®</sup> SMU200A and Microwave Signal Generator R&S<sup>®</sup> SMR

## Tests On 3GPP WCDMA FDD Node Bs in Accordance with Standard TS 25.141

### Application Note 1MA67

Application Note 1MA67 describes how to test 3GPP WCDMA FDD base stations using the Base Station Test Set<sup>®</sup> FSMU-W in accordance with the TS 25.141 standard. The R&S<sup>®</sup> FSMU-W is a powerful combination of the Signal Analyzer R&S<sup>®</sup> FSQ and the Vector Signal Generator R&S<sup>®</sup> SMU200A. Application Note 1MA67 is about transmitter, receiver, and performance tests including Error Vector Magnitude for High Speed Downlink Packet Access (HSDPA). For each test, this application note provides a hardware setup, step-by-step instructions on how to perform the test, and screenshots of measurement results.

Program 3G\_FSMU\_NodeB is included. Run 3G\_FSMU\_NodeB to perform measurements via remote control or to simulate the base station signals, or simply use it as a programming model for your own test scripts.



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The following abbreviations are used in this application note for Rohde & Schwarz test equipment:

- The WCDMA BS Test Set R&S®FSMU-W is referred to as the FSMU.
- The Vector Signal Generator R&S®SMU200A is referred to as the SMU.
- The Microwave Signal Generator R&S®SMR is referred to as the SMR.
- The Signal Analyzer R&S®FSQ is referred to as the FSQ.

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# 1 Overview

Application Note 1MA67 describes how to test 3GPP WCDMA FDD base stations using the Base Station Test Set<sup>®</sup>FSMU in accordance with the TS 25.141 standard. The R&S<sup>®</sup>FSMU is a powerful combination of the Signal Analyzer R&S<sup>®</sup>FSQ and the Vector Signal Generator R&S<sup>®</sup>SMU200A. Rohde & Schwarz presents these instruments together with comprehensive documentation and software examples for WCDMA base station test [2].

Application Note 1MA67 is about transceiver, receiver, and performance tests including Error Vector Magnitude for High Speed Downlink Packet Access (HSDPA). For each test, this application note provides a hardware setup, step-by-step instructions on how to perform the test, and screenshots of measurement results.

Program **3G\_FSMU\_NodeB** is included. Run **3G\_FSMU\_NodeB** to perform measurements via remote control or to simulate the base station signals, or simply use it as a programming model for your own test scripts.

Application Note 1MA67 supersedes Application Note 1MA37 [3], *Tests on 3G-Base Stations to TS 25.141*, which was issued two years ago.

In the meantime, Rohde & Schwarz has developed the SMU, which offers a very high dynamic range and fastest real-time WCDMA signal generation. The *SMU Test Case Wizard* - a completely new user friendly interface oriented towards the standard - simplifies manual and remote operation for 3GPP WCDMA BS measurements, see section 4.

On the analyzer side the FSQ offers a lot of new features as well such as List Mode for spurious emissions, Combined Measurements for faster transmitter testing, and High Speed Downlink Packet Access (HSDPA) processing.

Program **3G\_FSMU\_NodeB** fully uses these new features. And additional tests that are not part of TS 25.141 will be implemented, e.g. multicarrier measurements.

Application Note 1MA67 emphasizes practical aspects, i.e. how to perform the base station tests, which hardware setup is required, and step-by-step procedures. This information is provided in sections 6, 7, and 8.

Chapter 2 provides a short overview of the base station transmitter and receiver tests. Chapter 3 shows the principles for operating program **3G\_FSMU\_NodeB**. Chapter 4 introduces the SMU Test Case Wizard. Tips on how to measure path loss in Chapter 5 conclude these introductory sections.

If you are already familiar with base station testing, you can skip these sections.

Application Note 1MA67 refers to ETSI TS 25.141 Release 5. All tests are specific to frequencies of operating band I.

The SMU firmware must be version 1.35.09 or later, and the FSQ firmware at least 3.65 SP2.

## 2 The 3G Base Station Tests

There are three types of 3G base station tests in TS 25.141:

- Transmitter tests
- Receiver tests
- Performance tests

See Fig. 2\_1 for the principal test setup:

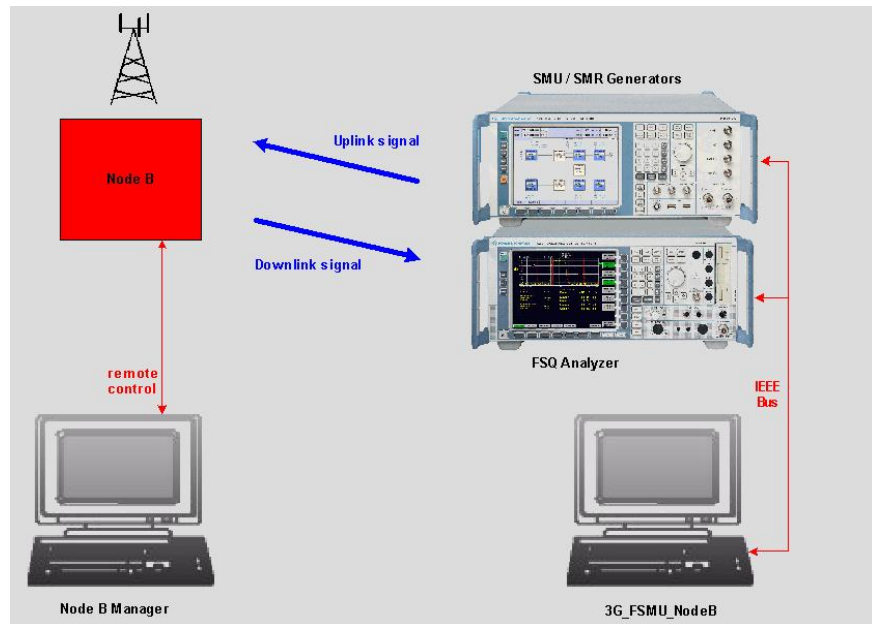


Fig. 2\_1: Principal test setup for 3G base station tests. For transmitter tests, the FSQ records the downlink signal of the base station. For receiver and performance tests, the SMU – and sometimes additional generators – provides one or more uplink and interfering signals.

Unlike mobile tests, the 3G base station tests of TS 25.141 are performed without any signaling. The base station is set to the appropriate test mode to transmit, to receive, and to evaluate bit and block error rates. Because there are no specifications on how to achieve this, the various base station manufacturers provide their own customized setup tools. Assume that the laptop on the left-hand side in Fig. 2\_1 is responsible for managing the base station under test.

Program **3G\_FSMU\_NodeB** running on the right-hand laptop in Fig. 2\_1 can control only the Rohde & Schwarz instruments. It configures the devices, runs the measurement sequence, and checks the test results against the limits of the standard.

Run the base station tests semiautomatically as follows:

1. Set up base station (left-hand laptop).
2. Run test using program **3G\_FSMU\_NodeB** (right-hand laptop).

3. Check results (left- or right-hand laptop, depending on test).
4. Repeat steps 1 to 3 with modified parameters if necessary.

**Note:** **3G\_FSMU\_NodeB** is distributed including the source code. Copy the remote control commands to your base station manager program, which makes it easy to integrate the analyzer and generators into your test systems.

For reference, the SMU simulates the downlink signals of a base station under test. The FSQ monitors the uplink signals in the time, frequency and code domains.

Fig. 2\_1 shows only the principal hardware setup. For most of the tests, you need additional components such as attenuators, couplers, filters, etc. A detailed hardware setup for each test is provided in sections 6, 7, and 8.

To keep the figures with the test setups simple, the remote control connections have been omitted on the following pages.

**Transmitter tests**

Transmitter tests are measurements on the base station downlink signal. The base station transmitter is active. For the downlink, TS 25.141 specifies five different types of test signals to make sure that measurement results from different base stations can be compared. These types of signals are called *test models (TM)*.

Table 2\_1 provides transmitter tests stipulated by TS 25.141.

No.	Test	Measurement	TM
<b>6.2</b>	<b>Base Station Output Power</b>		
6.2.1	BS Maximum Output Power	mean power of carrier	1
6.2.2	CPICH Power Accuracy	code domain power	2
<b>6.3</b>	<b>Frequency Error</b>	<b>TX frequency</b>	<b>1,4</b>
<b>6.4</b>	<b>Output Power Dynamics</b>		
6.4.1	Inner Loop Power Control	code domain power	2
6.4.2	Power Control Steps	code domain power	2
6.4.3	Power Control Dynamic	code domain power	2
6.4.4	Total Power Dynamic Range	power of one carrier	4
<b>6.5</b>	<b>Output Spectrum Emissions</b>		
6.5.1	Occupied Bandwidth	spectrum	1
6.5.2.1	Spectrum Emission Mask	spectrum	1
6.5.2.2	Adj. Channel Leakage Ratio	spectrum	1
6.5.3.4.1	Spurious Emissions Categ. A	spectrum	-
6.5.3.4.2	Spurious Emissions Categ. B	spectrum	-
6.5.3.4.3	Protection of the BS Receiver	spectrum	-
6.5.3.4.4	Coexist. with GSM900	spectrum	-
6.5.3.4.5	Coexist. with DCS1800	spectrum	-
6.5.3.4.6	Coexist. with PHS	spectrum	-
6.5.3.4.7	Coexist. with Adj. Services	spectrum	-
6.5.3.4.8	Coexist. with UTRA-TDD	spectrum	-
6.5.3.4.9	Coexist. with UTRA Band I	spectrum	-
6.5.3.4.10	Coexist. with UTRA Band III	spectrum	-
6.5.3.4.11	Coexist. with PCS1900	spectrum	-
6.5.3.4.12	Coexist. with GSM850	spectrum	-
<b>6.7</b>	<b>Transmit Modulation</b>		
6.7.1	Error Vector Magnitude	EVM, power, freq.	1,4,5
6.7.2	Peak Code Domain Error	error versus code	3

Table 2\_1: Summary of transmitter tests. The left-hand column lists the section number of the test in TS 25.141. It is followed by the name of the test and the physical parameter that is checked. The right-most column specifies which test model has to be used.

The FSQ covers all the tests. Measure the TX total power in the time domain. Measure the occupied bandwidth, ACLR, and spurious emissions

in the frequency domain with predefined limit lines. Measure the channel power, error vector magnitude and peak code domain error in the code domain using 3G personality FS-K72, and FS-K74 for HSDPA signals.

For tests 6.4.2 and 6.4.3, the SMU simulates the uplink signal of user equipment with transmission power control active. The FSQ measures the base station response as power steps of one code channel versus time.

**Receiver tests**

Receiver tests are Bit Error (BER) measurements of a wanted signal with and without additional interferers. The bit error rate is evaluated inside, or with additional equipment connected to the base station. The result is output on the left-hand laptop in Fig. 2\_1.

For the wanted signal, TS 25.141 defines the *Uplink Reference Measurement Channels* (UL RMC).

Table 2\_2 summarizes the receiver tests stipulated by TS 25.141.

No.	Test	Signal	UL RMC
7.2	Reference Sensitivity Level	wanted signal only	12.2
7.3	Dynamic Range	+ AWGN	12.2
7.4	Adjacent Channel Selectivity	+ WCDMA in adj. ch.	12.2
7.5	Blocking Characteristics	+ WCDMA / CW	12.2
7.6	Intermodulation Characteristics	+ WCDMA + CW	12.2
7.7	Spurious Emissions	-	-
7.8	Verification of BER Calculation	wanted signal only	12.2

Table 2\_2: Summary of the receiver tests. As in table 2\_1, the left-hand column lists the section number of this test in TS 25.141. It is followed by the name of the test and a short description of the signal constellation applied. The right-most column shows that all receiver tests use the same uplink reference measurement channel configuration with a data rate of 12.2 kbps.

Generate the wanted and the AWGN signals with the SMU. Generate further WCDMA and CW interferers with a second SMU or with the second channel of a two-channel SMU, or – for the blocking tests – with an SMR.

Check the RX spurious emissions (test 7.7) using the FSQ.



**Performance tests**

For performance tests, RF signals are applied simultaneously to both RX ports of a base station.

All tests (except the subset of preamble detection tests) are block error (BLER) measurements of a wanted signal. The interferer signal consists of Additive White Gaussian Noise (AWGN).

Table 2\_3 summarizes the performance tests stipulated by TS 25.141.

No.	Test	Signals	Variable
8.2	Demod. in Static Propagation Cond.	2 signals + AWGN	data rate
8.3	Demod. in Multipath Fading Cond.		
8.3.1	Multipath Fading Case 1	2 fading signals + AWGN	data rate
8.3.2	Multipath Fading Case 2	2 fading signals + AWGN	data rate
8.3.3	Multipath Fading Case 3	2 fading signals + AWGN	data rate
8.3.4	Multipath Fading Case 4	2 fading signals + AWGN	data rate
8.4	Demod. in Moving Propag. Cond.	2 del. signals + AWGN	data rate
8.5	Demod. in Birth / Death Propag. Cond.	2 alt. signals + AWGN	data rate
8.6	Verification of Int. BLER Calculation	1 signal with errors	data rate
8.8	<b>RACH Performance</b>		
8.8.1	Preamble Detection in Static Prop. Cond.	2 signals + AWGN	$E_c / N_0$
8.8.2	Preamble Detection in Fading Case 3	2 signals + AWGN	$E_c / N_0$
8.8.3	Message Demod. in Static Prop. Cond.	2 signals + AWGN	$E_c / N_0$
8.8.4	Message Demod. in Fading Case 3	2 signals + AWGN	$E_c / N_0$
8.9	<b>CPCH Performance</b>		
8.9.1	Preamble Detection in Static Prop. Cond.	2 signals + AWGN	$E_c / N_0$
8.9.2	Preamble Detection in Fading Case 3	2 signals + AWGN	$E_c / N_0$
8.9.3	Message Demod. in Static Prop. Cond.	2 signals + AWGN	$E_c / N_0$
8.9.4	Message Demod. in Fading Case 3	2 signals + AWGN	$E_c / N_0$

Table 2\_3: Summary of the performance tests. As in the previous tables, the left-hand column lists the section number of this test in TS 25.141. It is followed by the name of the test and a short description of the signal combination applied.

Performance tests are not only repeated using different frequencies but also with other parameters changed, such as different data rates or different  $E_c / N_0$ ; see right-most column of Table 2\_3.

A two-channel SMU is required in order to generate both test signals.

Like with the receiver tests, the BLER is evaluated internally or with additional equipment connected to the base station. The result is output on the left-hand laptop in Fig. 2\_1.

### 3 Program 3G\_FSMU\_NodeB

Install program **3G\_FSMU\_NodeB** on your PC. The instructions are provided in the *Installation Guide for Program 3G\_FSMU\_NodeB* in the annex.

Run **3G\_FSMU\_NodeB**.

The first time you start **3G\_FSMU\_NodeB**, a user interface similar to Fig. 3\_1 will appear.

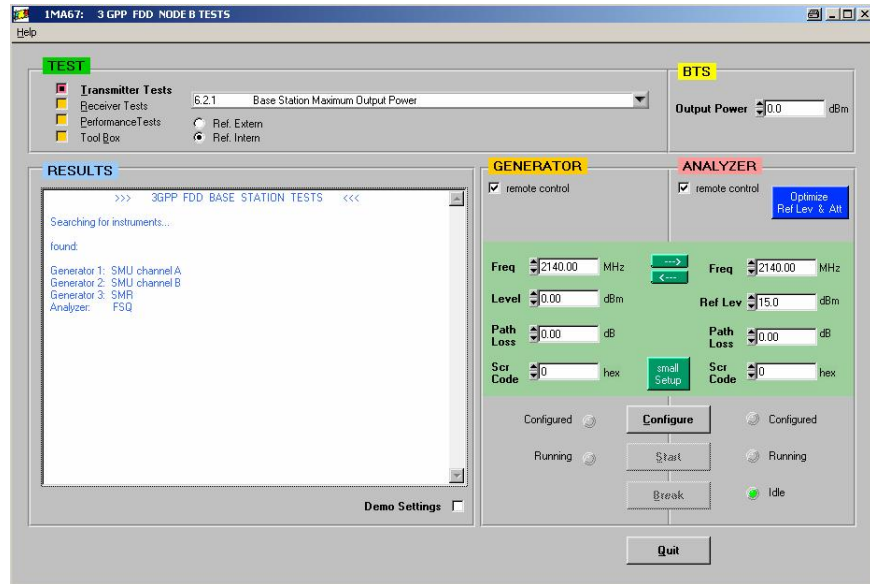


Fig. 3\_1: User interface of program **3G\_FSMU\_NodeB**. Proceed clockwise: Select your test from a list of standard tests. Enter your test parameters, e.g. frequency, level, and so on. You can control the test by clicking *Configure*, *Start*, or *Break*. Check your test results displayed in the result window.

When you start **3G\_FSMU\_NodeB**, it scans the IEC/IEEE bus for connected instruments. A list of detected devices will be output in the result window; see Fig. 3\_1.

Up to three generators are needed in order to run all tests. Generators 1 and 2 could be one two-channel SMU, or two one-channel SMUs. In this case, the generator with the lower IEC/IEEE address is selected as generator 1. The SMR is mandatory as generator 3, and the FSQ as the analyzer.

If required instruments are not connected, you will be informed. Nevertheless, you can navigate through the program at any time to simulate a measurement.

If you forget to connect an instrument or if devices could not be found – for example, if two of them are set to the same IEC/IEEE address – do the following:

1. Quit the program.
2. Connect the instruments correctly.
3. Run **3G\_FSMU\_NodeB** again.

## Selecting your test

Select your test type, e.g. *Transmitter tests*, and double-click one test in the list, see Fig. 3\_2.

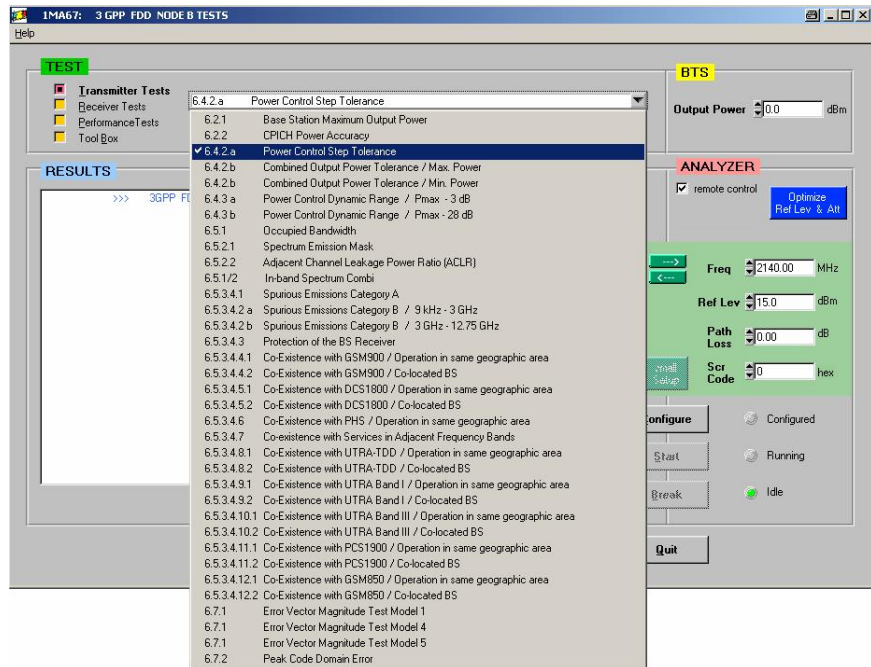


Fig. 3\_2: List of implemented transmitter tests. All tests use the FSQ to measure the base station downlink signal in the time, frequency, or code domain. A detailed description of each test is provided in sections 6, 7, and 8.

## Entering your test parameters

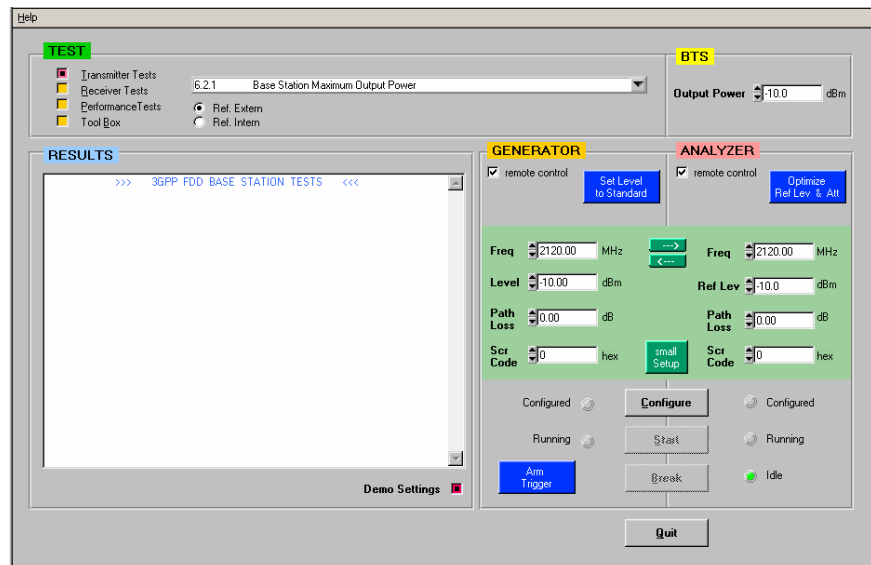


Figure 3\_3: Controls, and parameter entry fields of the program window.

- Ref. Extern / Intern:

For testing on the spot, set all instruments to the external reference provided by the base station. Set the reference to internal if you work without a base station under test.

- BS Output Power:

This parameter is used for transmitter tests only. Enter the rated max. output power of the base station under test.

- Frequency:

Enter the uplink or downlink frequency, respectively. You may copy the generator frequency to the analyzer field, and vice versa. If you receive a channel number instead of a frequency value, calculate the frequency as follows:

$$\text{frequency} = \text{channel number} / 5 \quad (\text{MHz})$$

- Path Loss:

Measure the path losses of your hardware setup and enter the attenuation as a positive value; see next section. This is very important in order to obtain reliable test results that can be compared with other measurements.

- Scrambling Code:

A base station uses different scrambling codes and a different counting system for uplink and downlink.

The uplink scrambling code is a natural number including zero. It can be any number within the absolute scrambling code space. This counting system is called the *secondary scrambling codes*.

For the downlink, the base station counts the scrambling codes with an increment of 10(hex) in the absolute code space. This counting system is called the *primary scrambling codes*.

Primary scrambling code 1 stands for secondary scrambling code 10(hex), primary code 2 for secondary code 20(hex), and so on.

Program **3G\_FSMU\_NodeB** always expects the absolute secondary scrambling code. Enter the value in hex format.

- Generator Level:

Enter the level required at the DUT connector. The path loss is automatically compensated by program **3G\_FSMU\_NodeB**. For receiver tests, click the blue button labeled *set level to standard* to set the levels in accordance with TS 25.141.

- Analyzer Ref. Level:

Enter Ref. Value manually, or click (for transmitter tests only) the blue button labeled *Optimize Ref. Lev. & Att., see below*.

- *Small Setup* Button

In general, transmitter tests do not need a generator (except test 6.4.2). However the program sets up the generator as well to provide the same downlink signal as expected from the base station. If you don't need this reference signal, click the green button labeled *small setup*, see Fig. 3\_3.

Then the input fields for the generator will disappear, and check box *remote control* is deactivated. The generator will no longer be addressed by the program.

*Small setup* is the normal setting for measurements on the base station. Test times are optimized.

Reactivate the generator by clicking the generator check box *remote control*.

Before running receiver or performance tests, you may first want to monitor your uplink signal with the analyzer. If not, switch to *small setup*. The input fields of the analyzer will now disappear. Reactivate the instrument by clicking the analyzer check box *remote control*.

### Blue Buttons:

- Optimize Ref. Lev. & Att.:

Appears for transmitter tests only. Calculates and sets the optimum values for the analyzer reference level and input attenuator. The optimum is derived from the entries of BS output power and analyzer path loss.

- Set Level to Standard:

Appears for receiver and performance tests only. Sets the generator levels in accordance with TS 25.141.

- Arm Trigger:

Appears for receiver and performance tests only. Resets the generator trigger to *armed auto*. This stops a running generator until the next trigger.

### Demo Settings:

If there is no base station available, simulate the downlink signal with SMU generator. For receiver and performance tests, monitor the uplink test signal with FSQ analyzer.

- Connect analyzer and generator RF ports directly together.
- Activate check box *Demo Settings*.
- Run your test.

*Demo Settings* will match the settings of the analyzer with the settings of the generator. Note that now the levels applied are no longer compliant to

the standard. Demo Settings guarantees that the signals have sufficient carrier to noise ratio without overdriving the analyzer.

The 10 MHz reference of the instruments is set to internal.

To make the Demo Settings mode plainly visible, the parameter input fields of program **3G\_FSMU\_NodeB** are dimmed. They cannot be accessed until the check box Demo Settings is deactivated. Deactivating *Demo Settings* does not change any parameters.

### Save / Restore of parameters:

If you quit the program, all current test parameters will be stored automatically on your hard disk and reloaded at the next program start.

## Running a test

Once the hardware has been set up and the measurement parameters have been entered, you can run a test.

1. Click *Configure*.

This will set up the Rohde & Schwarz instruments. Configuration always starts with a RESET of the connected devices in order to be independent of the test history. Wait until configuration has finished.

Transmitter tests: The analyzer is now ready to be started. If the generator is not deactivated, it is already outputting an adequate downlink signal.

Receiver tests: The generator is waiting for the trigger from the base station. If not deactivated, the analyzer is ready to be started.

2. **Set up the base station.**

3. Click *Start*.

Transmitter tests: You have started an analyzer recording.

Receiver tests: You have started an analyzer recording if the analyzer is used.

4. **Repeating a test:**

Transmitter tests: Click *Start* again. You do not need to reconfigure.

Receiver tests: Click *Reset trigger* to stop the generator and make it wait for the next trigger from the base station.

**Note:** Once the instruments have been configured, program **3G\_FSMU\_NodeB** will no longer access the instrument settings. If necessary, modify these settings manually after configuration by the program has finished. Clicking *Start* or *Reset trigger* will not affect your manual changes.

5. Click *Break*.

Clicking this button breaks a running test. It could take some time for the click to be recognized. If a test is terminated this way, the test result may be invalid.

## Modifying a test

Program **3G\_FSMU\_NodeB** is distributed with the source code. It is written using LabWindows CVI. To modify the code and generate a version of your own, you need the LabWindows CVI software from National Instruments (Rev. 5.5 or later).

When you look at the code, you will find the transmitter tests in file `t_tests.c`, the receiver test in file `r_tests.c`, and the performance tests in file `p_tests.c`. For each test, one function is called when *Configure* is clicked, e.g. `Config_621()`, and another when *Start* is clicked, e.g. `Run_621()`. Edit these functions to change or add remote control commands or to modify the test sequence.

The other program files control the user interface and program flow, the remote control, and the error handling.

- After code modifications, recompile the program and build a new executable.

## Help function:

This application note is included in the program **3G\_FSMU\_NodeB**. To open it during operation

- click the *Help* item in the menu bar, and *help...* in the subsequent pulldown menu.

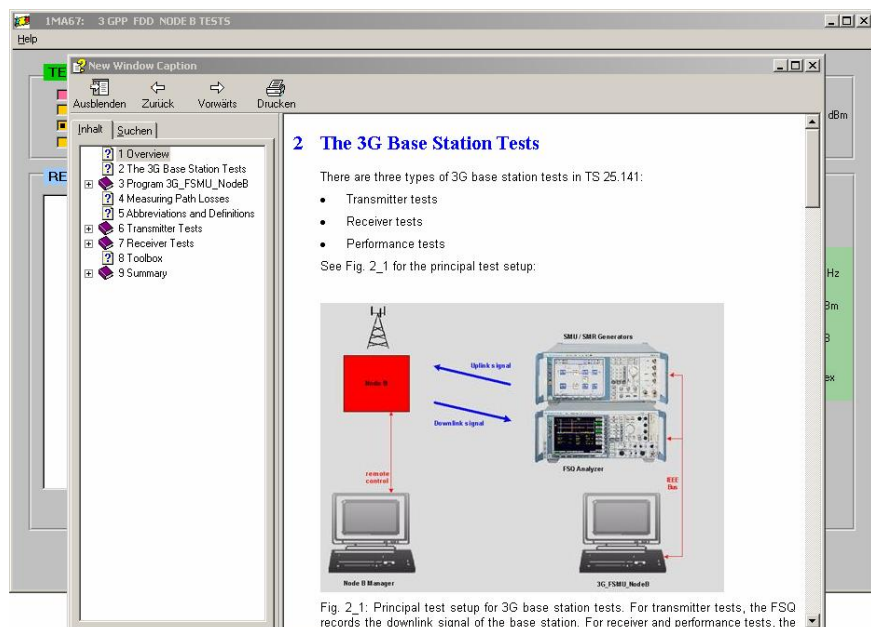


Fig. 2\_1: Principal test setup for 3G base station tests. For transmitter tests, the FSQ records the downlink signal of the base station. For receiver and performance tests, the

Fig. 3\_4: Help function shows application note 1MA67

## 4 The SMU Test Case Wizard

The Test Case Wizard is a program running on the SMU, to help you set up base station tests for the 3GPP standard TS 25.141. It covers all tests which can be performed by the SMU generator without additional instruments: signal generation for TX test *Power Control Steps*, the RX tests, and the Performance tests.

For **manual operation** start the Wizard via menu button *Test Case Wizard...* in the SMU 3GPP FDD main panel. A window similar to Figure 4.1 opens:

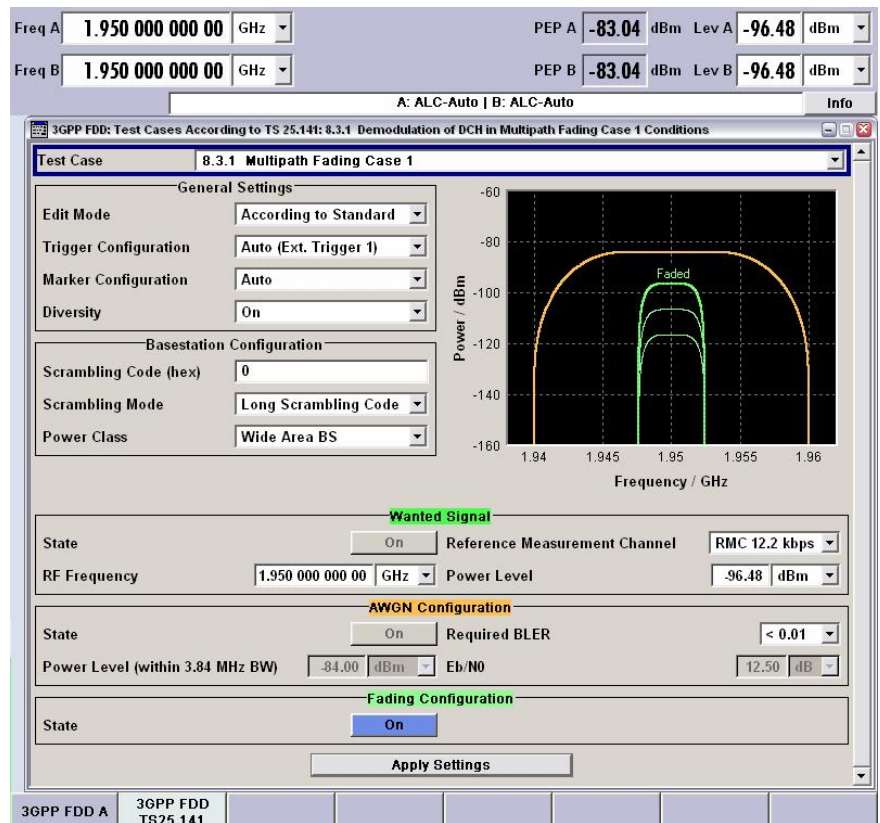


Figure 4.1: The SMU Test Case Wizard window. To select a test click the down arrow on the right in the field *Test Case*. A list of TX, RX, and Performance tests will appear. Select test case you require, e.g. Performance test 8.3.1.

The SMU Test Case Wizard provides two Edit Modes:

- *According to Standard*,
- *User Definable*.

*According to Standard* configures the generator completely in accordance with the specification TS 25.141. By selecting the required test case, the SMU is preset to generate wanted and interfering signals, modulated and / or unmodulated carriers, and AWGN, as stipulated by the standard. Levels and level ratios, frequency offsets, and noise and fading conditions are set automatically.



*User Definable* supports variation from the standard. The grey fields in Fig. 4.1 will turn into white edit fields. Enter values as you require for the power levels of the wanted and the interfering signal, or for  $E_b / N_0$ . Switch AWGN, or Fading *On* or *Off*.

Finally click *Apply Settings* which acts as an Enter key for all of the settings above, and switch the RF outputs on.

A graphical display in the Wizard window shows which signals are active during the selected test. For test case *8.3.1 Multipath Fading Case 1* the green curves in Fig. 4.1 symbolize the wanted signal with varying signal strength. The orange line represents the AWGN interferer applied with constant amplitude over a bandwidth greater than the channel bandwidth.

For **remote control** the SMU Test Case Wizard offers a new set of IEEE-commands for extensive generator settings. This simplifies the writing of tests scripts.

See for example the command to select the test case 8.3.1:

```
:SOUR:BB:W3GP:TS25141:TCASe TC831
```

This automatically presets:

- Type, power level, and fading profile of the wanted signal according to TS 25.141
- Fading *On*
- AWGN *On*, system bandwidth and power level according to TS 25.141
- Trigger 1 *External*
- Diversity *On*

To apply the pre-settings use command

```
:SOUR:BB:W3GP:TS25141:TCASe:EXECute
```

The new commands are additional; the old ones still work. For example, you can set the trigger to *Internal* independently at any time.

Program 3G\_FSMU\_NodeB fully takes advantage of the new IEEE commands. For more information, refer to [2].

**Note:** The Test Case Wizard is already prepared for Rel. 6 of TS 25.141. It supports the three Power Classes of base stations:

- *Wide Area BS*
- *Medium Range BS*
- *Local Area BS*

For base stations built according to Rel. 5 or less, set Power Class to *Wide Area BS*.

## 5 Measuring Path Losses

Before running any of the tests, carefully measure the insertion loss between the base station under test and each instrument of the current hardware setup. Enter the measured values in program **3G\_FSMU\_NodeB** as generator or analyzer path loss respectively before you start the test. The losses will be automatically compensated by the software.

Some tests run within a limited frequency range. For test *6.2.1 Base Station Maximum Output Power*, for example, you only need the insertion loss at low, middle, and high frequencies of the allocated downlink band. You can probably use one and the same loss value three times.

Other tests, e.g. spurious emissions or receiver blocking tests, span a frequency range from 1 MHz up to 12.75 GHz with continuously increasing path loss. To compensate precisely for the analyzer insertion loss, enter level correction tables as transducer tables in FSQ, see section "Frequency Correction" in [2].

As an easy first approach, enter the (highest) loss at the highest frequency. If the test fails at lower frequencies, reduce the path loss to an appropriate value at these frequencies.

A helpful tool for measuring frequency response is the Rohde & Schwarz application program FreRes, part of Application Note 1MA09, which can be downloaded free of charge from

<http://www.rohde-schwarz.com/appnote/1MA09>

**Note:** For measurements below 10 MHz, set the analyzer to input DC.

## 6 Transmitter Tests

Transmitter tests are measurements on the base station downlink signal. Nearly all tests stipulate to set the base station to maximum power.

- **Always insert an attenuator (with sufficient attenuation) at the base station output. Make sure that the attenuator can handle the high power applied. Keep in mind that the attenuator will heat up.**
- **The maximum power at the analyzer's RF input must not exceed +30 dBm.**

Graphical User Interface GUI of program **3G\_FSMU\_NodeB**:

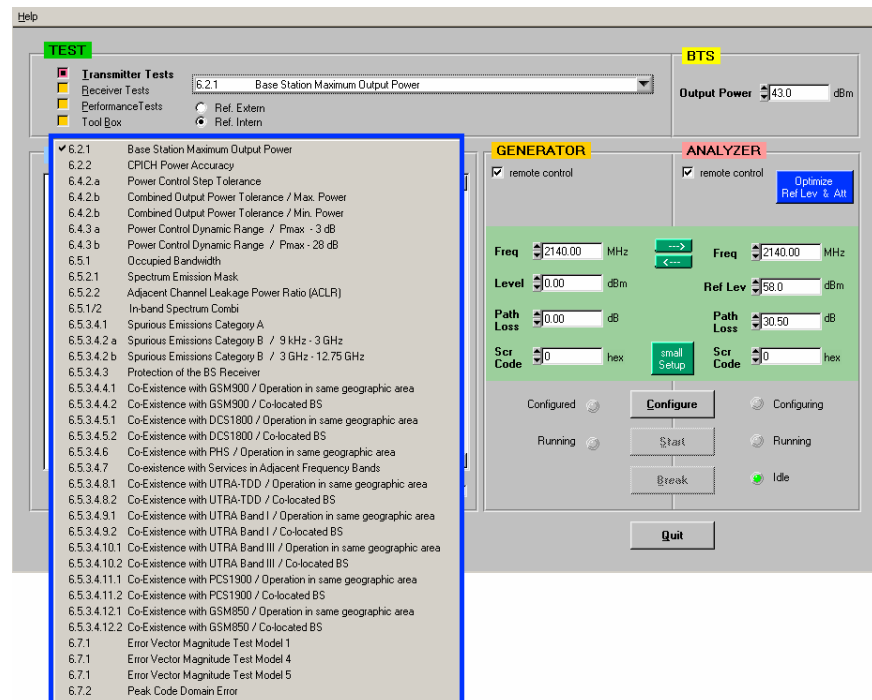


Fig. 6\_1: GUI for all TX tests, and a test list. If you click *Small Setup* the edit fields for the generator disappear, and program **3G\_FSMU\_NodeB** runs with maximum speed.

## 6.2.1 Base Station Maximum Output Power

The output power of the base station is the mean power of one carrier delivered to a load with impedance equal to the nominal load impedance of the base station transmitter.

The purpose of test 6.2.1 is to verify that the maximum output power of the base station across the frequency range remains within +2.7 dB and -2.7 dB of the manufacturer's rated maximum output power.

The test uses test model 1. Both *Ref. Extern* or *Intern* is applicable.

### Recommended hardware test setup:

Fig. 6.2.1\_1 shows the test setup for Base Station Maximum Output Power measurements. This setup is used for all transmitter measurements, except for test 6.4.2 *Power Control Steps and Transmit Intermodulation*.

The base station TX signal is attenuated by 30 dB before it reaches the FSQ. The base station maximum output power should be below 45.7 dBm. Attenuated by 30 dB, the level at the analyzer RF port never exceeds the analyzer input limit of +30 dBm.

The 30 dB attenuation is considered part of the path loss between the base station and the FSQ. If the path loss is measured and entered in program **3G\_FSMU\_NodeB**, it is compensated automatically.

Make sure that the attenuator can handle the high output power of the base station.

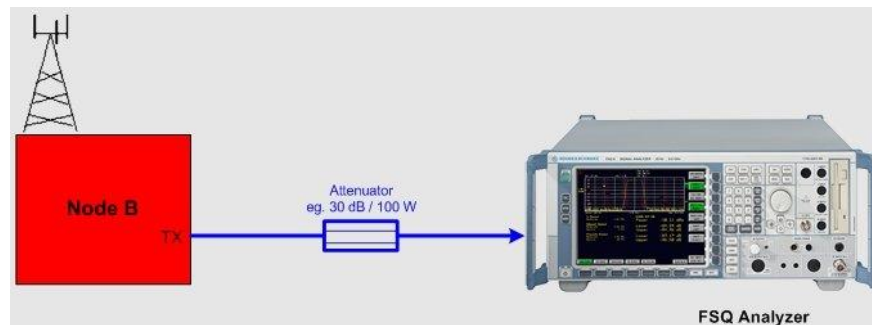


Fig. 6.2.1\_1: Hardware test setup for Base Station Maximum Output Power test. The FSQ records and evaluates the downlink signal characteristics. A high-power attenuator protects the input of the analyzer.

### Instruments and accessories:

1. FSQ (signal analyzer)
2. Attenuator, 30 dB, 50 W min.(e.g. Suhner)

### Path loss compensation:

- Measure the path loss between the base station antenna connector and the FSQ.

A helpful tool for measuring the path loss is the Rohde & Schwarz application program FreRes (Frequency Response), part of Application Note 1MA09, which can be downloaded free of charge from

<http://www.rohde-schwarz.com/appnote/1MA09>

**Test procedure:**

1. Connect the base station with the FSQ as shown in Fig. 6.2.1\_1.
2. Run program **3G\_FSMU\_NodeB**.

**In the program window:**

3. Select *Transmitter Test 6.2.1*.
4. Select *small Setup* (only the analyzer is needed).
5. Enter the BS max. rated power as *Output Power*.
6. Set the analyzer frequency *Freq* to the lowest frequency within the operating frequency band (B frequency).
7. Enter the analyzer *Path Loss* of your hardware test setup.
8. Click *Optimize Ref Level & Att*.
9. Click *Configure*.

**On the base station:**

10. Set the base station to the lowest frequency within the operating frequency band (B frequency), and to max. output power with a combination of channels specified as test model 1. Use the type of test model 1 (1-64, 1-32, 1-16) with the largest number of channels that can be supported by the base station.

**In the program window:**

11. Click *Start*.
12. Check results.
13. Repeat the test at the middle and top frequencies (M and T).

**Test results:**

Fig. 6.2.1\_2 shows the measurement result on the analyzer screen. Fig. 6.2.1\_3 shows the numeric evaluation of program **3G\_FSMU\_NodeB**.

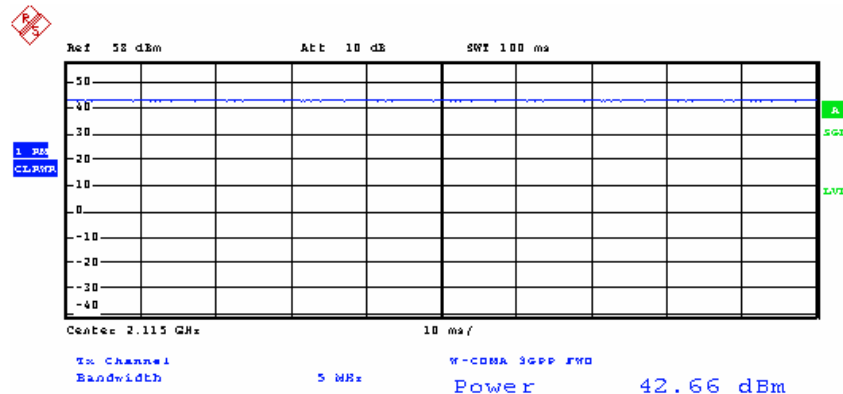


Fig. 6.2.1\_2: Base Station Maximum Output Power measured in the time domain with RMS detector. The analyzer uses an RRC measurement filter of 5 MHz bandwidth which covers one complete channel.

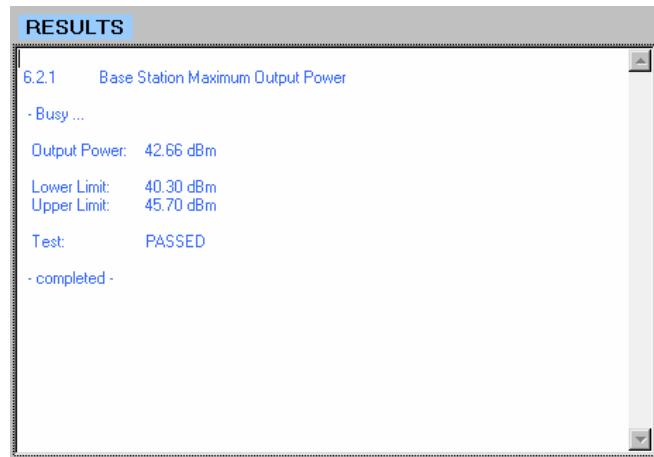


Fig. 6.2.1\_3: Base Station Maximum Output Power as provided by program **3G\_FSMU\_NodeB**. The measurement limits of  $\pm 2.7$  dB are related to the value *Output Power* which was entered during step 6 of the test procedure.

*PASSED* is displayed if the limits are not violated.

You can repeat the measurement without reconfiguring the instruments. Simply click *Start* again.

Base Station Maximum Output Power could be measured by using the Rohde & Schwarz NRP-Z power sensors as well; see [2]. The measurement result will be the same if there are no significant spurious emissions and if the *adjacent channel leakage ratio* (ACLR) is low, e.g. -45 dBc or -50 dBc, respectively (which are the limits of test 6.5.2.2 ACLR).

### Simulation of Node B by the SMU:

1. Connect the FSQ input directly with (port A of) the SMU.
2. Run program **3G\_FSMU\_NodeB**.

### In the program window:

3. Select *Transmitter Test 6.2.1*.
4. Use full (not small) setup. If the generator input fields are not visible, activate the *remote control* check box of the generator.
5. Activate *Demo Settings*.
6. Click *Configure*.
7. When configuration has finished, click *Start*.
8. Check results.

## 6.2.2 CPICH Power Accuracy

CPICH Power Accuracy is defined as the maximum deviation between the primary CPICH code domain power indicated on the BCH and the primary CPICH power measured at the TX antenna interface.

The purpose of test 6.2.2 is to verify that the base station under test delivers primary CPICH code domain power within +2.9 dB and -2.9 dB of the ordered absolute value.

The test uses test model 2.

### Recommended hardware test setup:

Fig. 6.2.2\_1 shows the test setup for CPICH Power Accuracy measurements. This setup is the same as for 6.2.1 *Base Station Maximum Output Power*.

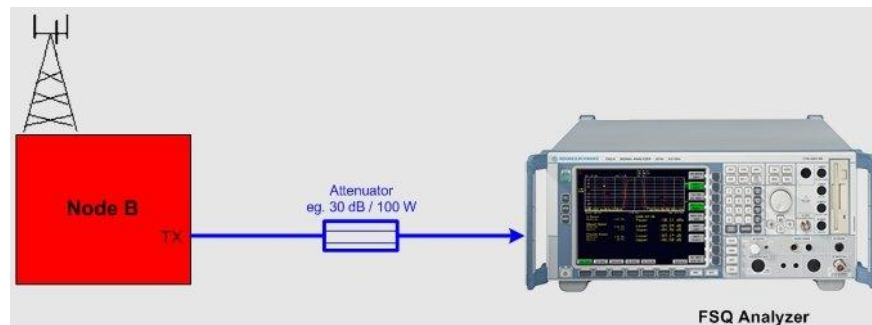


Fig. 6.2.2\_1: Hardware test setup for CPICH Power Accuracy test. The FSQ records and evaluates the downlink signal characteristics. A high-power attenuator protects the input of the analyzer.

### Instruments and accessories:

- FSQ (signal analyzer) with option FS-K72 installed
- Attenuator, 30 dB, 50 W min. (e.g. Suhner)

### Path loss compensation:

- Measure the path loss between the base station antenna connector and the FSQ; see section 6.2.1 *Base Station Maximum Output Power*.

### Test procedure:

1. Connect the base station with the FSQ as shown in Fig. 6.2.2\_1.
2. Run program **3G\_FSMU\_NodeB**.

### In the program window:

3. Select *Transmitter Test 6.2.2*.
4. Select *small Setup* (only the analyzer is requested).

5. Enter the BS max. rated power as *Output Power*.
6. Set the analyzer frequency *Freq* to the lowest frequency within the operating frequency band (B frequency).
7. Enter the analyzer *Path Loss* of your hardware test setup.
8. Click *Optimize Ref Level & Att.*
9. Enter the downlink scrambling code *Scr Code* of the base station in the analyzer input field.

**3G\_FSMU\_NodeB** expects the **absolute** scrambling code number. For downlink, the base station counts the scrambling codes with increments of 10(hex). These code numbers are called the *primary codes*.

If the documented base station scrambling code is 1, enter 10(hex), for 2 enter 20(hex), and so on.

10. Click *Configure*.

### On the base station:

11. Set the base station to the lowest frequency within the operating frequency band (B frequency), and to max. output power with a combination of channels specified as test model 2.

### In the program window:

12. Click *Start*.
13. Check results.
14. Repeat the test at the middle and top frequencies (M and T).

### Test results:

Fig. 6.2.2\_2 shows the measurement result on the analyzer screen, and Fig. 6.2.2\_3 the numeric evaluation of program **3G\_FSMU\_NodeB**.



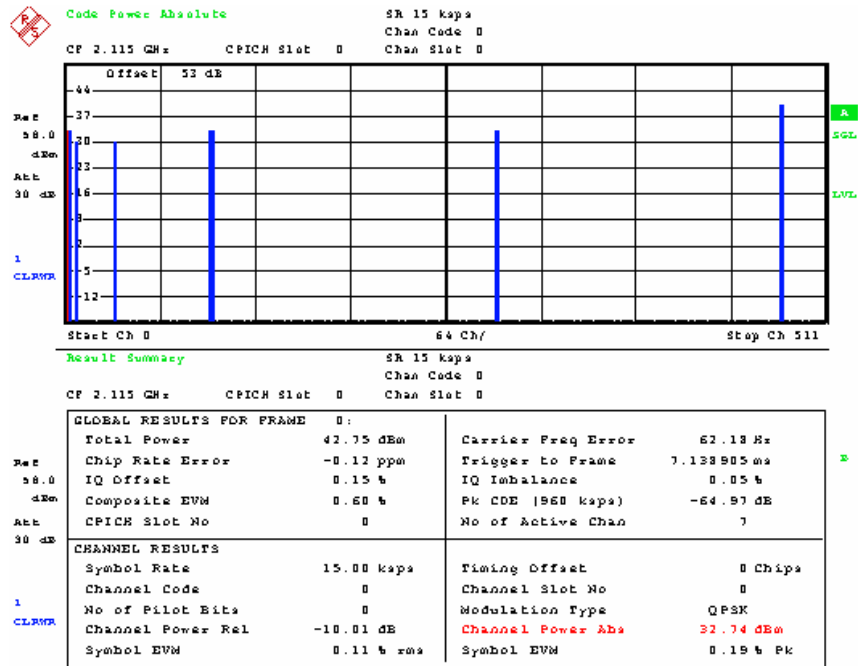


Fig. 6.2.2\_2: CPICH Power Accuracy. The analyzer displays the code domain representation of the downlink signal (test model 2) in the upper half of the screen. You can find the CPICH at the left-most position, with channel number 0. The lower half of the analyzer screen shows numeric measurements results. It contains the *GLOBAL RESULTS* as total power, frequency error, and so on; and *CHANNEL RESULTS* for the selected CPICH channel, e.g. the absolute channel power *Channel Power Abs.*, which has to be checked by this test.

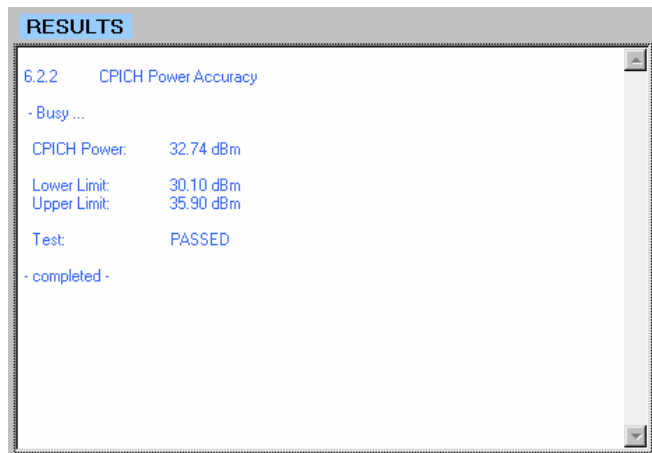


Fig. 6.2.2\_3: CPICH Power Accuracy as provided by program **3G\_FSMU\_NodeB**. The CPICH power of test model 2 is stipulated as total power minus 3 dB. The measurement limits of  $\pm 2.9$  dB are related to the value *Output Power* (which was entered during step 6 of the test procedure) of -3 dB.

*PASSED* is displayed if the limits are not violated.

You can repeat the measurement without reconfiguring the instruments. Simply click *Start* again.

**Simulation of Node B by the SMU:**

1. Connect the FSQ input directly with (port A of) the SMU.
2. Run program **3G\_FSMU\_NodeB**.

**In the program window:**

3. Select *Transmitter Test 6.2.2*.
4. Use full (not small) setup. If the generator input fields are not visible, activate the *remote control* check box of the generator.
5. Activate *Demo Settings*.
6. Click *Configure*.
7. When the configuration has finished, click *Start*.
8. Check results.

## 6.3 Frequency Error

The Frequency Error is tested together with the Error Vector Magnitude (EVM); see section 6.7.1.

## 6.4. Output Power Dynamics

### 6.4.2 a Power Control Steps

### 6.4.2 b Combined Output Power Tolerance

The Power Control Step is the required step change in the downlink transmitter output power of one code channel in response to the corresponding power control command. A power step size of 1 dB is mandatory; a step size of 0.5 dB is optional.

The purpose of this test is to verify that the step size lies between 0.4 dB and 1.6 dB for the 1 dB steps, and between 0.15 dB and 0.85 dB for 0.5 dB steps.

The Combined (or aggregate) Output Power Tolerance is the required total change in the downlink transmitter output power of one code channel in response to ten consecutive power control commands corresponding to the code channel in question.

The purpose of this test is to verify that the combined power control step range after ten consecutive equal commands lies between 7.9 dB and 12.1 dB for 1 dB steps, and between 3.9 dB and 6.1 dB for 0.5 dB steps.

Both tests use test model 2.

Program **3G\_FSMU\_NodeB** checks the 1 dB limits only.

#### Recommended hardware test setup:

Fig. 6.4.2\_1 shows the test setup for Power Control Steps and Combined Output Power tolerance.

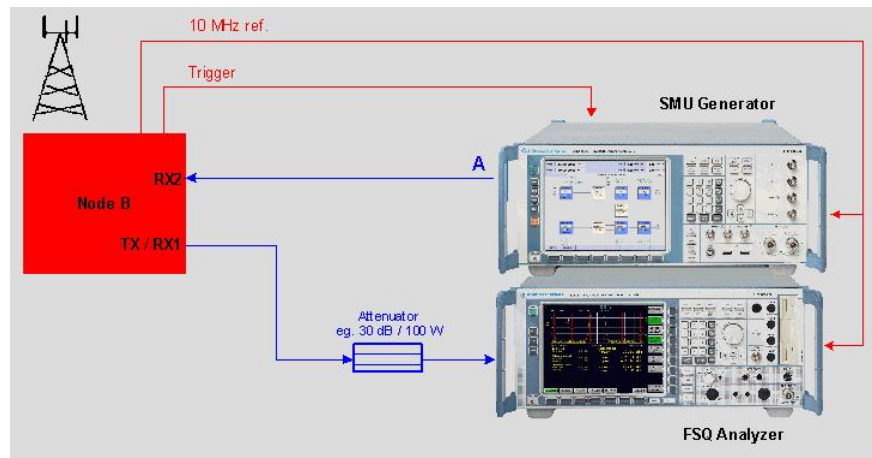


Fig. 6.4.2\_1: Test setup for Power Control Steps and Combined Output Power Tolerance. Antenna diversity is used: The RX2 input of the base station receives the SMU uplink signal with the transmission power control bit TPC, toggling for power control steps or alternating after ten slots for combined output tolerance. The FSQ is connected via a high-power attenuator at the RX1/TX socket of the base station under test.

To synchronize the frame timing of the base station and the SMU, the base station provides a frame trigger that starts the generator. Connect this signal to the BNC socket *TRIGGER1* on the frontpanel of the SMU. The

Trigger could be the *start of frame number* (SFN) or a signal that indicates the start of a data block (e.g. *transmission time interval* (TTI)).

- Some base stations provide a DC bias at the RX connector to supply a mast amplifier. Make sure that the bias is disabled, or use a DC blocking circuitry between base station and SMU.

The standard stipulates that all steps within the power control dynamic range declared by the manufacturer must be measured. We recommend that testing be done at least at a high, low, and middle output power.

For measuring the combined output power, **3G\_FSMU\_NodeB** provides two tests 6.4.2 b:

*Combined Output Power Tolerance/Max. Power* is intended for high output power. It starts with ten steps to decrease the power, and continues with ten steps to increase the power, and so on.

*Combined Output Power Tolerance/Min. Power* is intended for low output power. It starts with ten steps to increase the power, and continues with ten steps to decrease the power, and so on.

### Instruments and accessories:

- FSQ (signal analyzer) with option FS-K72 installed
- SMU (generator)
- Attenuator, 30 dB, 50 W min. (e.g. Suhner)

### Path loss compensation:

- Measure the path loss between the base station antenna connector RX1/TX and the FSQ.
- Measure the path loss between the base station antenna connector RX2 and the SMU.

### Test procedure:

1. Connect the base station with the generator and analyzer as shown in Fig. 6.4\_1.
2. Run program **3G\_FSMU\_NodeB**.

### In the program window:

3. Click check box *Ref. Extern*.
4. Select the appropriate test from the list of 6.4.2 tests.
5. Enter the base station power (to be defined in step 18) as *BS Output Power*.
6. Set the analyzer frequency *Freq* to the lowest frequency within the operating frequency band (B frequency).
7. Enter the analyzer *Path Loss* of your hardware test setup.
8. Click *Optimize Ref Level & Att*. This sets the analyzer *Ref Lev*.
9. Enter the TX downlink scrambling code (specified by the base station) for the analyzer.

**3G\_FSMU\_NodeB** expects the **absolute** scrambling code number. For downlink, the base station counts the scrambling codes with increments of 10(hex). These code numbers are called the *primary codes*.

If the documented base station scrambling code is 1, enter 10(hex), for 2 enter 20(hex), and so on.

10. Use full (not small) setup. If the generator input fields are not visible, activate the *remote control* check box of the generator.
11. Set the generator frequency to the analyzer frequency minus 190 MHz.
12. Set the generator level to  $-80$  dBm.
13. Enter the generator *Path Loss* of your hardware test setup.
14. Enter the uplink scrambling code for the generator. This is the absolute (secondary) scrambling code as specified for the base station receiver.
15. Click *Configure*.

The SMU generator now waits for the trigger signal from the base station.

### On the base station:

16. Set the base station to the lowest frequency within the operating frequency band (B frequency).
17. Set the base station power to appropriate levels within its power control dynamic range. Select test model 2.
18. Set the base station to start the inner loop power control test.

When the trigger occurs, the generator provides the uplink signal with the TPC bit alternating for each slot or after ten equal bits, respectively.

### In the program window:

19. Click *Start*.

The analyzer starts a single sweep recording two frames. The program automatically searches an adequate section of the trace and evaluates the power step size.

20. Check results.
21. Repeat the test using other power levels.
22. Repeat the test at the middle and top frequencies (M and T).

### Test result for Power Control Steps:

Fig. 6.4.2\_2 shows the measurement result on the analyzer screen. Fig. 6.4.2\_3 shows the numeric evaluation of program **3G\_FSMU\_NodeB**.

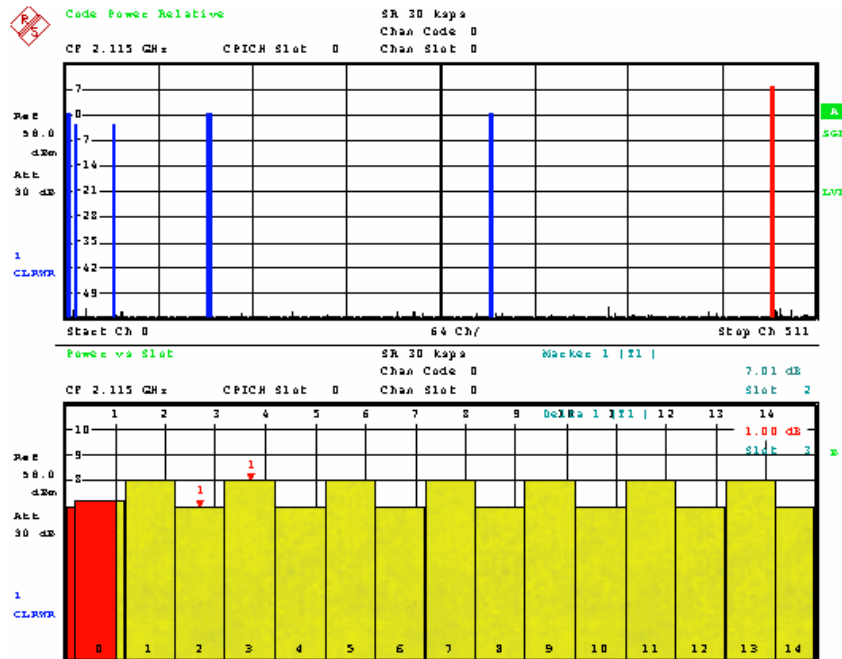


Fig. 6.4.2\_2: Power Control Steps are represented in the lower half of the screen as power versus slot. The displayed curve shows the power of channel 120. This is the right-most code channel of the code domain display in the upper half of the analyzer screen. The step width is measured by the analyzer's delta marker.

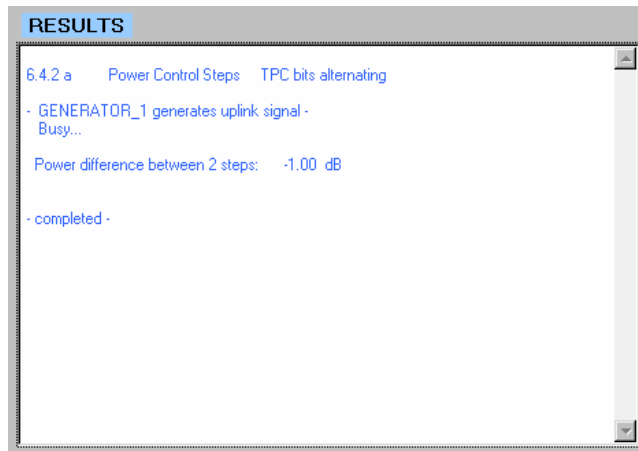


Fig. 6.4.2\_3: Test results for test 6.4.2 Power Control Steps of program 3G\_FSMU\_NodeB. PASSED is displayed if the step size lies between 0.4 dB and 1.6 dB.

**Test result for Combined Output Power Tolerance:**

Fig. 6.4.2\_4 shows the measurement result on the analyzer screen. Fig. 6.4.2\_5 shows the numeric evaluation of program 3G\_FSMU\_NodeB.

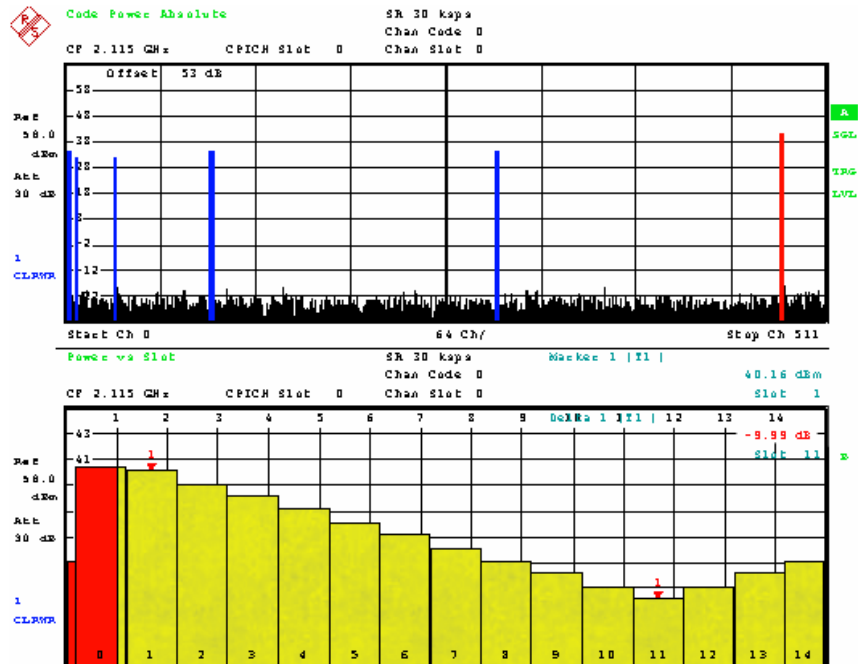


Fig. 6.4.2\_4: The power versus slot is represented in the lower half of the screen. The displayed curve shows the power change of channel 120. This is the right-most code channel of the code domain display in the upper half of the analyzer screen. With trigger free run the analyzer records two frames to have at least one complete power ramp in its memory. The power difference of ten steps is evaluated by **3G\_FSMU\_NodeB** software.

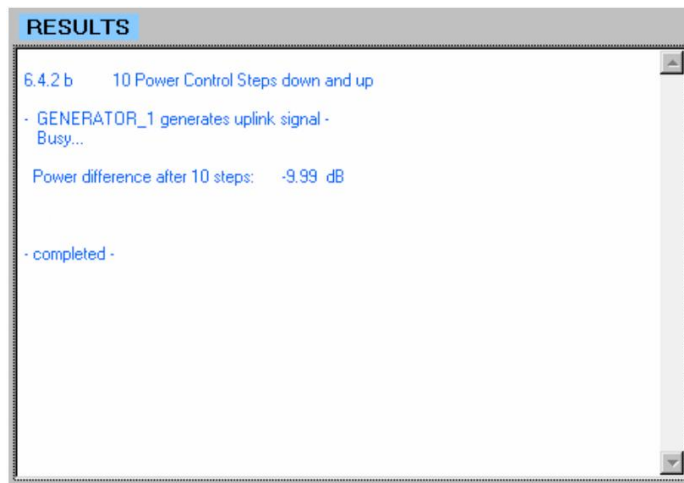


Fig. 6.4.2\_5: Test results for test 6.4.2 Combined Output Power Tolerance of program **3G\_FSMU\_NodeB**. Limits are checked in the same manner as for 1 dB steps. *PASSED* is displayed if the aggregate power change lies between 7.9 dB and 12.1 dB.

**Simulation of Node B by the SMU:**

1. Connect the FSQ input directly with (port A of) the SMU.
2. Run program **3G\_FSMU\_NodeB**.

**In the program window:**

3. Select one of the *Transmitter Tests 6.4.2*.
4. Use full (not small) setup. If the generator input fields are not visible, activate the *remote control* check box of the generator.
5. Activate *Demo Settings*.
6. Click *Configure*.
7. When the configuration has finished, click *Start*.
8. Check results.

### 6.4.3 Power Control Dynamic Range

The Power Control Dynamic Range is the difference between the maximum and the minimum code domain power of one code channel, while the power levels for the other code channels remain unchanged.

The test consists of three steps:

1. Measure the base station maximum output power  $P_{max}$  in accordance with test 6.2.1 using test model 1.
2. Set the base station to test model 2, and measure the code domain power of DPCH on channel 120 (which should be  $P_{max}$  minus 3 dB) using test 6.4.3 a.
3. Set the code domain power of channel 120 to  $P_{max}$  minus 28 dB. Measure again using test 6.4.3 b.

The purpose of this test is to verify that the maximum code domain power of channel 120 is equal to or greater than  $P_{max}$  minus 4.1 dB, and the minimum code domain power equal to or less than  $P_{max}$  minus 26.9 dB.

**Recommended hardware test setup:**

Fig. 6.4.3\_1 shows the test setup for base station Power Control Dynamic Range measurements. This setup is the same as for 6.2.1 *Base Station Maximum Output Power*.

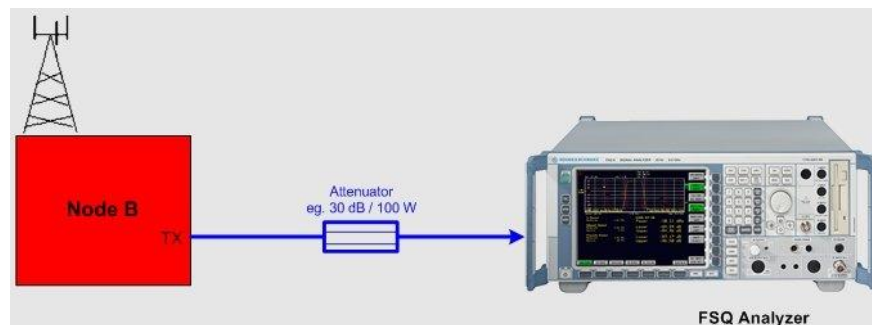


Fig. 6.4.3\_1: Hardware test setup for Power Control Dynamic Range test. The FSQ records and evaluates the downlink signal characteristics. A high-power attenuator protects the input of the analyzer.



### Instruments and accessories:

- FSQ (signal analyzer) with option FS-K72 installed
- Attenuator, 30 dB, 50 W min. (e.g. Suhner)

### Path loss compensation:

- Measure the path loss between the base station antenna connector RX1/TX and the FSQ.

### Test procedure:

1. Connect the base station with the FSQ as shown in Fig. 6.4.3\_1.

### In the program window:

2. If not already done, run test *6.2.1 Base Station Maximum Output Power* to determine Pmax.
3. Select *Transmitter Test 6.4.3 / max power*.
4. Select *small Setup* (only the analyzer is needed).
5. Enter the Pmax of the base station as *BS Output Power*.
6. Set the analyzer frequency *Freq* to the lowest frequency within the operating frequency band (B frequency).
7. Enter the analyzer *Path Loss* of your hardware test setup.
8. Click *Optimize Ref Level & Att*.
9. Enter the downlink scrambling code *Scr Code* of the base station in the analyzer input field.

**3G\_FSMU\_NodeB** expects the **absolute** scrambling code number. For downlink, the base station counts the scrambling codes with increments of 10(hex). These code numbers are called the *primary codes*.

If the documented base station scrambling code is 1, enter 10(hex), for 2 enter 20(hex), and so on.

10. Click *Configure*.

### On the base station:

11. Set the base station to the lowest frequency within the operating frequency band (B frequency), and to max. output power with a combination of channels specified as test model 2.

### In the program window:

12. Click *Start*.
13. Check results.
14. Repeat the test at the middle and top frequencies (M and T).
15. Repeat the measurements with test *6.4.3 / min power* and code channel 120 set to Pmax minus 28 dB.

Test results:

Fig. 6.4.3\_2 shows the measurement result on the analyzer screen, and Fig. 6.4.3\_3 the numeric evaluation of program 3G\_FSMU\_NodeB.

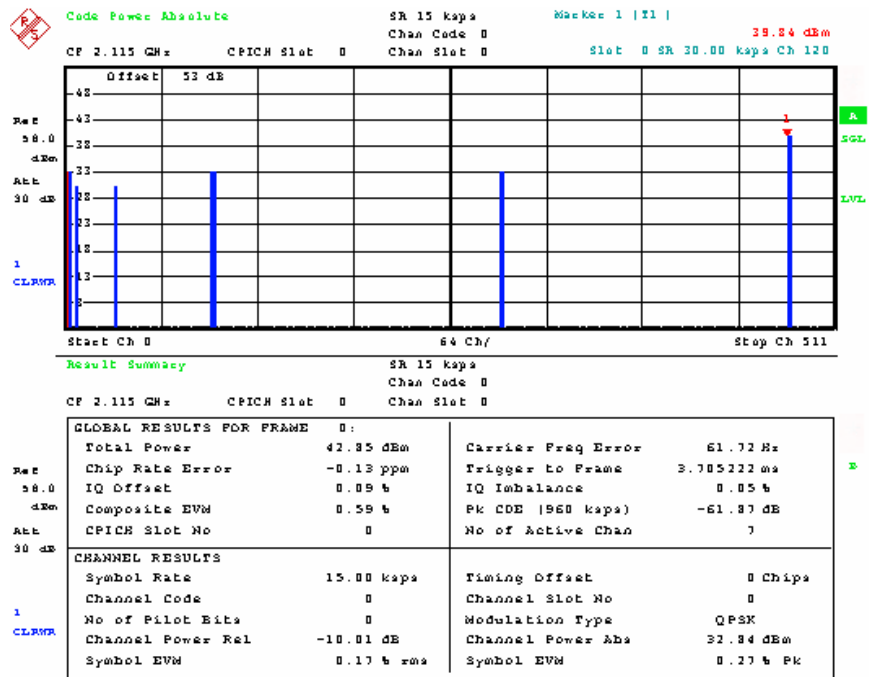


Fig. 6.4.3\_2: Power Control Dynamic Range test. The analyzer displays the code domain representation of the downlink signal (test model 2) in the upper half of the screen. You can find the DPCH under test on the right. The lower half of the analyzer screen shows numeric measurements results. It contains the *GLOBAL RESULTS* as total power, frequency error, and so on; and *CHANNEL RESULTS* for the selected channel, e.g. the absolute channel power *Channel Power Abs.*, which is the measurement result of this test.

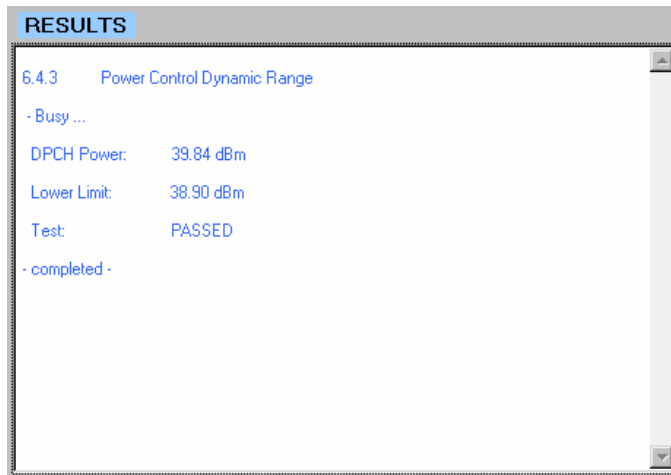


Fig. 6.4.3\_3: Power Control Dynamic Range test as provided by program 3G\_FSMU\_NodeB. The measurement limits of -4.1 dB (or -26.9 dB, respectively) are relative to the value *Output Power* that was entered during step 7 of the test procedure.

*PASSED* is displayed if the limits are not violated.

You can repeat the measurement without reconfiguring the instruments. Simply click *Start* again.

### Simulation of Node B by the SMU:

1. Connect the FSQ input directly with (port A of) the SMU.
2. Run program **3G\_FSMU\_NodeB**.

### In the program window:

3. Select *Transmitter Test 6.4.3 max. or min. power*.
4. Use full (not small) setup. If the generator input fields are not visible, activate the *remote control* check box of the generator.
5. Activate *Demo Settings*.
6. Click *Configure*.
7. When the configuration has finished, click *Start*.
8. Check results.

## 6.4.4 Total Power Dynamic Range

The Total Power Dynamic Range is tested together with the Error Vector Magnitude (EVM); see section 6.7.1.

## 6.5.1 Occupied Bandwidth

This test is shown here as a single measurement. You can do this test together with tests *Spectrum Emission Mask* and *Adjacent Channel Leakage Power Ratio* in a single shot, see section 6.5.1/2 *In-band Spectrum Combi*.

The Occupied Bandwidth is the width of a frequency band such that the mean power emitted below the lower and above the upper frequencies are equal to 0.5 percent of the total mean transmitted power.

The purpose of this test is to verify that the emission of the base station does not occupy an excessive bandwidth.

The test uses test model 1.

### Recommended hardware test setup:

Fig. 6.5.1\_1 shows the test setup for Occupied Bandwidth Measurements. This setup is the same as for 6.2.1 *Base Station Maximum Output Power*.

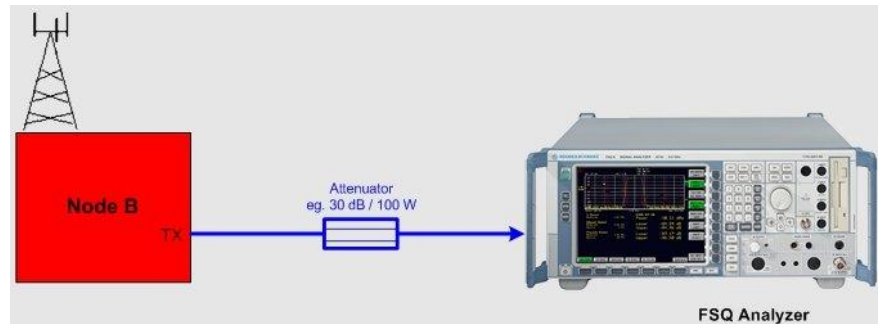


Fig. 6.5.1\_1: Hardware test setup for Occupied Bandwidth test. The FSQ records and evaluates the downlink signal characteristics. A high-power attenuator protects the input of the analyzer.

### Instruments and accessories:

- FSQ (signal analyzer) with option FS-K72 installed
- Attenuator 30 dB, 50 W min.

### Path loss compensation:

- Measure the path loss between the base station TX connector and the FSQ.

### Test procedure:

1. Connect the base station with the FSQ as shown in Fig. 6.5.1\_1.
2. Run program **3G\_FSMU\_NodeB**.

### In the program window:

3. Select *Transmitter Test 6.5.1*.
4. Select *small Setup* (only the analyzer is needed).
5. Enter the Pmax of the base station as *Output Power*.
6. Set the analyzer frequency *Freq* to the lowest frequency within the operating frequency band (B frequency).
7. Enter the analyzer *Path Loss* of your hardware test setup.
8. Click *Optimize Ref Level & Att*.
9. Click *Configure*.

### On the base station:

10. Set the base station to the lowest frequency within the operating frequency band (B frequency), and to max. output power with a combination of channels specified as test model 1.

### In the program window:

11. Click *Start*.
12. Check results.
13. Repeat the test at the middle and top frequencies (M and T).

**Test results:**

Fig. 6.5.1\_2 shows a measurement result on the analyzer screen. Fig. 6.5.3\_3 shows the numeric evaluation of program **3G\_FSMU\_NodeB**.

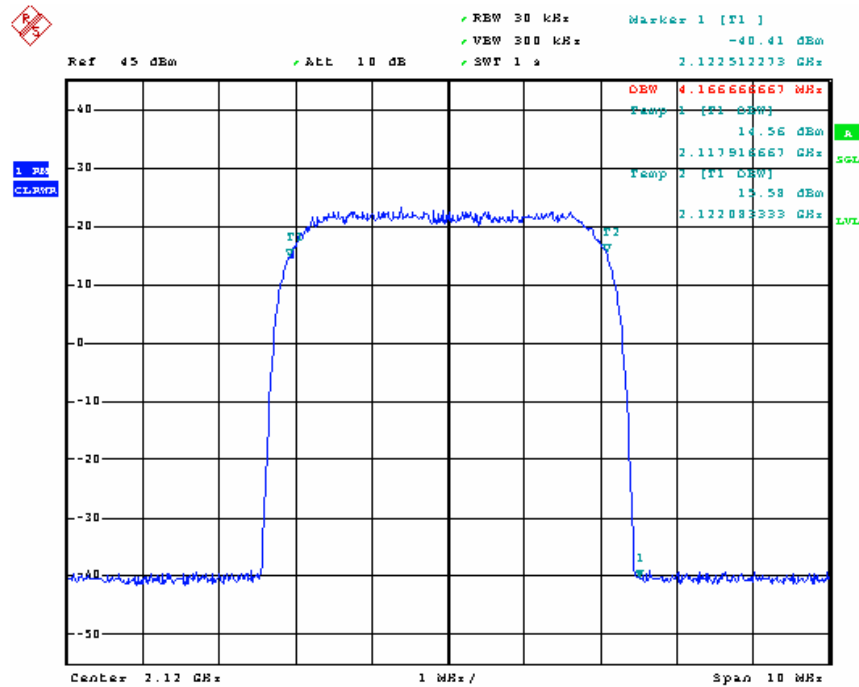


Fig. 6.5.1\_2: Occupied Bandwidth on the analyzer. 99% of the total power are measured between the markers T1 and T2.

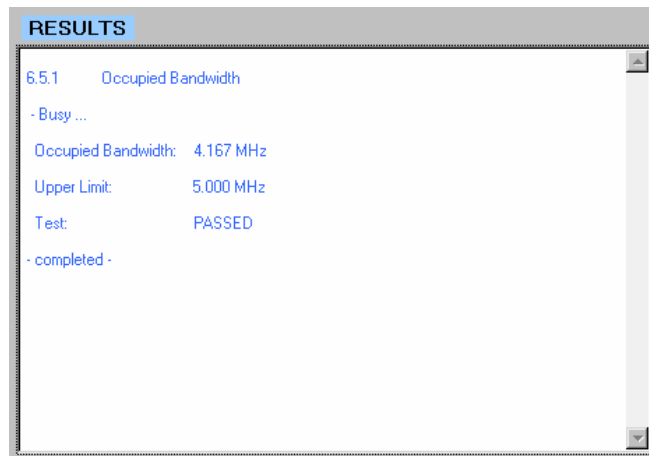


Fig. 6.5.1\_3: Occupied Bandwidth test as provided by program **3G\_FSMU\_NodeB**

*PASSED* is displayed if the occupied bandwidth is equal to or less than 5 MHz.

You can repeat the measurement without reconfiguring the instruments. Simply click *Start* again.

**Simulation of Node B by the SMU:**

1. Connect the FSQ input directly with (port A of) the SMU.
2. Run program **3G\_FSMU\_NodeB**.

**In the program window:**

3. Select *Transmitter Test 6.5.1*.
4. Use full (not small) setup. If the generator input fields are not visible, activate the *remote control* check box of the generator.
5. Activate *Demo Settings*.
6. Click *Configure*.
7. When the configuration has finished, click *Start*.
8. Check results.

### 6.5.2.1 Spectrum Emission Mask

This test is shown here as a single measurement. You can do this test together with tests *Occupied Bandwidth* and *Adjacent Channel Leakage Power Ratio* in one shot, see section 6.5.1/2 *In-band Spectrum Combi*.

Spectrum Emission Mask checks for unwanted emissions outside the assigned channel in the downlink band.

Test purpose is to verify that the emission of the base station do not exceed the limits defined by a mask defined in TS 25.141 standard.

The test uses test model 1.

**Recommended hardware test setup:**

Fig. 6.5.2.1\_1 shows the test setup for Spectrum Emission Mask measurements. This setup is the same as for 6.2.1 *Base Station Maximum Output Power*.

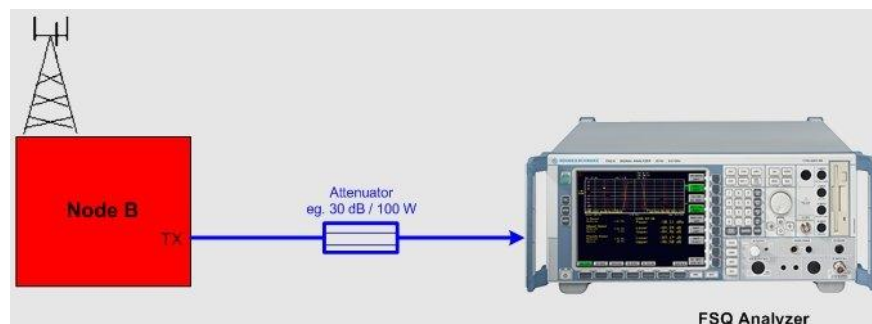


Fig. 6.5.2.1\_1: Hardware test setup for Spectrum Emission Mask test. The FSQ records and evaluates the downlink signal characteristics. A high-power attenuator protects the input of the analyzer.

### Instruments and accessories:

- FSQ (signal analyzer) with option FS-K72 installed
- Attenuator 30 dB, 50 W min.

### Path loss compensation:

- Measure the path loss between the base station TX connector and the FSQ.

### Test procedure:

1. Connect the base station with the FSQ as shown in Fig. 6.5.2.1\_1.
2. Run program **3G\_FSMU\_NodeB**.

### In the program window:

3. Select *Transmitter Test 6.5.2.1*.
4. Select *small Setup* (only the analyzer is needed).
5. Enter the Pmax of the base station as *Output Power*.
6. Set the analyzer frequency *Freq* to the lowest frequency within the operating frequency band (B frequency).
7. Enter the analyzer *Path Loss* of your hardware test setup.
8. Click *Optimize Ref Level & Att*.
9. Click *Configure*.

### On the base station:

10. Set the base station to the lowest frequency within the operating frequency band (B frequency), and to max. output power with a combination of channels specified as test model 1.

### In the program window:

11. Click *Start*.
12. Check results.
13. Repeat the test at the middle and top frequencies (M and T).

### Test results:

Fig. 6.5.2.1\_2 shows a measurement result on the analyzer screen. Fig. 6.5.2.1\_3 shows the numeric evaluation of program **3G\_FSMU\_NodeB**.

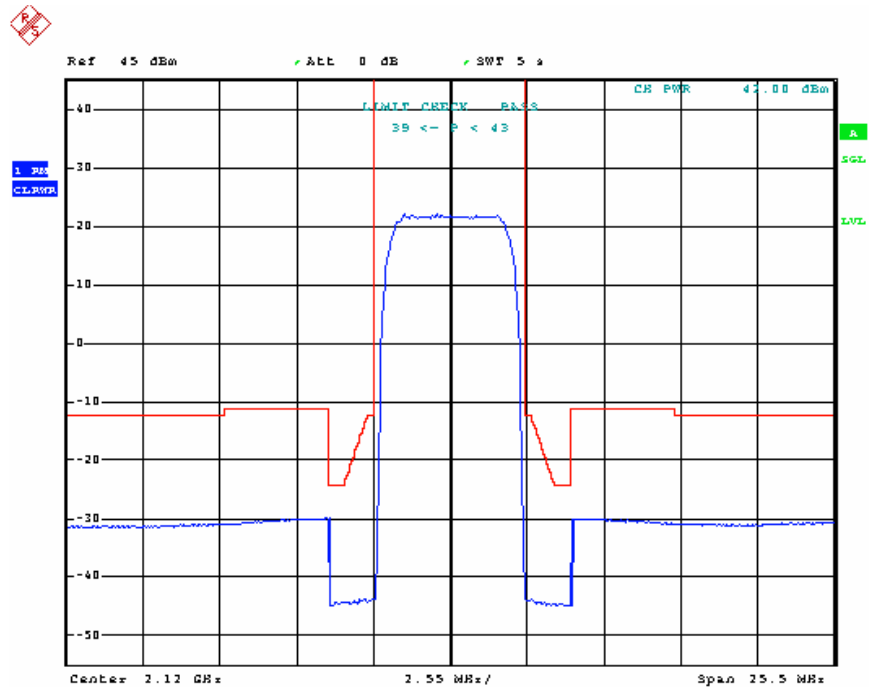


Fig. 6.5.2.1\_2: Spectrum Emission Mask on the analyzer. The measured values are far below the mask limits.

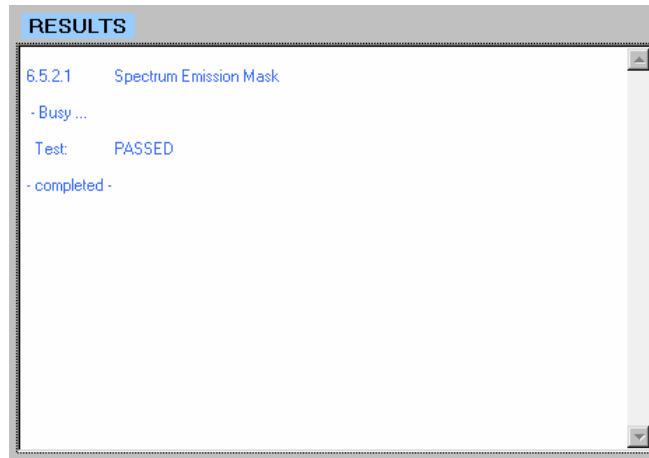


Fig. 6.5.2.1\_3: Spectrum Emission Mask test as provided by program **3G\_FSMU\_NodeB**

*PASSED* is displayed if the measured values do not exceed the mask limits.

You can repeat the measurement without reconfiguring the instruments. Simply click *Start* again.

**Simulation of Node B by the SMU:**

1. Connect the FSQ input directly with (port A of) the SMU.
2. Run program **3G\_FSMU\_NodeB**.



**In the program window:**

3. Select *Transmitter Test 6.5.2.1*.
4. Use full (not small) setup. If the generator input fields are not visible, activate the *remote control* check box of the generator.
5. Activate *Demo Settings*.
6. Click *Configure*.
7. When the configuration has finished, click *Start*.
8. Check results.

### 6.5.2.2 Adjacent Channel Leakage Power Ratio

This test is shown here as a single measurement. You can do this test together with tests *Occupied Bandwidth* and *Spectrum Emission Mask* in one shot, see section 6.5.1/2 *In-band Spectrum Combi*.

Adjacent Channel Leakage power Ratio (ACLR) is the ratio of the RRC filtered mean power centered on the assigned channel frequency to the RRC filtered mean power centered on an adjacent channel frequency.

Test purpose is to verify that the ACLR does not exceed 44.2 dB for a 5 MHz channel offset, and 49.2 dB for a 10 MHz channel offset.

The test uses test model 1.

**Recommended hardware test setup:**

Fig. 6.5.2.2\_1 shows the test setup for ACLR measurements. This setup is the same as for 6.2.1 *Base Station Maximum Output Power*.

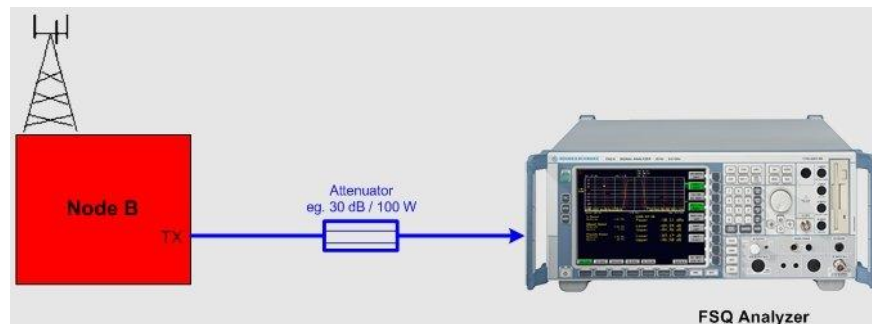


Fig. 6.5.2.2\_1: Hardware test setup for Adjacent Channel Leakage power Ratio test. The FSQ records and evaluates the downlink signal characteristics. A high-power attenuator protects the input of the analyzer.

### Instruments and accessories:

- FSQ (signal analyzer) with option FS-K72 installed
- Attenuator 30 dB, 50 W min.

### Path loss compensation:

- Measure the path loss between the base station TX connector and the FSQ.

### Test procedure:

1. Connect the base station with the FSQ as shown in Fig. 6.5.2.2\_1.
2. Run program **3G\_FSMU\_NodeB**.

### In the program window:

3. Select *Transmitter Test 6.5.2.2*.
4. Select *small Setup* (only the analyzer is needed).
5. Enter the Pmax of the base station as *Output Power*.
6. Set the analyzer frequency *Freq* to the lowest frequency within the operating frequency band (B frequency).
7. Enter the analyzer *Path Loss* of your hardware test setup.
8. Click *Optimize Ref Level & Att*.
9. Click *Configure*.

### On the base station:

10. Set the base station to the lowest frequency within the operating frequency band (B frequency), and to max. output power with a combination of channels specified as test model 1.

### In the program window:

11. Click *Start*.
12. Check results.
13. Repeat the test at the middle and top frequencies (M and T).

### Test results:

Fig. 6.5.2.2\_2 shows a measurement result on the analyzer screen. Fig. 6.5.2.2\_3 shows the numeric evaluation of program **3G\_FSMU\_NodeB**.

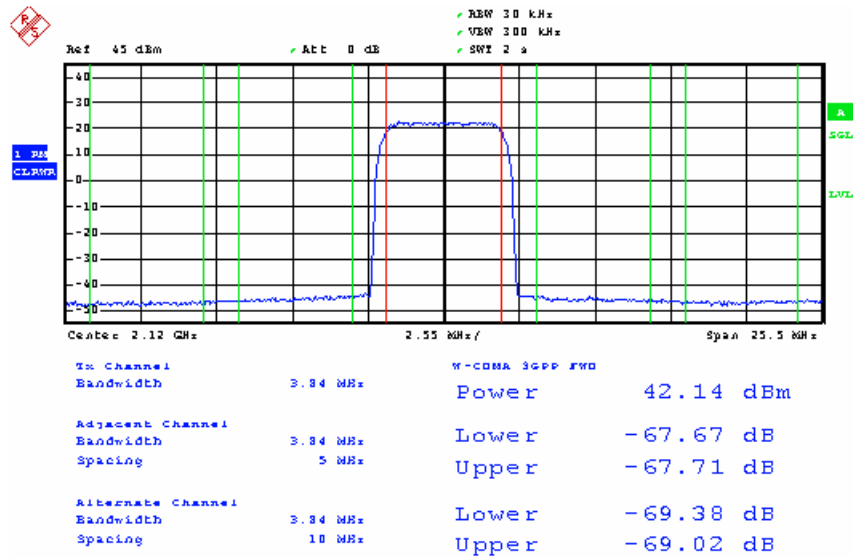


Fig. 6.5.2.2\_2: Adjacent Channel Leakage Power ratio on the analyzer. The channels with 5 MHz offset are listed as Adjacent channels. Channels with 10 MHz offset are listed as alternate channels.

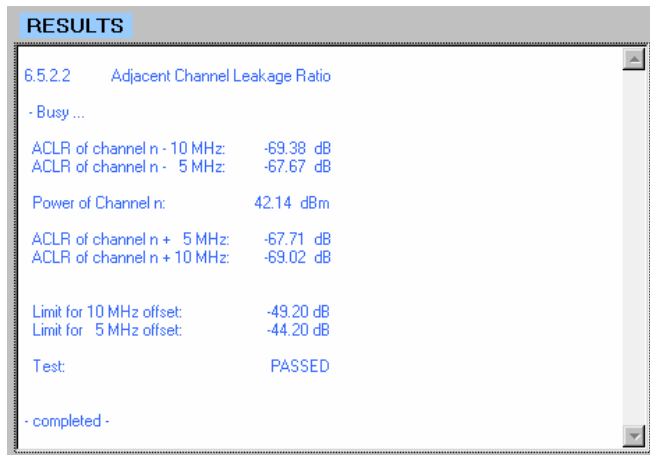


Fig. 6.5.2.2\_3: Adjacent Channel Leakage power Ratio results as provided by program **3G\_FSMU\_NodeB**

*PASSED* is displayed if the measured values do not exceed the limits of the standard.

You can repeat the measurement without reconfiguring the instruments. Simply click *Start* again.

**Simulation of Node B by the SMU:**

1. Connect the FSQ input directly with (port A of) the SMU.
2. Run program **3G\_FSMU\_NodeB**.

**In the program window:**

3. Select *Transmitter Test 6.5.2.2*.

4. Use full (not small) setup. If the generator input fields are not visible, activate the *remote control* check box of the generator.
5. Activate *Demo Settings*.
6. Click *Configure*.
7. When the configuration has finished, click *Start*.
8. Check results.

### 6.5.1/2 In-band Spectrum Combi

Three tests can be performed together in one single fast measurement:

- Occupied Bandwidth
- Spectrum Emission Mask
- Adjacent Channel Leakage power Ratio ACLR

The Occupied Bandwidth is the width of a frequency band such that the mean power emitted below the lower and above the upper frequencies are equal to 0.5 percent of the total mean transmitted power.

The purpose of this test is to verify that the emission of the base station does not occupy an excessive bandwidth.

The Spectrum Emission Mask and Adjacent Channel Leakage power Ratio (ACLR) check for out-of-band emissions. These are unwanted emissions outside the channel bandwidth (excluding spurious emissions).

The purpose of both tests is to verify that the emissions close to the assigned channel do not exceed the limits of the mask specified in the standard.

All three tests use test model 1.

#### **Recommended hardware test setup:**

Fig. 6.5.1/2\_1 shows the test setup for the three tests. This setup is the same as for 6.2.1 *Base Station Maximum Output Power*.

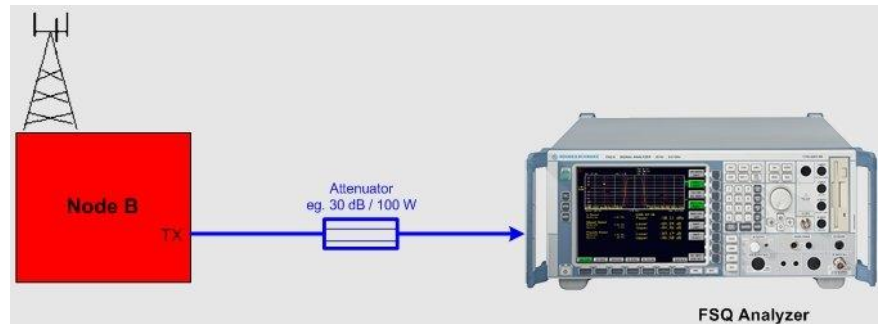


Fig. 6.5.1/2\_1: Hardware test setup for In-band Spectrum Combi measurement. The FSQ records and evaluates the downlink signal characteristics. A high-power attenuator protects the input of the analyzer.

### Instruments and accessories:

- FSQ (signal analyzer)
- Attenuator, 30 dB, 50 W min., DC to 12.75 GHz (e.g. Suhner)

### Path loss compensation:

- Measure the path loss between the base station antenna connector and the FSQ.

### Test procedure:

1. Connect the base station with the FSQ as shown in Fig. 6.5.1/2\_1.
2. Run program **3G\_FSMU\_NodeB**.

### In the program window:

3. Select *Transmitter Test 6.5.1 / 2*
4. Select *small Setup* (only the analyzer is needed).
5. Enter the BS max. rated power as *Output Power*.
6. Set the analyzer frequency *Freq* to the lowest frequency within the operating frequency band (B frequency).
7. Enter the analyzer *Path Loss* of your hardware test setup.
8. Click *Optimize Ref Level & Att*.
9. Click *Configure*.

### On the base station:

10. Set the base station to the lowest frequency within the operating frequency band (B frequency), and to max. output power with a combination of channels specified as test model 1. Use the type of test model 1 (1-64, 1-32, 1-16) with the largest number of channels that can be supported by the base station.

### In the program window:

11. Click *Start*.
12. Check results.

13. Repeat the test at the middle and top frequencies (M and T).

**Test results:**

Fig. 6.5.1/2\_2 shows the measurement result on the analyzer screen. Fig. 6.5.1/2\_3 shows the numeric evaluation of program 3G\_FSMU\_NodeB.

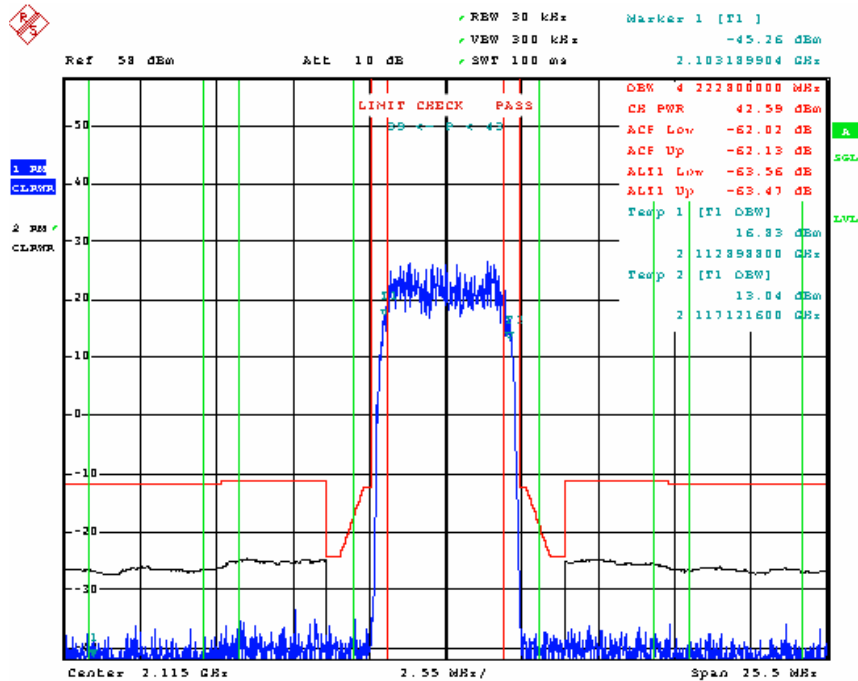


Fig. 6.5.1/2\_2: In-band Spectrum Combi on the analyzer screen. Markers 1 and 2 are set to the -3 dB points to evaluate the current frequency occupation of the base station transmitter signal. Limit lines define the max. emissions for the Spectrum Emission Mask and ACLR. They are adapted to the received base station power automatically.

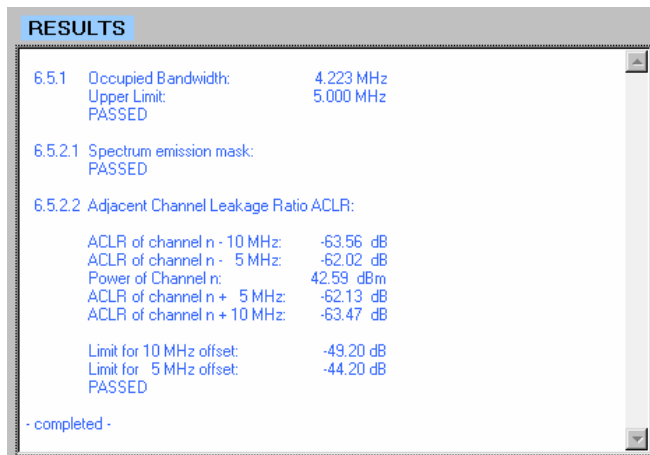


Fig. 6.5.1/2\_3: Base station In-band Spectrum Combi as provided by program 3G\_FSMU\_NodeB.

PASSED is displayed if the measurement results meet the requirements of the standard.

You can repeat the measurement without reconfiguring the instruments. Simply click *Start* again.

### Simulation of Node B by the SMU:

1. Connect the FSQ input directly with (port A of) the SMU.
2. Run program **3G\_FSMU\_NodeB**.

### In the program window:

3. Select *Transmitter Test 6.5.1 / 2*
4. Use full (not small) setup. If the generator input fields are not visible, activate the *remote control* check box of the generator.
5. Activate *Demo Settings*.
6. Click *Configure*.
7. When configuration has finished, click *Start*.
8. Check results.

## 6.5.3 Spurious Emissions

Spurious Emissions are emissions caused by unwanted transmitter effects such as harmonic emission, parasitic emission, intermodulation, and frequency conversion products, but exclude out-of-band emissions. (Out-of-band emissions are tested by 6.5.2.1 *Spectrum Emission Mask* and by 6.5.2.2 *Adjacent Channel Leakage Power Ratio* tests.)

The requirement applies to dedicated frequency ranges. Leave a gap from 12.5 MHz below the lowest carrier frequency to 12.5 MHz above the highest carrier frequency used.

The purpose of this test is to verify that the spurious emissions do not exceed the specified limits.

With respect to measurement, the various tests have to be divided into two types with different requirements and thus different hardware test setups:

- General spurious emissions with fairly high limits
- Spurious emissions for base stations collocated with base stations of other services, tests with very low emission limits, requiring high dynamic measurements

The hardware setup differs, but the test procedure is the same.

Tests with fairly high limits are:

#### **6.5.3.4.1 Spurious Emissions Category A**

Test Spurious Emissions (Category A) uses the same hardware setup and test procedure as the other tests below.

#### **6.5.3.4.2 Spurious Emissions Category B**

Test Spurious Emissions (Category B) uses the same hardware setup and test procedure as the other tests below.

##### **6.5.3.4.4.1 Coexistence with GSM900**

Test Spurious Emissions in coexistence with GSM900 uses the same hardware setup and test procedure as the other tests below.

##### **6.5.3.4.5.1 Coexistence with DCS1800**

Test Spurious Emissions in coexistence with DCS1800 uses the same hardware setup and test procedure as the other tests below.

##### **6.5.3.4.6 Coexistence with PHS**

Test Spurious Emissions in coexistence with PHS uses the same hardware setup and test procedure as the other tests below.

##### **6.5.3.4.7 Coexistence with Services in Adj. Bands**

Test Spurious Emissions in coexistence with services in adjacent frequency bands uses the same hardware setup and test procedure as the other tests below.

##### **6.5.3.4.8.1 Coexistence with UTRA TDD**

Test Spurious Emissions in coexistence with UTRA TDD uses the same hardware setup and test procedure as the other tests below.

##### **6.5.3.4.9.1 Coexistence with UTRA Band I**

Test Spurious Emissions in coexistence with UTRA Band I uses the same hardware setup and test procedure as the other tests below.

##### **6.5.3.4.10.1 Coexistence with UTRA Band III**

Test Spurious Emissions in coexistence with UTRA Band III uses the same hardware setup and test procedure as the other tests below.

##### **6.5.3.4.11.1 Coexistence with PCS1900**

Test Spurious Emissions in coexistence with PCS1900 uses the same hardware setup and test procedure as the test below.

##### **6.5.3.4.12.1 Coexistence with GSM850**

**Recommended hardware test setup:**



Fig. 6.5.3\_1 shows the test setup for these eleven tests. The setup is the same as for 6.2.1 Base Station Maximum Output Power.

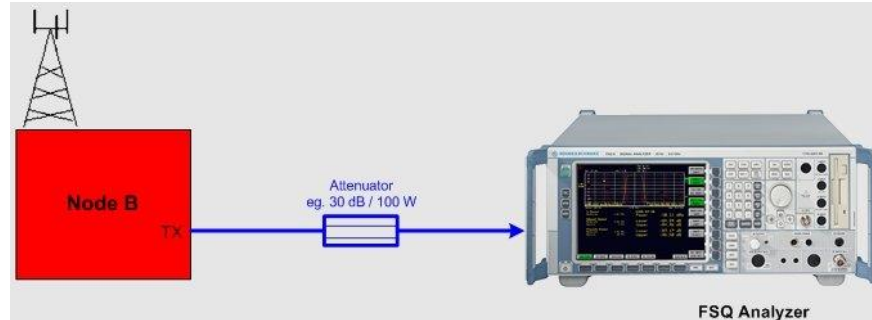


Fig. 6.5.3\_1: Hardware test setup for Spurious Emission test with high limits. The FSQ records and evaluates the downlink signal characteristics. A high-power attenuator protects the input of the analyzer.

Tests with high dynamic requirements are:

#### **6.5.3.4.3 Protection of the BS receiver**

Test Spurious Emissions / Protection of the BS receiver uses the same hardware setup and test procedure as the other tests below.

#### **6.5.3.4.4.2 Coexistence with GSM900 / Coll. BS**

Test Spurious Emissions for BS co-located with GSM900 uses the same hardware setup and test procedure as the other tests below.

#### **6.5.3.4.5.2 Coexistence with DTS1800 / Coll. BS**

Test Spurious Emissions for BS co-located with DTS1800 uses the same hardware setup and test procedure as the other tests below.

#### **6.5.3.4.8.2 Coexistence with UTRA TDD / Coll. BS**

Test Spurious Emissions for BS co-located with UTRA TDD uses the same hardware setup and test procedure as the other tests below.

#### **6.5.3.4.9.2 Coexistence with UTRA Band I / Coll. BS**

Test Spurious Emissions for BS co-located with UTRA Band I uses the same hardware setup and test procedure as the other tests below.

#### **6.5.3.4.10.2 Coexistence with UTRA Band III / Coll. BS**

Test Spurious Emissions for BS co-located with UTRA Band III uses the same hardware setup and test procedure as the other tests below.

### 6.5.3.4.11.2 Coexistence with PCS1900 / Coll. BS

Test Spurious Emissions for BS co-located with PCS1900 uses the same hardware setup and test procedure as the test below.

### 6.5.3.4.12.2 Coexistence with GSM850 / Coll. BS

#### Recommended hardware test setup:

Fig. 6.5.3\_2 shows the test setup for the eight tests.

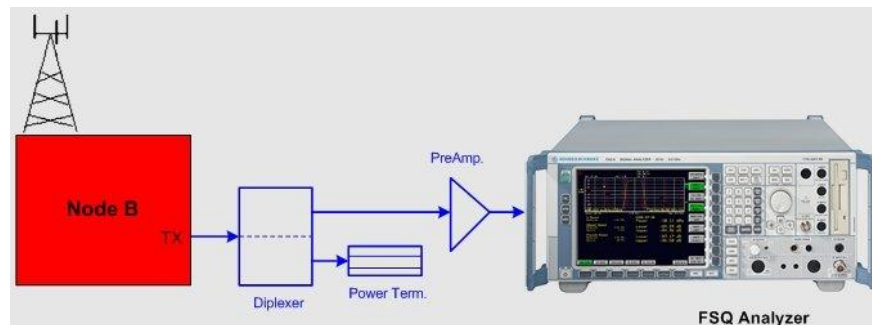


Fig. 6.5.3\_2: Hardware test setup for Spurious Emission test with high dynamic requirements. A diplexer suppresses the base station TX carrier. A preamplifier improves the sensitivity of the test setup.

#### Instruments and accessories:

FSQ (signal analyzer)

- Attenuator, 30 dB, 50 W min., DC to 12.75 GHz (e.g. Suhner)
- For high dynamic tests: diplexer, preamplifier (e.g. MITEC MPN2-00200200-27P)

**Note:** Application Note 1EF45 provides a lot of tips on how to measure spurious emissions on 3GPP Base Station Transmitters, see [5].

#### Path loss compensation:

- Measure the path loss between the base station antenna connector and the FSQ.

#### Test procedure:

1. Connect the base station with the FSQ as shown in Fig. 6.5.3\_1 or 6.5.3\_2, respectively.
2. Run program **3G\_FSMU\_NodeB**.

#### In the program window:

3. Select the appropriate spurious emission test.
4. Select *small Setup* (only the analyzer is needed).
5. Set the analyzer frequency *Freq* to the lowest frequency within the operating frequency band (B frequency).  
This frequency will be taken as the lowest allocated service frequency. The measurements of spurious emissions of category A or B are performed up to 12.5 MHz below this frequency and then are continued at 12.5 MHz above.
6. Enter the analyzer *Path Loss* of your hardware test setup.  
Due to the high span of some spurious tests, enter the (highest) loss at the highest frequency as a first approach. If the test fails at lower frequencies, reduce the path loss to an appropriate value at these frequencies.
7. Click *Optimize Ref Level & Att.*
8. Click *Configure.*

#### On the base station:

9. Set the base station to the lowest frequency within the operating frequency band (B frequency), and to max. output power with a combination of channels specified as test model 1. Use the type of test model 1 (1-64, 1-32, 1-16) with the largest number of channels that can be supported by the base station.

#### In the program window:

10. Click *Start.*
11. Check results.
12. Repeat the test at the highest allocated frequency.

Simulation of Node B doesn't make sense. To demonstrate the principle of operation you may run these tests without a base station connected.

#### Test results:

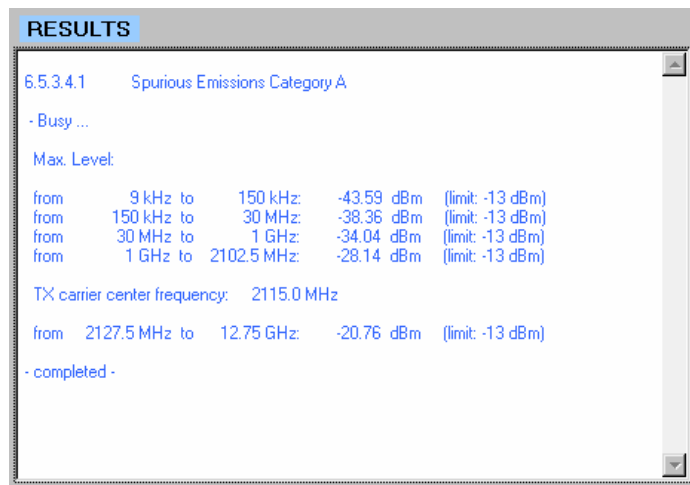


Fig. 6.5.3\_3: Result of Spurious Emission test as provided by program **3G\_FSMU\_NodeB**. Spurious emissions of category A are displayed. You

will see the frequency ranges to be tested, the maximum emission within each range, and the limit in accordance with the standard.

**Note:** For test Spurious Emissions Category A the program **3G\_FSMU\_NodeB** uses the list function of the analyzer:

You can specify different frequency sections each with individual parameters such as Ref.-Level, RBW, sweep time, points per section, and so on.

We recommend the list mode if different ranges have to be scanned. The maximum number of sweep point is 100000. Spurious Emissions Category B exceeds this limit. So this test is still implemented as a sequence of standard sweeps.

### 6.7.1 Error Vector Magnitude

The Error Vector Magnitude (EVM) is a measure of the difference vector (the error vector) between the measured waveform and an ideal reference waveform. The EVM result is defined as the square root of the ratio of the mean error vector power to the mean reference power.

6.7.1 consists of three tests:

1. Set the base station to Pmax using test model 1. Measure the Error Vector Magnitude, Frequency Error, and the mean power of the signal.
2. Set the base station to Pmax minus 18 dB using test model 4. Measure the Error Vector Magnitude, Frequency Error, and the mean power of the signal.

If the base station supports HS-PDSCH transmission using 16QAM:

3. Set the base station to Pmax using test model 5. Measure the Error Vector Magnitude, and the mean power of the signal.

The purpose of this test is to verify that the error vector magnitude is less than 17.5% for a composite signal using only QPSK modulation (test models 1 and 4), and less than 12.5% for a composite signal that includes 16QAM modulation. Together with the EVM, the Frequency Error and the Total Power Dynamic range are checked.

#### Recommended hardware test setup:

Fig. 6.7.1\_1 shows the test setup for Error Vector Magnitude measurements. This setup is the same as for *6.2.1 Base Station Maximum Output Power*.

Test 6.7.1 includes test 6.3 *Frequency Error*. To achieve sufficient accuracy to meet the requirements for this test, you need a high precision 10 MHz reference for FSQ. If the base station reference output does not provide enough long term stability, connect a Rubidium or a Cesium standard to FSQ.

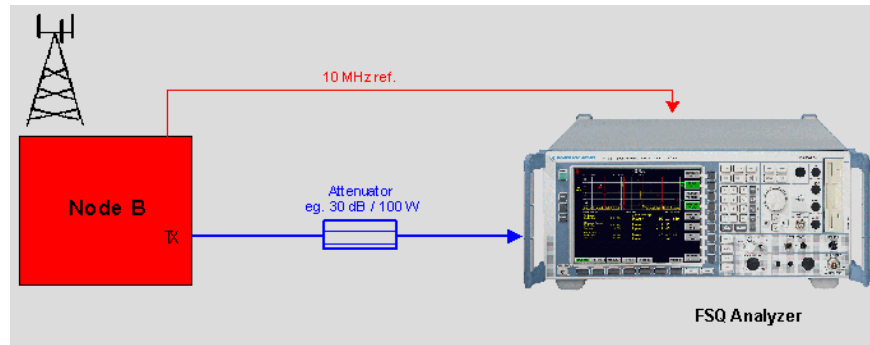


Fig. 6.7.1\_1: Hardware test setup for the Error Vector Magnitude test. The FSQ records and evaluates the downlink signal characteristics. A high-power attenuator protects the input of the analyzer.

**Instruments and accessories:**

FSQ (signal analyzer) with option FS-K72 and FS-K74 installed

Attenuator, 30 dB, 50 W min.

**Path loss compensation:**

- Measure the path loss between the base station antenna connector RX1/TX and the FSQ.

**Test procedure:**

1. Connect the base station with the FSQ as shown in Fig. 6.7.1\_1.
2. Run program **3G\_FSMU\_NodeB**.

**In the program window:**

3. Select *Transmitter Test 6.7.1 / test model 1*.
4. Click check box *Ref. Extern*.
5. Select *small Setup* (only the analyzer is needed).
6. Enter the Pmax of the base station as *BS Output Power*.
7. Set the analyzer frequency *Freq* to the lowest frequency within the operating frequency band (B frequency).
8. Enter the analyzer *Path Loss* of your hardware test setup.
9. Click *Optimize Ref Level & Att*.
10. Enter the scrambling code *Scr Code* of the base station in the analyzer input field.

**3G\_FSMU\_NodeB** expects the **absolute** scrambling code number. For downlink, the base station counts the scrambling codes with increments of 10(hex). These code numbers are called the *primary codes*.

If the documented base station scrambling code is 1, enter 10(hex), for 2 enter 20(hex), and so on.

11. Click *Configure*.

**On the base station:**

12. Set the base station to the lowest frequency within the operating frequency band (B frequency), and to max. output power with a combination of channels specified as test model 1.

**In the program window:**

13. Click *Start*.
14. Check results. Note the measurement results for the global power.
15. Repeat the test at the middle and top frequencies (M and T).
16. Repeat measurements with test 6.7.1 / *test model 4* and base station power set to Pmax minus 18 dB. Calculate the base station total power dynamic from the difference between the measurement results of this test and the previous test using Pmax.
17. Repeat the test at the middle and top frequencies (M and T).
18. If supported by the base station, repeat measurements with test 6.7.1 / *test model 5* and base station power set to Pmax.
19. Repeat the test at the middle and top frequencies (M and T).

**Test results:**

Fig. 6.7.1\_2 shows a measurement result on the analyzer screen. Fig. 6.7.1\_3 shows the numeric evaluation of program 3G\_FSMU\_NodeB.

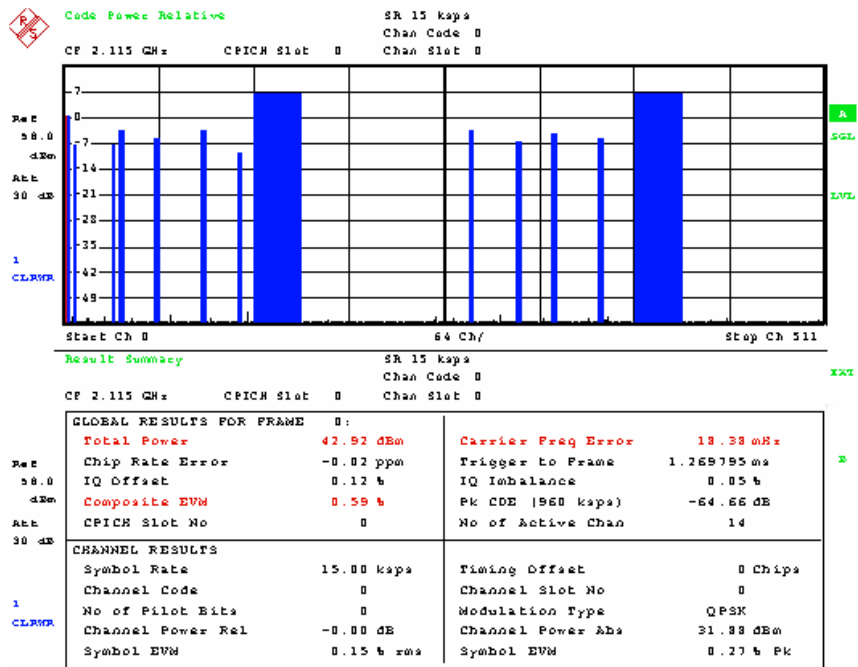


Fig. 6.7.1\_2: Error Vector Magnitude results of a composite signal including 16QAM modulation (test model 5). In the upper half of the screen, the analyzer displays the code domain representation of the downlink signal. The lower half of the screen shows the numeric measurement results. It contains the *GLOBAL RESULTS* as total power, frequency error, and the composite error vector magnitude to be checked by this test. The *CHANNEL RESULTS* field provides additional information about the channel that is selected in the code domain display, e.g. the absolute channel power, and the EVM of this channel.

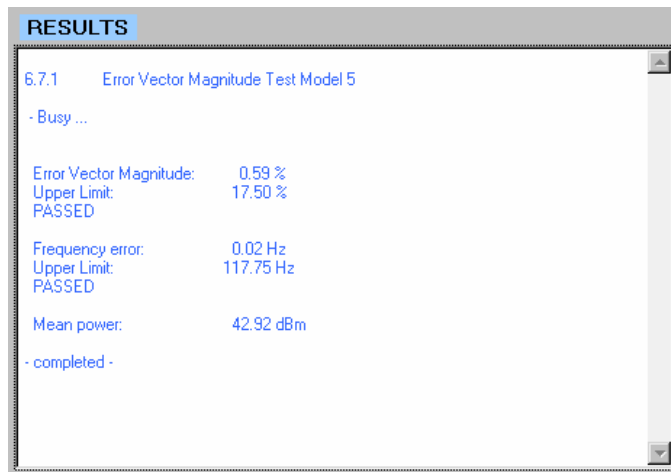


Fig. 6.7.1\_3: Error Vector Magnitude test as provided by program **3G\_FSMU\_NodeB**

*PASSED* is displayed if the EVM and the Frequency Error are below the standard limits.

You can repeat the measurement without reconfiguring the instruments. Simply click *Start* again.

#### Simulation of Node B by the SMU:

1. Connect the FSQ input directly with (port A of) the SMU.
2. Run program **3G\_FSMU\_NodeB**.

#### In the program window:

3. Select *Transmitter Test 6.7.1 / any test model*.
4. Use full (not small) setup. If the generator input fields are not visible, activate the *remote control* check box of the generator.
5. Activate *Demo Settings*.
6. Click *Configure*.
7. When the configuration has finished, click *Start*.
8. Check results.

## 6.7.2 Peak Code Domain Error

The code domain error is computed by projecting the error vector (as defined in 6.7.1) onto the code domain at spreading factor 256. It is expressed as the ratio of the mean power of the error vector for each single code to the mean power of the composite waveform. The Peak Code Domain Error (PCDE) is defined as the maximum of these 256 values.

The purpose of this test is to verify that the peak code domain error is less than  $-32$  dB to limit intercode crosstalk.

The test uses test model 3.

#### Recommended hardware test setup:

Fig. 6.7.2\_1 shows the test setup for Peak Code Domain Error. This setup is the same as for 6.2.1 *Base Station Maximum Output Power*.

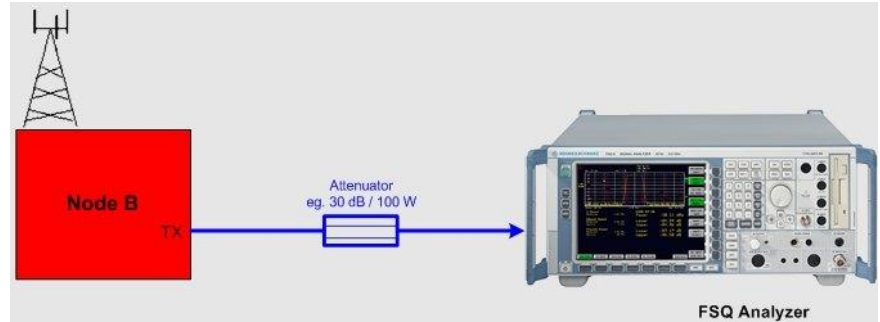


Fig. 6.7.2\_1: Hardware test setup for Peak Code Domain Error test. The FSQ records and evaluates the downlink signal characteristics. A high-power attenuator protects the input of the analyzer.

### Instruments and accessories:

- FSQ (signal analyzer) with option FS-K72 installed
- Attenuator 30 dB, 50 W min.

### Path loss compensation:

- Measure the path loss between the base station TX connector and the FSQ.

### Test procedure:

1. Connect the base station with the FSQ as shown in Fig. 6.7.2\_1.
2. Run program **3G\_FSMU\_NodeB**.

### In the program window:

3. Select *Transmitter Test 6.7.2*.
4. Select *small Setup* (only the analyzer is needed).
5. Enter the Pmax of the base station as *Output Power*.
6. Set the analyzer frequency *Freq* to the lowest frequency within the operating frequency band (B frequency).
7. Enter the analyzer *Path Loss* of your hardware test setup.
8. Click *Optimize Ref Level & Att*.
9. Enter the scrambling code *Scr Code* of the base station in the analyzer input field.

**3G\_FSMU\_NodeB** expects the **absolute** scrambling code number. For downlink, the base station counts the scrambling codes with increments of 10(hex). These code numbers are called the *primary codes*.

If the documented base station scrambling code is 1, enter 10(hex), for 2 enter 20(hex), and so on.

10. Click *Configure*.

### On the base station:



- Set the base station to the lowest frequency within the operating frequency band (B frequency), and to max. output power with a combination of channels specified as test model 1.

**In the program window:**

- Click *Start*.
- Check results.
- Repeat the test at the middle and top frequencies (M and T).

**Test results:**

Fig. 6.7.2\_2 shows a measurement result on the analyzer screen. Fig. 6.7.2\_3 shows the numeric evaluation of program **3G\_FSMU\_NodeB**.

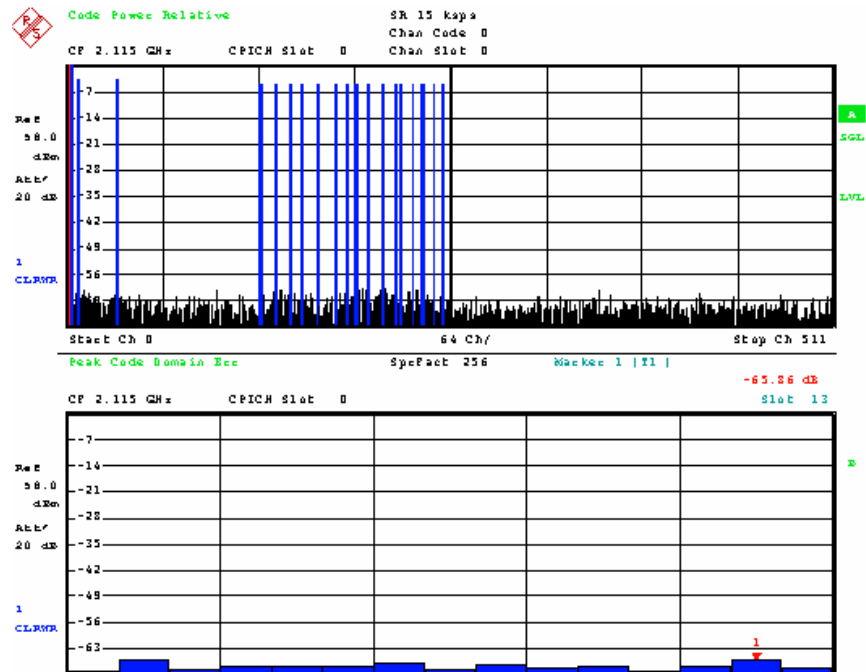


Fig. 6.7.2\_2: Peak Code Domain Error on the analyzer. In the upper half of the screen, the analyzer displays the code domain representation of the downlink signal. The code domain errors appear as the 'noise floor'.

The lower half of the screen shows the Peak Code Domain Error versus slot. The marker is set to maximum.

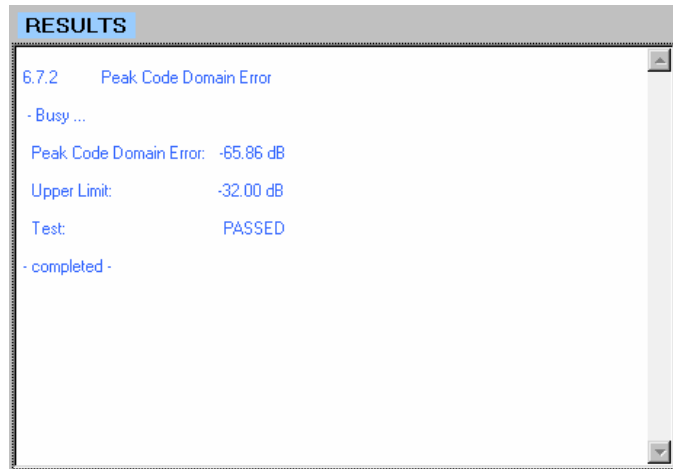


Fig. 6.7.2\_3: Peak Code Domain Error as provided by program **3G\_FSMU\_NodeB**.

*PASSED* is displayed if the peak code domain error is equal to or less than  $-32$  dB.

You can repeat the measurement without reconfiguring the instruments. Simply click *Start* again.

### Simulation of Node B by the SMU:

1. Connect the FSQ input directly with (port A of) the SMU.
2. Run program **3G\_FSMU\_NodeB**.

### In the program window:

3. Select *Transmitter Test 6.7.2*.
4. Use full (not small) setup. If the generator input fields are not visible, activate the *remote control* check box of the generator.
5. Activate *Demo Settings*.
6. Click *Configure*.
7. When the configuration has finished, click *Start*.
8. Check results.

## 7 Receiver Tests

The receiver tests assume that the base station under test is not equipped with RX diversity. For receivers with diversity, tests are to be performed by applying the specific signals to one of the receiver inputs, and terminating or disabling the other(s).

Once the base station has synchronized to the incoming signals, the bit error rate (BER) is measured. This can be done internally or by external equipment connected to the base station.

For internal BER calculation, test 7.8 (Verification of the Internal BER Calculation) should be done first. This is a test without RF impairments, using fairly high signal levels.

All other tests work with very low RX levels.

Graphical User Interface GUI of program **3G\_FSMU\_NodeB**:

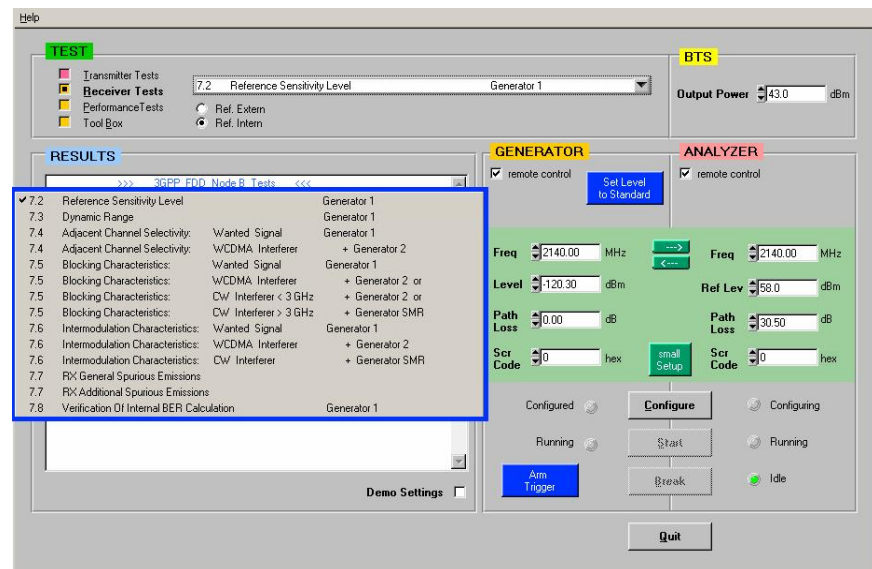


Fig. 7\_1: GUI for all RX tests, and a test list. If you click *Small Setup* the edit fields for the analyzer disappear, and program **3G\_FSMU\_NodeB** runs with maximum speed.

- To program the levels of TS 25.141, click *Set Level to Standard*.
- To quickly raise the signals out of the noise, click *Demo Settings*.

Most of the receiver tests apply signal impairments to the wanted signal, such as additive white Gaussian noise (AWGN), or WCDMA and CW interferers.

These signals are generated independently. As an example, Figure 7\_2 shows the paths inside a two-channel SMU for test 7.4 *Adjacent Channel Selectivity*.

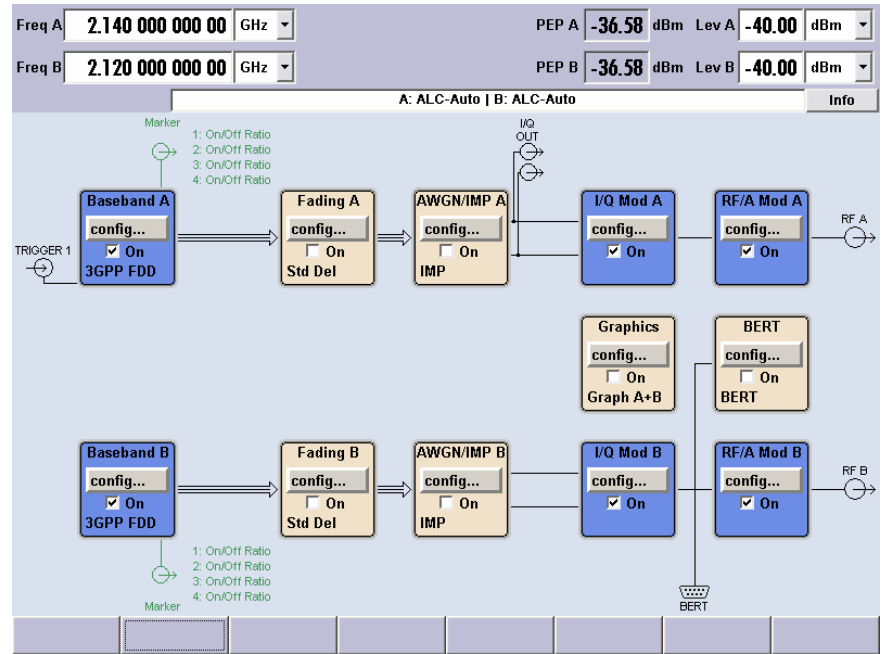


Figure 7\_2: Independent generation of a wanted WCDMA signal and a WCDMA interferer in a two-channel SMU. If AWGN is used, it is added in the baseband. RF signals are combined later outside the generator.

## 7.2 Reference Sensitivity Level

The Reference Sensitivity Level is the minimum mean input power at which the BER must not exceed 0.1%. The reference limit is specified as  $-120.3$  dBm in TS 25.141.

The purpose of this test is to verify that the BER does not exceed 0.1% at the reference sensitivity limit. The test is performed under static conditions without any interfering signal. An uplink reference measurement channel (RMC) with a data rate of 12.2 kbps is used.

### Recommended hardware test setup:

Fig. 7.2\_1 shows the test setup for reference sensitivity level measurements.

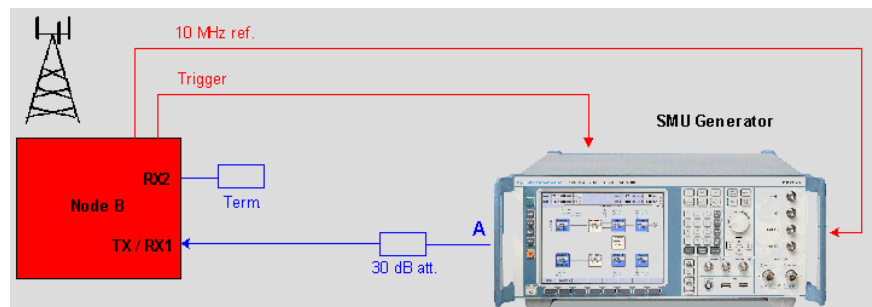


Fig. 7.2\_1: Hardware test setup for the Reference Sensitivity Level test. The SMU establishes an uplink reference measurement channel with a data rate of 12.2 kbps. To improve the impedance matching of the base station and generator (for high level accuracy), a 30 dB attenuator is inserted into the RF path. The bit error rate BER is calculated either internally or by a PC connected to the base station.

To synchronize the SMU to the base station frame timing Node B provides a trigger which starts the generator. Connect this signal to the BNC socket *TRIGGER1* on the frontpanel of the SMU. Trigger could be the start of frame number (SFN), or a signal that indicates the start of a data block (e.g. transmission time interval (TTI)).

- Some base stations provide a DC bias at the RX connector to supply a mast amplifier. Make sure that the bias is disabled, or use a DC blocking circuitry between base station and SMU.

### Instruments and accessories:

- SMU (generator), FSMU standard configuration
- Attenuator 30 dB, Termination

### Path loss compensation:

- Measure the path loss between the base station antenna connector RX1/TX and the SMU.

### Test procedure:

1. Connect the base station with the SMU as shown in Fig. 7.2\_1.
2. Run program **3G\_FSMU\_NodeB**.

### In the program window:

3. Select *Receiver Test 7.2 Reference Sensitivity Level*.
4. Click check box *Ref. Extern*.
5. Select *small Setup* (only the generator is needed).
6. Set the generator frequency *Freq* to the lowest frequency within the operating frequency band (B frequency).

generator frequency = base station TX frequency minus 190 MHz

7. Enter the generator *Path Loss* of your hardware test setup.
8. Click *Set Level to Standard*.
9. Enter the uplink scrambling code *Scr Code*.
10. Click *Configure*.

### On the base station:

11. Set the base station to receive and to calculate the BER. Start with the lowest frequency within the operating frequency band (B frequency).

### In the program window:

12. Click *Start*.
13. Wait until the SMU has been triggered.

### On the base station:

14. Wait until the base station receiver has counted the specified number of frames.
15. Check the bit error rate.
16. Repeat the test at the middle and top frequencies (M and T).

### Test results:

Because the BER is calculated and displayed at the individual base station or on a PC connected to the base station, no general result form can be provided here. Most BS test manager programs display the bit error rate and block error rate (BER and BLER) and the number of counted bits and frames.

- Without a trigger, the SMU signal is unmodulated.
- If the base station does not synchronize, check the frequency and (uplink) scrambling code.

### Analyzing the uplink signal of the SMU:

With full setup in program **3G\_FSMU\_NodeB**, the analyzer can display the RMC in the frequency domain. Connect the analyzer and generator RF ports and increase the output level at the SMU to raise the signal above the noise. Install option FS-K73 on the FSQ to examine the uplink signal in the code domain.

## 7.3 Dynamic Range

The receiver Dynamic Range is the ability to handle a certain amount of Additive White Gaussian noise (AWGN) in the reception channel. The level of the WCDMA uplink signal (wanted signal) is set to  $-89.8$  dBm, and the level of the AWGN interfering signal to  $-73$  dBm/3.84 MHz bandwidth.

The purpose of this test is to verify that the BER does not exceed 0.1% under these conditions. For the wanted signal, an RMC with a data rate of 12.2 kbps is used.

### Recommended hardware test setup:

Fig. 7.3\_1 shows the test setup for Dynamic Range measurements. It is the same setup as used for test 7.2.

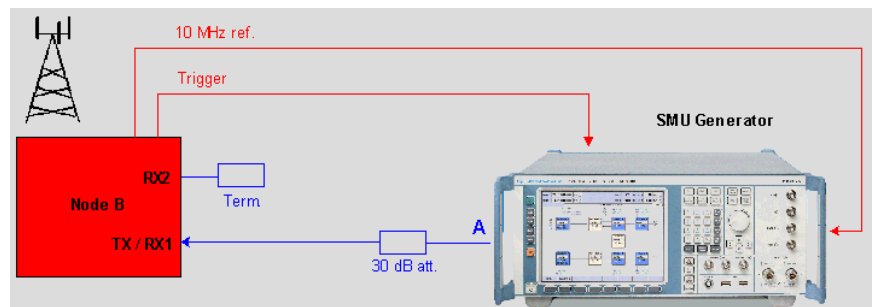


Fig. 7.3\_1: Hardware test setup for the Dynamic Range test. The SMU establishes both the uplink reference measurement channel (wanted signal) and the AWGN interferer. These signals are combined inside the generator in the base band.

To improve the impedance matching of the base station and generator (for high level accuracy), a 30 dB attenuator is inserted into the RF path. The bit error rate (BER) is calculated either internally or by a PC connected to the base station.

To synchronize the SMU to the base station frame timing Node B provides a trigger which starts the generator. Connect this signal to the BNC socket *TRIGGER1* on the frontpanel of the SMU. Trigger could be the start of frame number (SFN) or a signal that indicates the start of a data block (e.g. transmission time interval (TTI)).

- Some base stations provide a DC bias at the RX connector to supply a mast amplifier. Make sure that the bias is disabled, or use a DC blocking circuitry between base station and SMU.

### Instruments and accessories:

- SMU (generator), FSMU standard configuration
- Attenuator 30 dB, RF termination

### Path loss compensation:

- Measure the path loss between the base station antenna connector RX1/TX and the SMU.

### Test procedure:

1. Connect the base station with the SMU as shown in Fig. 7.2\_1.
2. Run program **3G\_FSMU\_NodeB**.

### In the program window:

3. Select *Receiver Test 7.3 Dynamic Range*.
4. Click check box *Ref. Extern*.
5. Select *small Setup* (only the generator is needed).
6. Set the generator frequency *Freq* to the lowest frequency within the operating frequency band (B frequency).

generator frequency = base station TX frequency minus 190 MHz

7. Enter the generator *Path Loss* of your hardware test setup.
8. Click *Set Level to Standard*.  
This sets the levels of the wanted and the interfering signals.

The bandwidth of the AWGN interferer has to be greater than 3.84 MHz. It is set to 7.68 MHz by program **3G\_FSMU\_NodeB**. Accordingly, the AWGN level is raised by 3 dB from -73 dBm to -70 dBm.

9. Enter the uplink scrambling code *Scr Code*.
10. Click *Configure*.

### On the base station:

11. Set the base station to receive and to calculate the BER. Start with the lowest frequency within the operating frequency band (B frequency).

### In the program window:

12. Click *Start*.
13. Wait until the SMU has been triggered.

### On the base station:

14. Wait until the base station receiver has counted the specified number of frames.
15. Check the bit error rate.
16. Repeat the test at the middle and top frequencies (M and T).

### Test results:

Because the BER is calculated and displayed at the individual base station or on a PC connected to the base station, no general result form can be provided here. Most BS test manager programs display the bit error rate and block error rate (BER and BLER) and the number of counted bits and frames.

- Without a trigger, the SMU signal is unmodulated.
- If the base station does not synchronize, check the frequency and (uplink) scrambling code, and repeat the test with AWGN switched off.



**Analyzing the uplink signal of the SMU:**

With full setup in program **3G\_FSMU\_NodeB**, the analyzer can display the RMC signal in the frequency domain. Connect the analyzer and generator RF ports and increase the output level on the SMU.

For this test, the wanted signal is hidden below the noise. If you increase the output level, the ratio of the wanted signal to the AWGN interferer is kept constant by the SMU. As a result, you will initially see only higher noise on the screen. Then switch off the AWGN to make the wanted signal visible.

Fig. 7.3\_2 shows the wanted signal with and without the AWGN interferer.

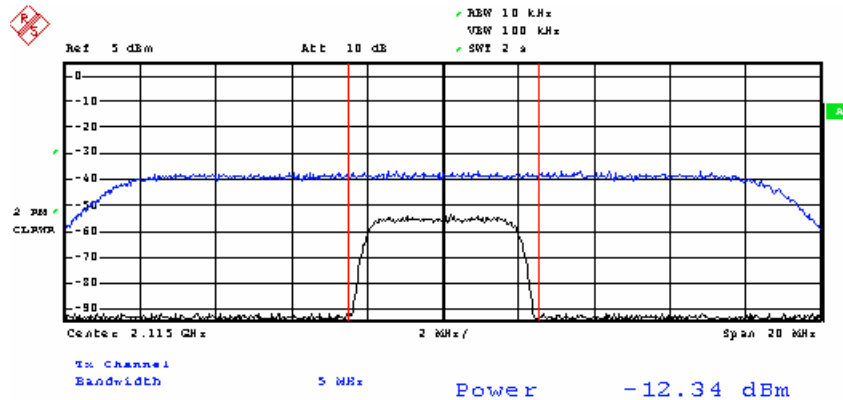


Fig. 7.3\_2: The wanted signal is hidden below the noise. The lower trace shows the wanted signal with AWGN switched off, the upper trace the sum of wanted and AWGN signal.

Install option FS-K73 on the FSQ to examine the uplink signal in the code domain. The FSQ only synchronizes if AWGN is switched off.

**7.4 Adjacent Channel Selectivity ACS**

Adjacent Channel Selectivity is the ability of the base station to receive a wanted uplink signal in the presence of an adjacent channel signal.

The level of the wanted signal is set to  $-115$  dBm, and the level of the adjacent channel signal to  $-52$  dBm. The frequency offset is  $\pm 5$  MHz.

The purpose of this test is to verify that the BER does not exceed 0.1% under these conditions. For the wanted signal, an RMC with a data rate of 12.2 kbps is used.

**Recommended hardware test setup:**

Fig. 7.4\_1 shows the test setup for Adjacent Channel Selectivity measurements.

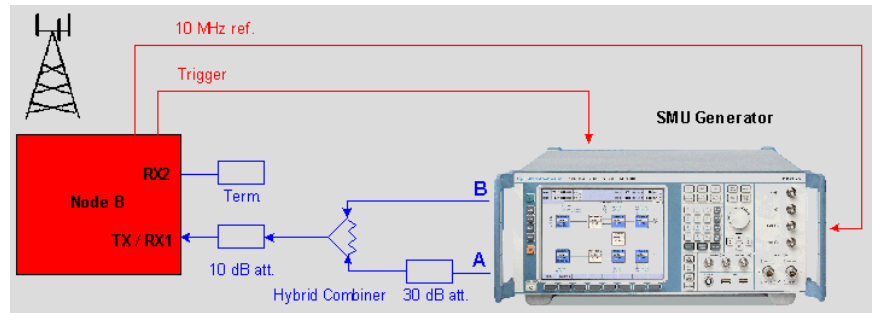


Fig. 7.4\_1: Hardware test setup for the Adjacent Channel Selectivity test. Both the wanted signal and the adjacent channel interferer can be generated by one two-channel SMU or two single-channel SMUs. The wanted and interferer signals are added together by a hybrid combiner. A 30 dB attenuator decouples the two paths further and enhances the level accuracy of the wanted signal. To improve the impedance matching at the base station RF connector, another attenuator is inserted into the RF path.

The bit error rate (BER) is calculated either internally or by a PC connected to the base station.

To synchronize the SMU to the base station frame timing Node B provides a trigger which starts the generator. Connect this signal to the BNC socket *TRIGGER1* on the frontpanel of the SMU. The Trigger could be the start of frame number (SFN), or a signal that indicates the start of a data block (e.g. transmission time interval (TTI)).

- Some base stations provide a DC bias at the RX connector to supply a mast amplifier. Make sure that the bias is disabled, or use a DC blocking circuitry between base station and SMU.

**Instruments and accessories:**

- SMU (generator) in FSMU Standard configuration + options FSMU-B1 + FSMU-B2
- Attenuators 10 dB, 30 dB, RF termination
- Hybrid combiner 1920 MHz to 1980 MHz (e.g. Minicircuits ZFSC-2-2500)

**Path loss compensation:**

- Measure the path losses between the base station antenna connector RX1/TX and each of the two SMU outputs.

**Test procedure:**

1. Connect the base station with the SMU as shown in Fig. 7.4\_1.
2. Run program **3G\_FSMU\_NodeB**.

**Generate wanted signal**

**In the program window:**

3. Select *Receiver Test 7.4 Adjacent Channel Selectivity / Wanted Signal*.
4. Click check box *Ref. Extern*.
5. Select *small Setup* (only the generator is needed).

6. Set the generator frequency *Freq* to the lowest frequency within the operating frequency band (B frequency).

generator frequency = base station TX frequency minus 190 MHz

7. Enter the generator *Path Loss* between RF port A of the SMU and the RF port of the base station.
8. Click *Set Level to Standard*.
9. Enter the uplink scrambling code *Scr Code*.
10. Click *Configure*.

**Note:** If you use a two-channel SMU, *Configure* will reset both channel A and channel B.

11. When configuration has finished, click *Start*. Generator 1 now waits for the trigger signal from the base station.

#### Generate interferer signal at –5 MHz offset

##### In the program window:

12. Select *Receiver Test 7.4 Adjacent Channel Selectivity / WCDMA Interferer*.
13. Click check box *Ref. Extern*.
14. Select *small Setup* (only the generator is needed).
15. Set the generator frequency *Freq* to the lowest frequency within the operating frequency band minus 5 MHz (B frequency minus 5 MHz).
16. Enter the generator *Path Loss* between RF port B of the SMU and the RF port of the base station.
17. Click *Set Level to Standard*.
18. Enter the uplink scrambling code *Scr Code*.
19. Click *Configure*.

**Note:** If you use a two-channel SMU, *Configure* will cause no RESET.

20. When configuration has finished, click *Start*. The interferer signal is now active.

##### On the base station:

21. Set the base station to receive and to calculate the BER. Start with the lowest frequency within the operating frequency band (B frequency).
22. Wait until the SMU has been triggered.
23. Wait until the base station receiver has counted the specified number of frames.
24. Check the bit error rate.

#### Repeat the test at +5 MHz offset:

**In the program window:** (still *Receiver Test 7.4 Adjacent Channel Selectivity / WCDMA Interferer*)

25. Set the interferer frequency to the lowest frequency within the operating frequency band plus 5 MHz (B frequency plus 5 MHz).
26. Select *Receiver Test 7.4 Adjacent Channel Selectivity / Wanted Signal*.

**Note:** Do not click *Configure*. This would reset both channel A and channel B (on a two-channel SMU).

27. Click *Reset Trigger*. Generator 1 now waits for the trigger signal from the base station.
28. Repeat steps 21 to 24.
  
29. Repeat steps 3 to 28 at the middle and top frequencies (M and T).

### Test results:

Because the BER is calculated and displayed at the individual base station or on a PC connected to the base station, no general result form can be provided here. Most BS test manager programs display the bit error rate and the block error rate (BER and BLER) and the number of counted bits and frames.

### Analyzing the uplink signal of the SMU:

With full setup in program **3G\_FSMU\_NodeB**, the frequency and modulation bandwidth of the wanted and the interfering signals can be measured by the analyzer. Connect the RF ports of the analyzer and generator. Install option FS-K73 on the FSQ to examine the uplink signal in the code domain.

- Without a trigger, the SMU signal is unmodulated.
- If the base station does not synchronize, check the frequency and (uplink) scrambling code and repeat the test.

## 7.5 Blocking Characteristics

The Blocking Characteristics are a measure of the receiver's ability to receive a wanted signal in the presence of an unwanted interferer at frequencies other than those of the adjacent channels.

The purpose of this test is to verify that the base station receiver can withstand high-level interference with the BER not exceeding 0.1%.

All interferer frequencies between 1 MHz and 12.75 GHz have to be tested in a 1 MHz grid, with a gap of  $\pm 12.5$  MHz around the wanted signal. For each of these frequencies, a bit error measurement is performed.

There are two types of interfering signals; see Fig. 7.5\_1.

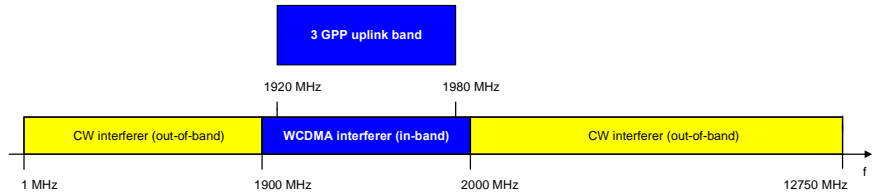


Fig. 7.5\_1: Interferer frequency band and types of interferer. From 1900 MHz to 2000 MHz, a WCDMA interferer is applied. Below and above, the interferer signal is an unmodulated CW carrier.

If the base station is collocated with GSM800, GMM850, PCS1900, and base stations operating in the DCS1800 band, there are additional tests with a higher interferer level.

Program **3G\_FSMU\_NodeB** can neither initiate the test at the base station nor read the BER results from there. This means that it is not possible to run a Blocking test with frequencies automatically incremented. Thus, if a BER measurement has finished, increment the interfering frequency on program **3G\_FSMU\_NodeB** and start the next test at the base station.

**Recommended hardware test setup:**

For Blocking tests without collocated base stations, two test setups are shown in Figs. 7.5\_2 and 7.5\_3. The first setup is for frequencies below 3 GHz, and the second for frequencies up to 12.75 GHz. If base stations are collocated, use the test setup shown in Fig. 7.5\_4.

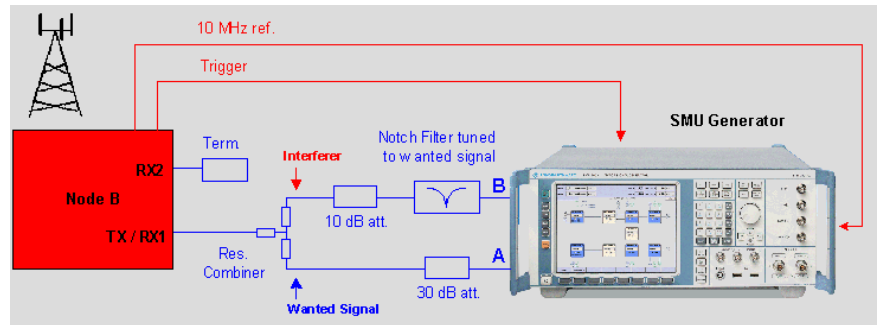


Fig. 7.5\_2: Test setup for frequencies up to 3 GHz. Both the wanted signal and the adjacent channel interferer can be generated by one two-channel SMU or two single-channel SMUs. The wanted and interferer signals are added together by a resistive combiner. A 30 dB attenuator in the generator paths decouples the instruments and enhances the level accuracy of the wanted signal. The notch filter in the interferer path yields an ACLR of 72 dB as mentioned in the standard. Tune it to the center frequency of the wanted signal.

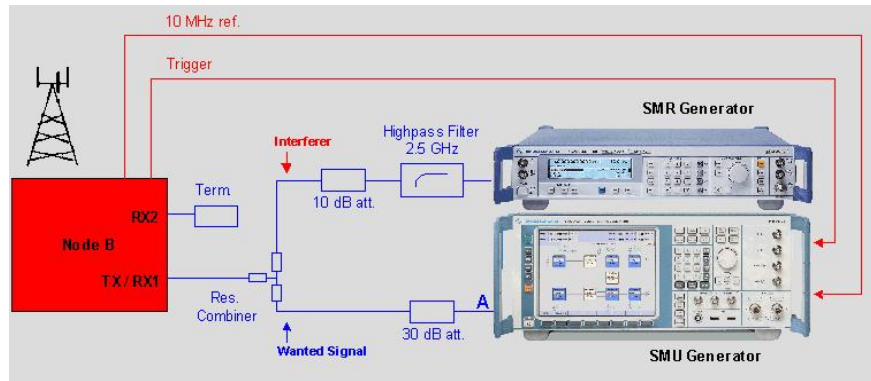


Fig. 7.5\_3: Test setup for frequencies greater than 3 GHz. The SMU generates the wanted signal. The adjacent channel interferer comes from the SMR. The two signals are added together by a resistive combiner. A 30 dB attenuator in the generator paths decouples the instruments and enhances the level accuracy of the wanted signal. The high-pass filter in the interferer path yields an ACLR of 72 dB as mentioned in the standard.

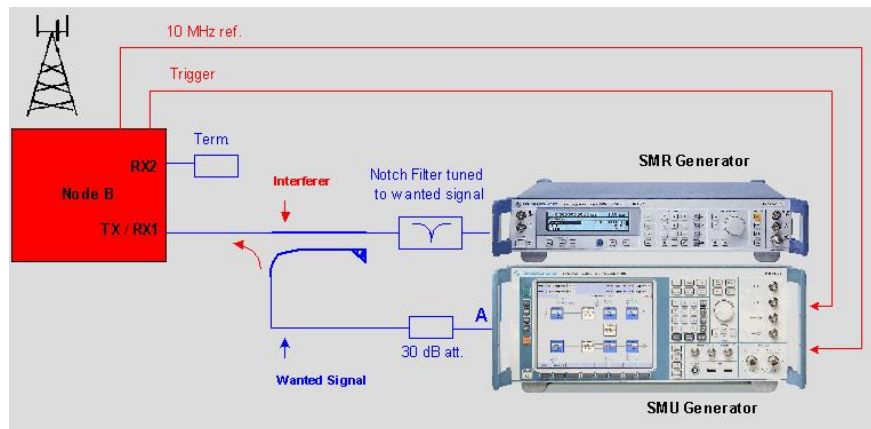


Fig. 7.5\_4: Test setup if base stations are collocated. A high-level interferer signal of 16 dBm is provided by the SMR. A directional coupler combines the wanted signal and unwanted interferer with low insertion loss. The notch filter in the interferer path yields an ACLR of 72 dB as mentioned in the standard. Tune it to the center frequency of the wanted signal.

The bit error rate (BER) is calculated inside the base station or on a connected PC.

To synchronize the SMU to the base station frame timing Node B provides a trigger which starts the generator. Connect this signal to the BNC socket *TRIGGER1* on the frontpanel of the SMU. Trigger could be the start of frame number (SFN) or a signal that indicates the start of a data block (e.g. transmission time interval (TTI)).

- Some base stations provide a DC bias at the RX connector to supply a mast amplifier. Make sure that the bias is disabled, or use a DC blocking circuitry between base station and SMU.

**Instruments and accessories:**

- SMR (generator)
- SMU (generator) as in FSMU Standard configuration + options FSMU-B1 + FSMU-B2

- Attenuators 10 dB, 30 dB, RF termination,
- Resistive combiner up to 12.75 GHz (e.g. Weinschel 1515-1)
- Tunable Notch filter (e.g. Wainwright WRCT 1900/2200-5/40-10SSK)
- 3 GHz highpass filter (e.g. Filtek HP12/3000-5AA)
- Directional coupler (e.g. Krytar Model 1815)

### Path loss compensation:

- Measure the path loss between the base station antenna connector RX1/TX and both generator paths.

### Test procedure:

1. Connect the base station with the SMU as shown in Fig. 7.5\_2, 7.5\_3, or 7.5\_4, respectively
2. Run program **3G\_FSMU\_NodeB**.

### In the program window:

#### Wanted signal

3. Select *Receiver Test 7.5 Blocking Characteristics Wanted Signal*.
4. Click check box *Ref. Extern*.
5. Select *small Setup* (only the generator is needed).
6. Set the generator frequency *Freq* to the middle frequency within the operating frequency band (M frequency).
7. Enter the *Path Loss* of the wanted signal.
8. Click *Set Level to Standard*.
9. Enter the uplink scrambling code *Scr Code*.
10. Click *Configure*.

**Note:** If you use a two-channel SMU, *Configure* will reset both channel A and channel B.

11. Click *Start*.

#### Interferer signal

12. Select *Receiver Test 7.5 Blocking Characteristics WCDMA Interferer*, or *CW Interferer < 3 GHz*, or *CW Interferer > 3 GHz*, respectively.
13. Click check box *Ref. Extern*.
14. Select *small Setup* (only the generator is needed).
15. Set the generator frequency *Freq* to the interferer frequency.
16. Enter the *Path Loss* of the interfering signal.
17. Enter as interferer Level: 

<i>noncollocated WCDMA</i>	<i>-40 dBm</i>
<i>noncollocated CW</i>	<i>-15 dBm</i>
<i>collocated base stations</i>	<i>+ 16 dBm</i>
18. For the WCDMA interferer, enter a scrambling code *Scr Code* that is different from the scrambling code of the uplink signal.
19. Click *Configure*.
20. Click *Start*.

**On the base station:**

21. Set the base station to receive at frequency M and to calculate the BER.
22. Wait until the SMU has been triggered.
23. Check the bit error rate.

-----  
**Next frequency:**

24. Enter the next interferer frequency on the generator.

**In the program window:**

25. Select *Receiver Test 7.5 Blocking Characteristics Wanted Signal*.

**Note:** Do not click *Configure*. This would reset both channel A and channel B (on a two-channel SMU).

30. Click *Arm Trigger*. Generator 1 now waits for the trigger signal from the base station.

**On the base station:**

31. Set the base station to receive at frequency M and to calculate the BER.
32. Wait until the SMU has been triggered.
33. Check the bit error rate.
34. Repeat steps 24 to 33 with other interferer frequencies.

**Test results:**

Because the BER is calculated and displayed at the individual base station or on a PC connected to the base station, no general result form can be provided here. Most BS test manager programs display the bit error rate and block error rate (BER and BLER) and the number of counted bits and frames.

- Without a trigger, the SMU signal is unmodulated.
- If the base station does not synchronize, check the frequency and (uplink) scrambling code.



## 7.6 Intermodulation Characteristics

Mixing of interfering signals can produce an interfering signal in the used receive channel. During this test, a WCDMA carrier with a 20 MHz offset to the wanted signal and a CW interferer with a 10 MHz offset are applied to check the intermodulation response rejection; see Fig. 7.6\_1.

The purpose of this test is to verify that the BER does not exceed 0.1% under these conditions. For the wanted signal, an RMC with a data rate of 12.2 kbps is used.

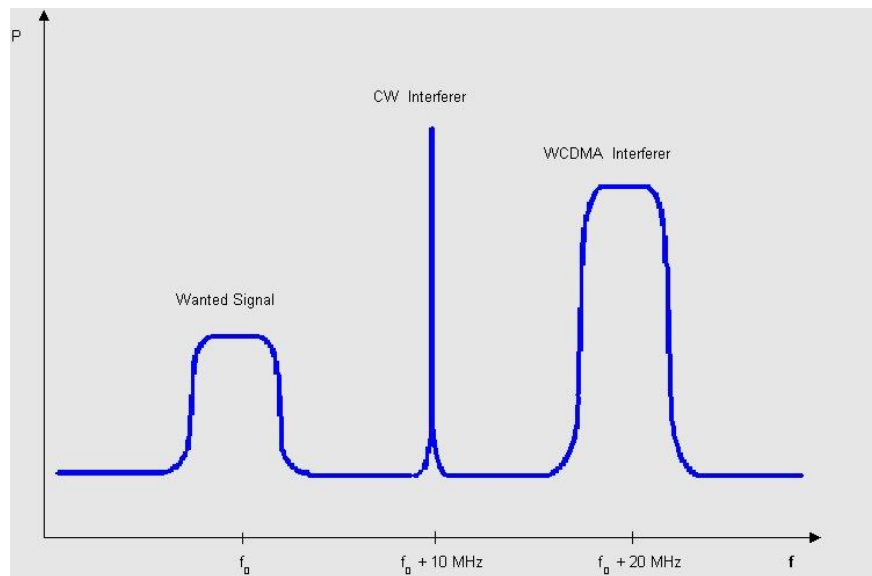


Fig. 7.6\_1: Signals applied during Intermodulation Characteristics test. Third-order mixing products of the WCDMA and CW interferers with high amplitude will fall within the band of the wanted signal.

### Recommended hardware test setup:

Fig. 7.6\_2 shows the test setup for Intermodulation Characteristics measurements.

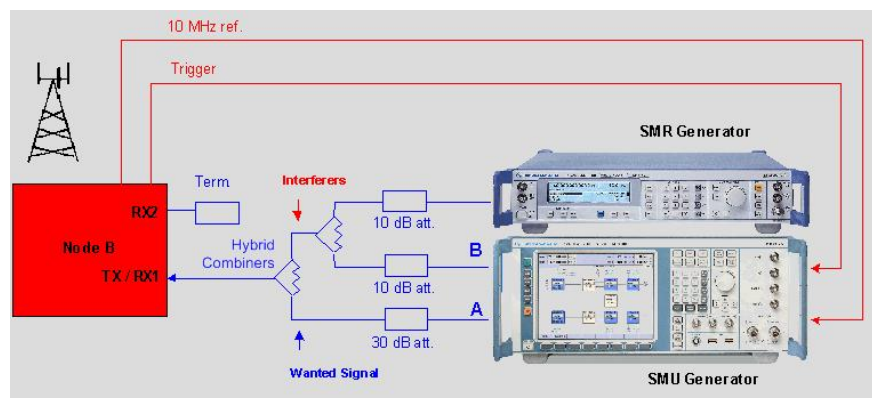


Fig. 7.6\_2: Hardware test setup for the Intermodulation Characteristics test. One two-channel SMU or two single-channel SMUs establish the uplink reference measurement channel (wanted signal) and a WCDMA interferer. An SMR generates the CW interferer. The signals are added together via hybrid combiners. Additional attenuators decouple the instruments.

To synchronize the SMU to the base station frame timing Node B provides a trigger which starts the generator. Connect this signal to the BNC socket *TRIGGER1* on the frontpanel of the SMU. Trigger could be the start of frame number (SFN) or a signal that indicates the start of a data block (e.g. transmission time interval (TTI)).

- Some base stations provide a DC bias at the RX connector to supply a mast amplifier. Make sure that the bias is disabled, or use a DC blocking circuitry between base station and SMU.

### Instruments and accessories:

- SMU (generator) as in FSMU Standard configuration + options FSMU-B1 + FSMU-B2, SMR
- Attenuators 10 dB, 30 dB, RF termination
- Hybrid combiners 1920 MHz to 1980 MHz (e.g. Minicircuits ZFSC-2-2500)

### Path loss compensation:

- Measure the path loss of the wanted signal and interferer paths.

### Test procedure:

1. Connect the base station with the SMU as shown in Fig. 7.6\_2.
2. Run program **3G\_FSMU\_NodeB**.

### Wanted signal

#### In the program window:

3. Select *Receiver Test 7.6 Intermodulation Characteristics Wanted Signal*.
4. Click check box *Ref. Extern*.
5. Select *small Setup* (only the generator is needed).
6. Set the generator frequency *Freq* to the lowest frequency within the operating frequency band (B frequency).

generator frequency = base station TX frequency minus 190 MHz

7. Enter the generator *Path Loss* of the wanted signal.
8. Click *Set Level to Standard*.
9. Enter the uplink scrambling code *Scr Code*.

10. Click *Configure*.

**Note:** If you use a two-channel SMU, *Configure* will reset both channel A and channel B.

11. Click *Start*.

### WCDMA interferer

12. Select *Receiver Test 7.6 Intermodulation Characteristics WCDMA Interferer*.

13. Click check box *Ref. Extern.*
14. Select *small Setup* (only the generator is needed)
15. Set the generator frequency *Freq* to the frequency of the wanted signal plus 20 MHz.
16. Enter the generator *Path Loss* of the WCDMA interferer path.
17. Click *Set Level to Standard.*
18. Enter a scrambling code *Scr Code* that is not the scrambling code of the wanted signal.
  
19. Click *Configure.*
20. Click *Start.*

### **CW interferer**

21. Select *Receiver Test 7.6 Intermodulation Characteristics CW Interferer.*
22. Click check box *Ref. Extern.*
23. Select *small Setup* (only the generator is needed).
24. Set the generator frequency *Freq* to the frequency of the wanted signal plus 10 MHz.
25. Enter the generator *Path Loss* of the CW interferer path.
26. Click *Set Level to Standard.*
27. Click *Configure.*
28. Click *Start.*

### **On the base station:**

29. Set the base station to receive and to calculate the BER. Start with the lowest frequency within the operating frequency band (B frequency).
30. Wait until the SMU has been triggered.
31. Wait until at least 30000 bits have been counted by the base station receiver.
32. Check the bit error rate.
  
33. Repeat the test at the middle and top frequencies (M and T). For the top frequency, use offsets of –10 MHz and –20 MHz, respectively.

### **Test results:**

Because the BER is calculated and displayed at the individual base station or on a PC connected to the base station, no general result form can be provided here. Most BS test manager programs display the bit error rate and block error rate (BER and BLER) and the number of counted bits and frames.

- Without a trigger, the SMU signal is unmodulated.
- If the base station does not synchronize, check the frequency and (uplink) scrambling code and repeat the test with AWGN switched off.

### **Analyzing the uplink signal of the SMU:**

With full setup in program **3G\_FSMU\_NodeB**, the analyzer can display the wanted signal and the interferers in the frequency domain. Connect the analyzer and generator RF ports and increase the output level of the wanted channel to raise the signal above the noise.

Install option FS-K73 on the FSQ to examine the uplink signal in the code domain.

## 7.7 Spurious Emissions

Spurious Emission power is the power of the emissions generated or amplified in the base station receiver that appears at the RX antenna port.

This test applies to BSs with separate RX and TX antenna ports. For base stations with shared RX and TX antenna ports, the Spurious Emissions (transmitter test 6.5.3) are valid.

This requirement applies at frequencies within specified frequency ranges that are more than 12.5 MHz below the lowest carrier frequency used or more than 12.5 MHz above the highest frequency used.

The purpose of this test is to verify that the spurious emissions do not exceed the specified limits.

Two tests with different requirements and thus different hardware test setups are specified:

- General Spurious Emissions with fairly high limits
- Additional Spurious Emissions with very low emission limits, requiring high dynamic measurements

The hardware setup differs, but the test procedure is the same for both tests.

### Recommended hardware test setup for Spurious Emissions:

Fig. 7.7\_1 shows the test setup for the RX General Spurious Emission test. Fig. 7.7\_2 shows the test setup for the RX Additional Spurious Emission test.

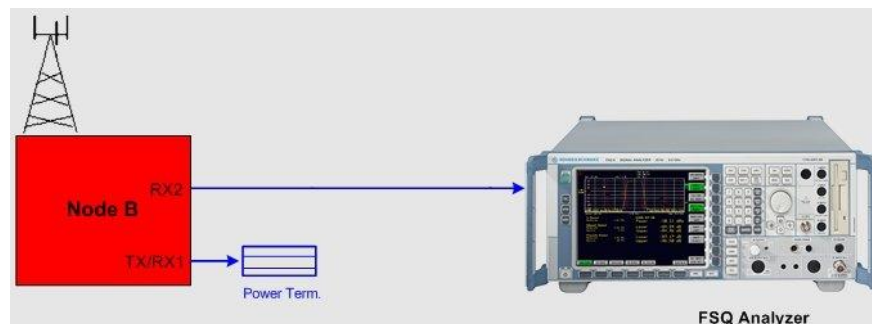


Fig. 7.7\_1: Hardware test setup for the RX General Spurious Emission test. The FSQ is connected directly to the RX port. Make sure that the base station does not provide a bias at its RX connector. In this case use a DC blocking circuit. Disabling the bias by software may not be sufficient, e.g. when rebooting the BS!

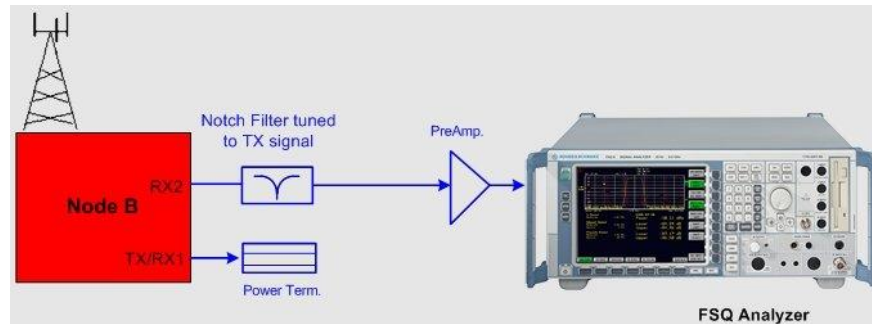


Fig. 7.7\_2: Hardware test setup for the RX Additional Spurious Emission test. The analyzer patch includes a notch filter tuned to the base station TX frequency. A preamplifier is used to achieve the requested sensitivity. Make sure that the base station does not provide a bias at its RX connector. In this case use a DC blocking circuit. Disabling the bias by software may not be sufficient, e.g. when rebooting the BS!

#### Instruments and accessories:

- FSQ (signal analyzer) as in standard configuration
- Power termination 50 W min. (e.g. Suhner)
- Notch filter (e.g. Wainwright WRCT 1900/2200-5/40-10SSK)
- Preamplifier (e.g. MITEC MPN2-00200200-27P)

#### Path loss compensation:

- Measure the path loss between the base station antenna connector and the FSQ.

#### Test procedure:

1. Connect the base station with the FSQ as shown in Fig. 7.7\_1 or 7.7\_2, respectively.
2. Run program **3G\_FSMU\_NodeB**.

#### In the program window:

3. Click check box *Ref. Extern*.
4. Select the appropriate RX Spurious Emission test.
5. Select *small Setup* (only the analyzer is needed).
6. Set the analyzer frequency *Freq* to the middle frequency within the operating frequency band (M frequency).  
The program leaves a gap of +/-12.5 MHz around this frequency.
7. Enter the analyzer *Path Loss* of your hardware test setup.  
Due to the high span of some spurious tests, enter the (highest) loss at the highest frequency as a first approach. If the test fails at lower frequencies, reduce the path loss to an appropriate value at these frequencies.
8. Click *Optimize Ref Level & Att*.
9. Click *Configure*.

**On the base station:**

10. Set the base station to the middle frequency within the operating frequency band (M frequency), and to max. output power with a combination of channels specified as test model 1. Use the type of test model 1 (1-64, 1-32, 1-16) with the largest number of channels that can be supported by the base station.

**In the program window:**

11. Click *Start*.
12. Check results.

**Test results:**

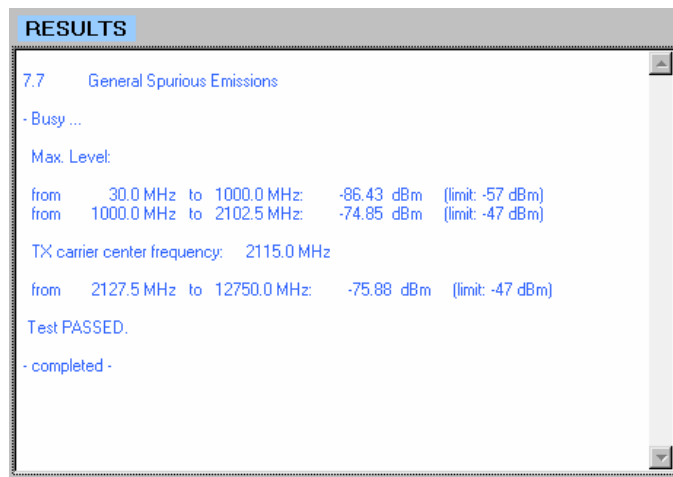


Fig. 7.7\_3: Result of the RX Spurious Emission test as provided by program **3G\_FSMU\_NodeB**. General Spurious Emissions are displayed. You will see the frequency ranges to be tested and the maximum emission within each range.

## 7.8 Verification of the Internal BER Calculation

A measurement signal with a known bit error rate is fed into the input of the base station receiver. The BER indicated by the base station must be within +/-10% of the BER generated by the RF signal source.

The purpose of this test is to verify that the BER calculation accuracy meets the requirements for conformance testing.

**Recommended hardware test setup:**

Fig. 7.8\_1 shows the test setup for Verification of the Internal BER Calculation. It is the same as for 7.2 *Reference Sensitivity* test.

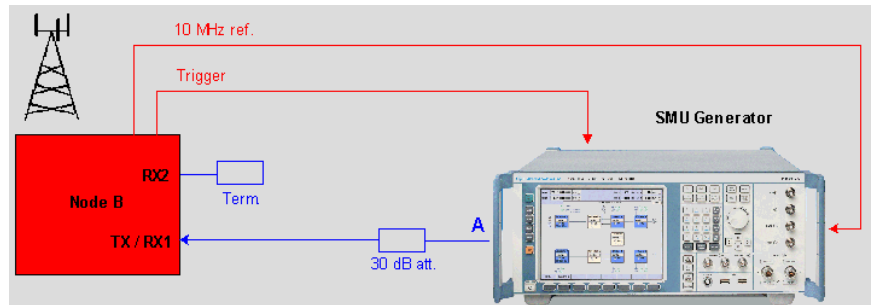


Fig. 7.8\_1: Hardware test setup for testing the Verification of Internal BER Calculation. The SMU establishes an uplink reference measurement channel with a data rate of 12.2 kbps, including bit errors of 1%. The RX level is equal to the reference sensitivity level plus 10 dB to make sure that the signal is received without additional errors.

To synchronize the SMU to the base station frame timing Node B provides a trigger which starts the generator. Connect this signal to the BNC socket *TRIGGER1* on the frontpanel of the SMU. The Trigger could be the start of frame number (SFN) or a signal that indicates the start of a data block (e.g. transmission time interval (TTI)).

- Some base stations provide a DC bias at the RX connector to supply a mast amplifier. Make sure that the bias is disabled, or use a DC blocking circuitry between base station and SMU.

**Instruments and accessories:**

- SMU (generator) as in FSMU standard configuration
- Attenuator 30 dB, RF-termination

**Path loss compensation:**

- Measure the path loss between the base station antenna connector RX1/TX and the SMU.

**Test procedure:**

1. Connect the base station with the SMU as shown in Fig. 7.8\_1.
2. Run program **3G\_FSMU\_NodeB**.

**In the program window:**

3. Select *Receiver Test 7.8 Verification of Internal BER Calculation*.
4. Click check box *Ref. Extern*.
5. Select *small Setup* (only the generator is needed).
6. Set the generator frequency *Freq* to the lowest frequency within the operating frequency band (B frequency).
7. Enter the generator *Path Loss* of your hardware test setup.
8. Click *Set Level to Standard*.
9. Enter the uplink scrambling code *Scr Code*.
10. Click *Configure*.

### On the base station:

11. Set the base station to receive and to calculate the BER. Start with the lowest frequency within the operating frequency band (B frequency).

### In the program window:

12. Click *Start*.
13. Wait until SMU has been triggered.

### On the base station:

14. Wait until the base station receiver has counted the specified number of frames.
15. Check the bit error rate.
16. Repeat the test at the middle and top frequencies (M and T).

### Test results:

Because the BER is calculated and displayed at the individual base station or on a PC connected to the base station, no general result form can be provided here. Most BS test manager programs display the bit error rate and the block error rate (BER and BLER) and the number of counted bits and frames.

- Without a trigger, the SMU signal is unmodulated.
- If the base station does not synchronize, check the frequency and (uplink) scrambling code.

### Analyzing the uplink signal of the SMU:

With full setup in program **3G\_FSMU\_NodeB**, the analyzer can display the RMC in the frequency domain. Connect the analyzer and generator RF ports and increase the output level on the SMU to raise the signal above the noise. Install option FS-K73 on the FSQ to examine the uplink signal in the code domain.



## 8 Performance Tests

The performance requirements of standard TS 25.141 only apply to a base station with dual receiver antenna diversity. To stimulate both inputs, two RF signals are provided by the test equipment; see Figure 8\_1. Both base station RX inputs receive the same (wanted) WCDMA signal, which is loaded by primarily two types of impairments:

- Additive white Gaussian noise (AWGN) added to the WCDMA signal.
- Different fading profiles to simulate typical propagation scenarios.

**Note:** For performance measurements, program **3G\_FSMU\_NodeB** requires a two-channel SMU.

### Recommended hardware test setup:

Figure 8\_1 shows the recommended hardware setup. It is the same for all performance tests.

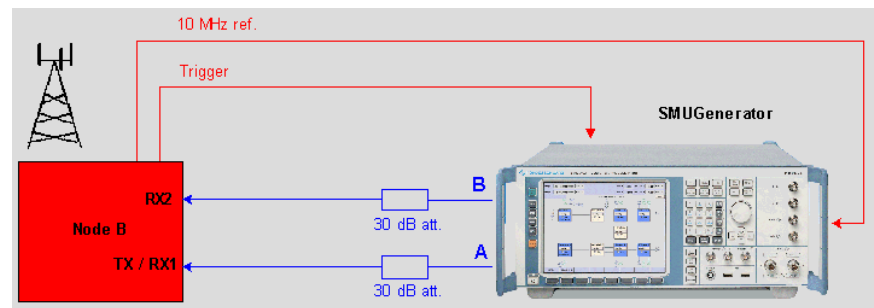


Figure 8\_1: Hardware test setup for all performance tests. The two-channel SMU establishes two wanted signals. Depending on the test, they come without or with added AWGN, and without or with fading. To improve the impedance matching of base station and generator (for high level accuracy), 30 dB attenuators are inserted into the RF path.

To synchronize the SMU to the base station frame timing, Node B provides a trigger that starts the generator. Connect this signal to the BNC socket *TRIGGER1* on the front panel of the SMU. The trigger could be the start of frame number (SFN) or a signal that indicates the start of a data block (e.g. transmission time interval (TTI)).

- Some base stations provide a DC bias at the RX connector to supply a mast amplifier. Make sure that the bias is disabled, or use a DC blocking circuitry between base station and SMU.

Graphical User Interface GUI of program 3G\_FSMU\_NodeB:

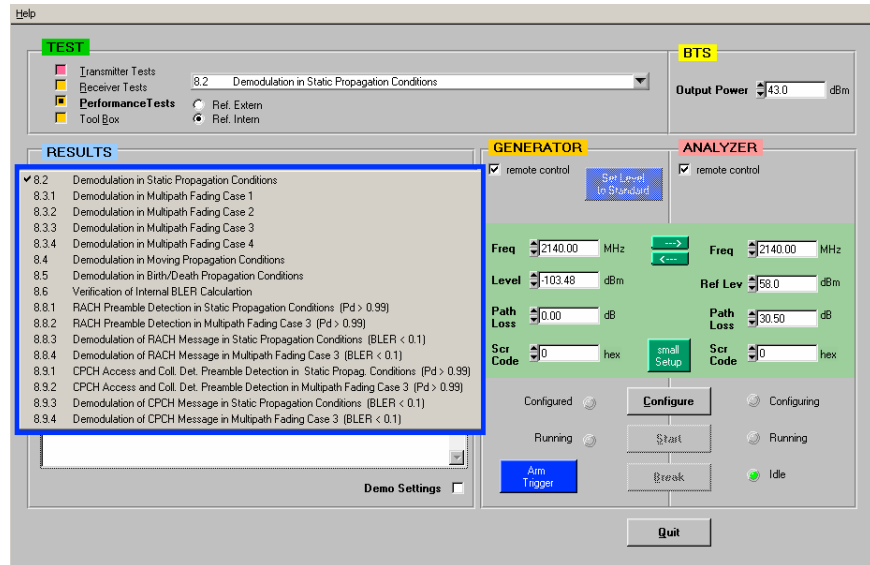


Fig. 8\_2: GUI for all Performance tests, and a test list. If you click *Small Setup* the edit fields for the analyzer disappear, and program 3G\_FSMU\_NodeB runs with maximum speed.

- To program the levels of TS 25.141, click *Set Level to Standard*.
- To quickly raise the signals out of the noise, click *Demo Settings*.

For each receiver path, the AWGN and the fading profiles are of the same type but they need to be generated independently. Figure 8\_3 shows how this is achieved inside the SMU.

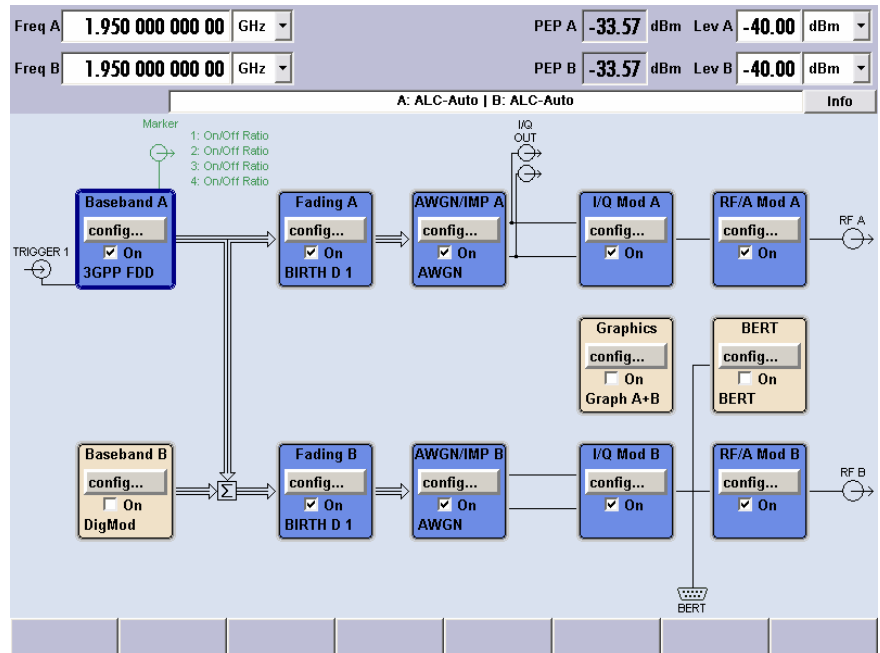


Figure 8\_3: Signal paths inside the SMU. The wanted signal is generated by only one baseband module. Then the signal is split, and two independent paths with their own fading, AWGN, I/Q modulator, and RF stages handle the remaining processing.

Once the base station has synchronized to the incoming signals, the BLER is measured. Like with the BER, this could be done internally or by external equipment connected to the base station.

For internal BLER calculation, test 8.6 (Verification of the Internal BLER Calculation) should be done first. This is the only performance test without RF impairments, using fairly high signal levels.

For all other performance tests, AWGN is switched on, and  $P_{AWGN}$  is set to -84 dBm at a bandwidth of 3.84 MHz. However, program **3G\_FSMU\_NodeB** needs an entry for the power of the wanted signal  $P_{wanted}$  (in input field *Generator Level*).

Calculate  $P_{wanted}$  as follows:

$$P_{wanted} / \text{dB} = P_{AWGN} / \text{dB} + \text{CNR} / \text{dB}$$

with carrier-to-noise ratio  $\text{CNR} / \text{dB} = 10 \log (R_b / 3.84 \cdot 10^6) + E_b/N_0$ .

$R_b$  stands for the measurement channel data rate; a value of the granted  $E_b/N_0$  is listed in the standard TS 25.141 for each test.

The item  $10 \log (R_b / 3.84 \cdot 10^6)$  could be considered as a gain we can take advantage of. It is caused mainly by signal spreading; see table 8.1.

Channel data rate $R_b$	$10\log(R_b / 3.84 \cdot 10^6)$
12.2 kbps	-24.98 dB
64 kbps	-17.78 dB
144 kbps	-14.25 dB
384 kbps	-10 dB

Table 8.1: Gain of WCDMA signals with different data rates.

(If you are testing a base station, simply click *Set Level to Standard*.)

Program **3G\_FSMU\_NodeB** keeps the individual CNR of each test constant. If you enter any  $P_{\text{wanted}}$  for the wanted signal in the *Generator Level* field, the program adjusts the AWGN power automatically.

Thus, you can monitor the shape of the wanted signal and how far it lies below the AWGN at any level higher than that stipulated by the standard. (If you click *Set Level to Standard* in the **3G\_FSMU\_NodeB** window, the output power of the SMU will be set correctly to the standard value with an AWGN power level of -84.0 dBm.)

Each performance test is to be done with varying parameters such as different measurement channel rates and two  $E_b/N_0$  ratios for BLER <  $10^{-1}$  and BLER <  $10^{-2}$ .

Intended as a programming example, **3G\_FSMU\_NodeB** provides each performance test for only one data rate, one  $E_b/N$ , and one BLER limit.

## 8.2 Demodulation of DCH in Static Prop. Conditions

The performance requirement of DCH in static propagation conditions is determined by the maximum BLER allowed when each of the antenna inputs receive a wanted signal with AWGN at a specified  $E_b/N_0$  limit (no fading applied). The BLER is calculated for each of the measurement channels supported by the base station.

The purpose of this test is to verify that the BLER does not exceed the specified limit.

Program **3G\_FSMU\_NodeB** uses a data rate of 12.2 kbps, and an  $E_b/N_0$  ratio of 5.5 dB for BLER <  $10^{-2}$ .

### Recommended hardware test setup:

Use hardware setup as in Figure 8\_1 (page 78).

### Instruments and accessories:

- SMU (generator) in FSMU standard configuration + options FSMU-B1 (2nd RF path) + FSMU-B2 (2nd baseband)
- 30 dB attenuators

### Path loss compensation:

- Make sure that the insertion loss for the two RF paths is identical. Always use cables of the same type and the same length.
- Measure the path losses between the base station antenna connectors and the SMU outputs.

### Test procedure:

1. Connect the base station with the SMU as shown in Fig. 8\_1.
2. Run program **3G\_FSMU\_NodeB**.

### In the program window:

3. Select *Performance Test 8.2.1 Demodulation of DCH in Static Propagation Conditions*.
4. Click check box *Ref. Extern*.
5. Select *small Setup* (only the generator is needed).
6. Set the generator frequency *Freq* to the lowest uplink frequency within the operating frequency band (B frequency).
7. Enter the generator *Path Loss* of your hardware test setup.
8. Click *Set Level to Standard*.
9. Enter the uplink scrambling code *Scr Code*.
10. Click *Configure*.

The AWGN signals are now available. The wanted signals are provided once triggering occurs.

### On the base station:

11. Set the base station to receive and to calculate the BLER. Start with the lowest frequency within the operating frequency band (B frequency).
  12. Wait until the SMU has been triggered.
  13. Wait until the base station receiver has counted the specified number of blocks.
  14. Check the BLER.
  15. Repeat the test at the middle and top frequencies (M and T).
- To stop a running SMU, click the blue button *Arm Trigger* (see Figure 8.2.1\_1). The SMU is now waiting for the next trigger input.

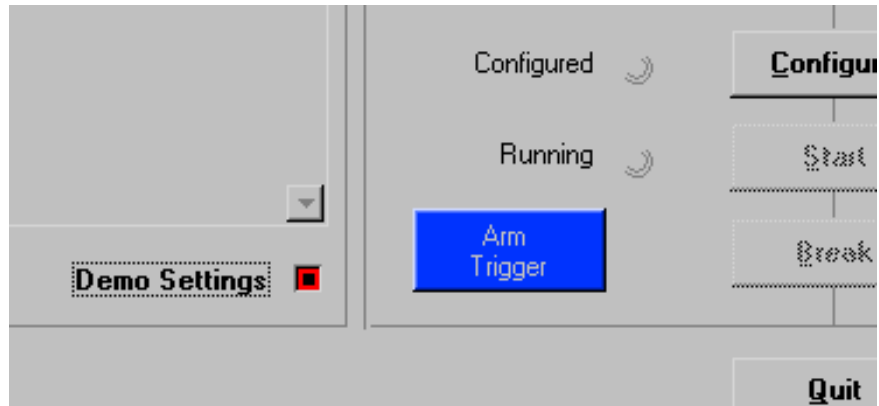


Figure 8.2.1\_1: Where to find the buttons *Arm Trigger* and *Demo Settings*

**Test results:**

Because the BLER is calculated and displayed at the individual base station or on a PC connected to the base station, no general result form can be provided here. Most BS test manager programs display the BER and BLER, and the number of counted bits and frames.

- Without a trigger, SMU only provides the AWGN.
- If the base station does not synchronize, check the frequency and (uplink) scrambling code.

**Monitoring the uplink signal of the SMU:**

With full setup in program **3G\_FSMU\_NodeB**, the analyzer can display the RMC in the frequency domain.

1. Connect the analyzer and generator RF port A (or B).
2. Use full (not small) setup. If the analyzer input fields are not visible, activate the *remote control* check box of the analyzer.
3. Click *Demo Settings* on program **3G\_FSMU\_NodeB**; see Figure 8.2.1\_1 above.
4. Click *Configure*.

The AWGN signals are now available. The wanted signals are provided once triggering occurs. (The 10 MHz reference is set to internal.)

To generate an external trigger

5. Connect BNC sockets Clock and Trigger 1 at the SMU front panel using a BNC cable.
6. Click *Start*. This will start the analyzer.

The wanted signal is hidden inside the AWGN. You get an analyzer screen similar to the upper curve in Figure 8.2.1\_3. To display the wanted signal

7. Select the Test Wizard on the SMU.
8. Switch AWGN off, and *Apply Settings*; see Figure 8.2.1\_2.



Figure 8.2.1\_2: How to switch off the AWGN on SMU Test Wizard.

With AWGN off, you get the wanted signal similar to the lower curve in Figure 8.2.1\_3.

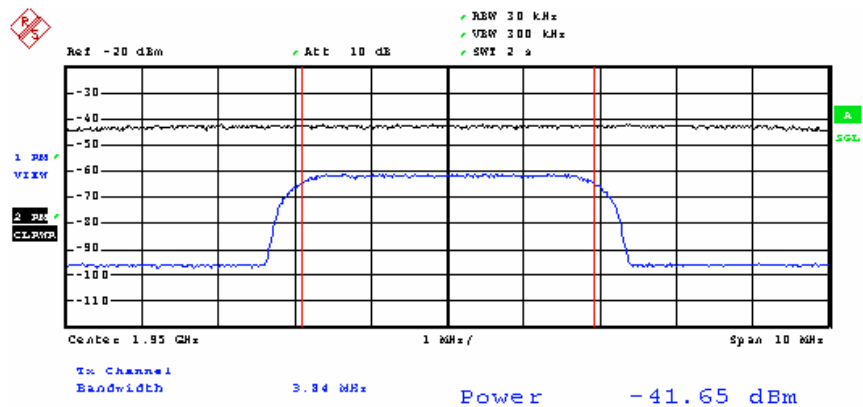


Figure 8.2.1\_3: Summary signal (above) and wanted signal (below) for test 8.2.1 Demodulation of DCH in Static Propagation Conditions (using *Demo Settings*). The wanted signal is hidden inside the AWGN signal. Program 3G\_FSMU keeps the carrier-to-noise ratio constant to illustrate the signal's ratio even at a level higher than that stipulated by the standard.

## 8.3 Demodulation of DCH in Multipath Fading Conditions

The performance requirement of DCH in multipath fading conditions is determined by the maximum BLER allowed when each of the antenna inputs receives a wanted signal with AWGN at a specified  $E_b/N_0$  limit. The BLER is calculated for each of the measurement channels supported by the base station. Four fading profiles (cases) are applied.

The purpose of this test is to verify that the BLER does not exceed the specified limit.

Program **3G\_FSMU\_NodeB** uses a data rate of 12.2 kbps.

Fading case 1:	$E_b/N_0 = 12.5$ dB	for BLER < $10^{-2}$ .
Fading case 2:	$E_b/N_0 = 9.6$ dB	for BLER < $10^{-2}$ .
Fading case 3:	$E_b/N_0 = 7.8$ dB	for BLER < $10^{-2}$ .
Fading case 4:	$E_b/N_0 = 10.8$ dB	for BLER < $10^{-2}$ .

### Recommended hardware test setup:

Use hardware setup as in Figure 8\_1 (page 78).

### Instruments and accessories:

- SMU (generator) in FSMU standard configuration + options FSMU-B1 (2nd RF path) + FSMU-B2 (2nd base band) + FSMU-B3 (Fading)
- 30 dB attenuators

### Path loss compensation:

- Make sure that the insertion loss for the two RF paths is identical. Always use cables of the same type and length.
- Measure the path losses between the base station antenna connectors and the SMU outputs.

### Test procedure:

1. Connect the base station with the SMU as shown in Fig. 8\_1.
2. Run program **3G\_FSMU\_NodeB**.

### In the program window:

3. Select *Performance Test 8.3.1 Demodulation of DCH in Multipath Fading Conditions / Case 1*.
4. Click check box *Ref. Extern*.
5. Select *small Setup* (only the generator is needed).
6. Set the generator frequency *Freq* to the lowest uplink frequency within the operating frequency band (B frequency).
7. Enter the generator *Path Loss* of your hardware test setup.



8. Click *Set Level to Standard*.
9. Enter the uplink scrambling code *Scr Code*.
10. Click *Configure*.

The AWGN signals are now available. The wanted signals are provided when triggering has occurred.

### On the base station:

11. Set the base station to receive and to calculate the BLER. Start with the lowest frequency within the operating frequency band (B frequency).
  12. Wait until the SMU has been triggered.
  13. Wait until the base station receiver has counted the specified number of blocks.
  14. Check the BLER.
  15. Repeat the test at the middle and top frequencies (M and T).
16. Proceed the same way with tests 8.3.2, 8.3.3, and 8.3.4 for fading cases 2, 3, and 4.
- To stop a running SMU, click the blue button *Arm Trigger* (see Figure 8.2.1\_1). The SMU is now waiting for the next trigger input.

### Test results:

Because the BLER is calculated and displayed at the individual base station or on a PC connected to the base station, no general result form can be provided here. Most BS test manager programs display the BER and BLER, and the number of counted bits and frames.

- Without a trigger, the SMU only provides the AWGN.
- If the base station does not synchronize, check the frequency and (uplink) scrambling code.

### Monitoring the uplink signal of the SMU:

With full setup in program **3G\_FSMU\_NodeB**, the analyzer can display the RMC in the frequency domain.

1. Connect the analyzer and generator RF port A (or B).
2. Use full (not small) setup. If the analyzer input fields are not visible, activate the *remote control* check box of the analyzer.
3. Click *Demo Settings* on program **3G\_FSMU\_NodeB**; see Figure 8.2.1\_1 above.
4. Click *Configure*.

The AWGN signals are now available. The wanted signals are provided once triggering occurs. (The 10 MHz reference is set to internal.)

To generate an external trigger

5. Connect BNC sockets *Clock* and *Trigger 1* at the SMU front panel using a BNC cable.
6. Click *Start*. This will start the analyzer.

The wanted signal is hidden inside the AWGN. You get an analyzer screen similar to the upper curve in Figures 8.3\_1 through 8.3\_4. To display the wanted signal

7. Select the Test Wizard on the SMU.
8. Switch AWGN off, and *Apply Settings*; see Figure 8.2.1\_2.

With AWGN off, you get the wanted signal similar to the lower curve in Figures 8.3\_1 through 8.3\_4.

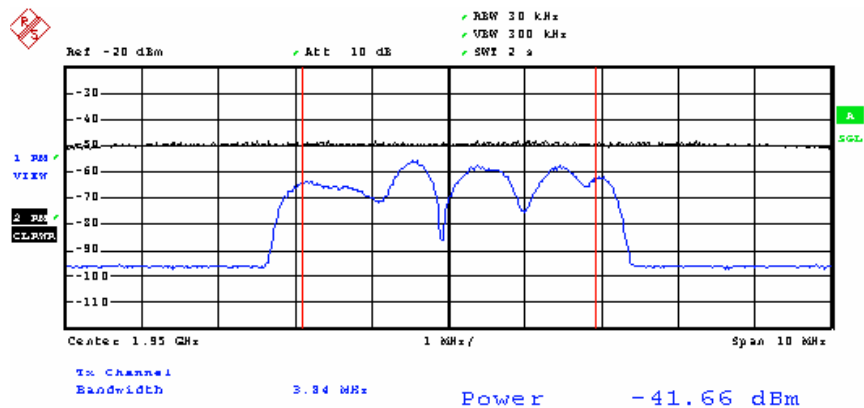


Figure 8.3\_1: Summary signal (above) and wanted signal (below) for test 8.3.1 Demodulation of DCH in Multipath Fading Conditions case 1 using *Demo Settings*. The wanted signal is hidden inside the AWGN signal. Program 3G\_FSMU keeps the carrier-to-noise ratio constant to illustrate the signal's ratio even at a level higher than that stipulated by the standard.

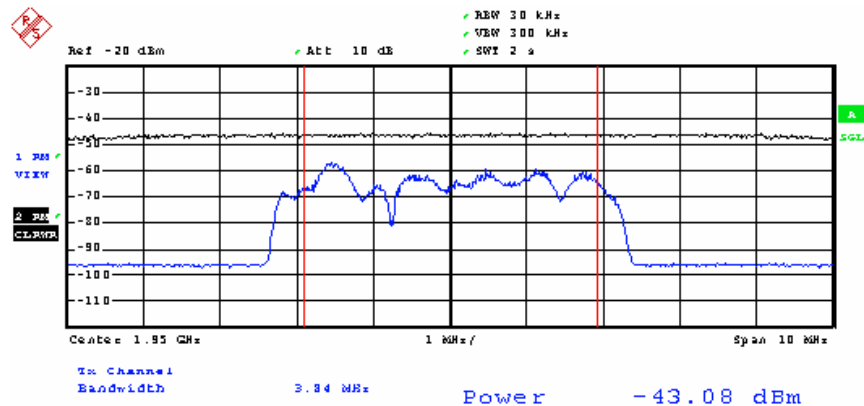


Figure 8.3\_2: Summary signal (above) and wanted signal (below) for test 8.3.2 Demodulation of DCH in Multipath Fading Conditions case 2.

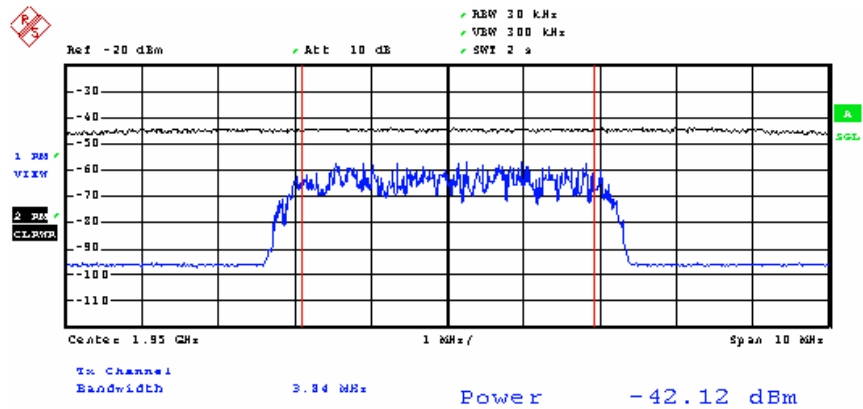


Figure 8.3\_3: Summary signal (above) and wanted signal (below) for test 8.3.3 Demodulation of DCH in Multipath Fading Conditions case 3.

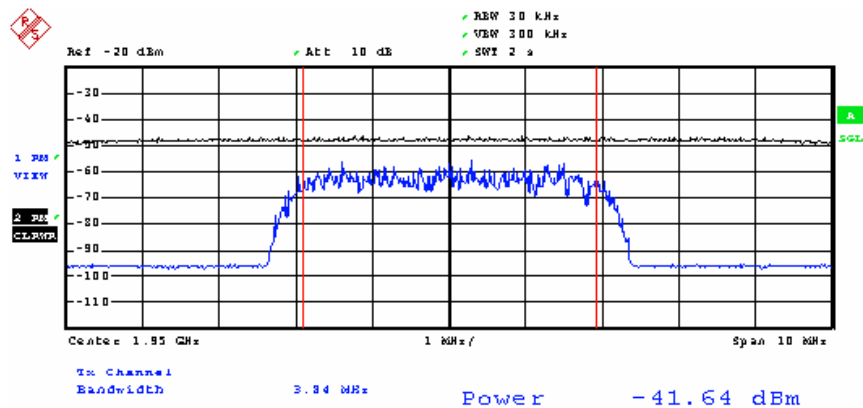


Figure 8.3\_4: Summary signal (above) and wanted signal (below) for test 8.3.4 Demodulation of DCH in Multipath Fading Conditions case 4.

## 8.4 Demodulation of DCH in Moving Prop. Conditions

The performance requirement of DCH in moving propagation conditions is determined by the maximum BLER allowed when each of the antenna inputs receives a wanted signal with AWGN at a specified  $E_b/N_0$  limit. The BLER is calculated for each of the measurement channels supported by the base station.

The purpose of this test is to verify that the BLER does not exceed the specified limit.

Program **3G\_FSMU\_NodeB** uses a data rate of 12.2 kbps, and an  $E_b/N_0$  limit of 6.3 dB for maximum BLER  $< 10^{-2}$ .

### Recommended hardware test setup:

Use hardware setup as in Figure 8\_1 (page 78).

### Instruments and accessories:

- SMU (generator) in FSMU standard configuration + options FSMU-B1 (2nd RF path) + FSMU-B2 (2nd base band) + FSMU-B3 (Fading)
- 30 dB attenuators

### Path loss compensation:

- Make sure that the insertion loss for the two RF paths is identical. Always use cables of the same type and length.
- Measure the path losses between the base station antenna connectors and the SMU outputs.

### Test procedure:

1. Connect the base station with the SMU as shown in Fig. 8\_1.
2. Run program **3G\_FSMU\_NodeB**.

### In the program window:

3. Select *Performance Test 8.4 Demodulation of DCH in Moving Propagation Conditions*.
4. Click check box *Ref. Extern*.
5. Select *small Setup* (only the generator is needed).
6. Set the generator frequency *Freq* to the lowest uplink frequency within the operating frequency band (B frequency).
7. Enter the generator *Path Loss* of your hardware test setup.
8. Click *Set Level to Standard*.
9. Enter the uplink scrambling code *Scr Code*.
10. Click *Configure*.

The AWGN signals are now available. The wanted signals are provided once triggering occurs.

### On the base station:

11. Set the base station to receive and to calculate the BLER. Start with the lowest frequency within the operating frequency band (B frequency).
  12. Wait until the SMU has been triggered.
  13. Wait until the base station receiver has counted the specified number of blocks.
  14. Check the BLER.
  15. Repeat the test at the middle and top frequencies (M and T).
- To stop a running SMU, click the blue button *Arm Trigger* (see Figure 8.2.1\_1). The SMU is now waiting for the next trigger input.

### Test results:

Because the BLER is calculated and displayed at the individual base station or on a PC connected to the base station, no general result form can be provided here. Most BS test manager programs display the BER and BLER, and the number of counted bits and frames.

- Without a trigger, the SMU only provides the AWGN.
- If the base station does not synchronize, check the frequency and (uplink) scrambling code.

### Monitoring the uplink signal of the SMU:

With full setup in program **3G\_FSMU\_NodeB**, the analyzer can display the RMC in the frequency domain.

1. Connect the analyzer and generator RF port A (or B).
2. Use full (not small) setup. If the analyzer input fields are not visible, activate the *remote control* check box of the analyzer.
3. Click Demo Settings on program **3G\_FSMU\_NodeB**; see Figure 8.2.1\_1 above.
4. Click *Configure*.

The AWGN signals are now available. The wanted signals are provided once triggering occurs. (The 10 MHz reference is set to internal.)

To generate an external trigger

5. Connect BNC sockets Clock and Trigger 1 at the SMU front panel using a BNC cable.
6. Click *Start*. This will start the analyzer.

The wanted signal is hidden inside the AWGN. You get an analyzer screen similar to the upper curve in Figure 8.4\_1. To display the wanted signal

7. Select the Test Wizard on the SMU.
8. Switch AWGN off, and *Apply Settings*; see Figure 8.2.1\_2.

With AWGN off, you get the wanted signal similar to the lower curve in Figure 8.4\_1.

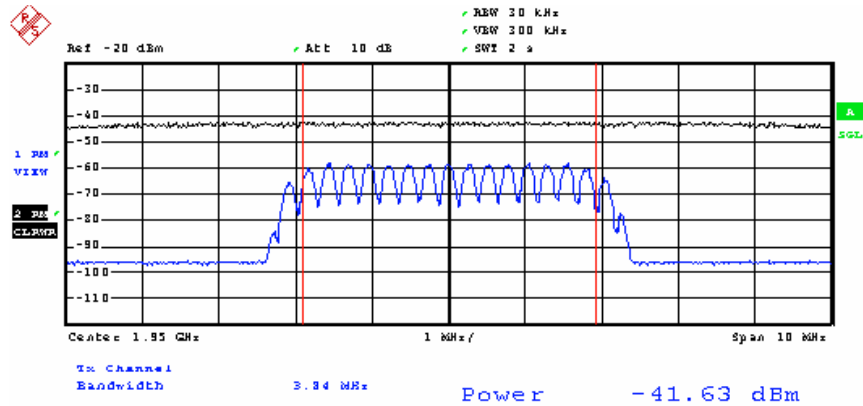


Figure 8.4\_1: Summary signal (above) and wanted signal (below) for test 8.4 Demodulation of DCH in Moving Propagation Conditions using *Demo Settings*. The wanted signal is hidden inside the AWGN signal. Program 3G\_FSMU keeps the carrier-to-noise ratio constant to illustrate the signal's ratio even at a level higher than that stipulated by the standard.

## 8.5 Demodulation of DCH in Birth / Death Prop. Conditions

The performance requirement of DCH in Birth/Death Propagation Conditions is determined by the maximum BLER allowed when each of the antenna inputs receives a wanted signal with AWGN at a specified  $E_b/N_0$  limit. The BLER is calculated for each of the measurement channels supported by the base station.

The purpose of this test is to verify that the BLER does not exceed the specified limit.

Program **3G\_FSMU\_NodeB** uses a data rate of 12.2 kbps, and an  $E_b/N_0$  limit of 8.3 dB for maximum BLER  $< 10^{-2}$ .

### Recommended hardware test setup:

Use hardware setup as in Figure 8\_1 (page 78).

### Instruments and accessories:

- SMU (generator) in FSMU standard configuration + options FSMU-B1 (2nd RF path) + FSMU-B2 (2nd base band) + FSMU-B3 (Fading)
- 30 dB attenuators

### Path loss compensation:

- Make sure that the insertion loss for the two RF paths is identical. Always use cables of the same type and length.
- Measure the path losses between the base station antenna connectors and the SMU outputs.

### Test procedure:

1. Connect the base station with the SMU as shown in Fig. 8\_1.
2. Run program **3G\_FSMU\_NodeB**.

### In the program window:

3. Select *Performance Test 8.5 Demodulation of DCH in Birth / Death Propagation Conditions*.
4. Click check box *Ref. Extern*.
5. Select *small Setup* (only the generator is needed).
6. Set the generator frequency *Freq* to the lowest uplink frequency within the operating frequency band (B frequency).
7. Enter the generator *Path Loss* of your hardware test setup.
8. Click *Set Level to Standard*.
9. Enter the uplink scrambling code *Scr Code*.
10. Click *Configure*.

The AWGN signals are now available. The wanted signals are provided once triggering occurs.

### On the base station:

11. Set the base station to receive and to calculate the BLER. Start with the lowest frequency within the operating frequency band (B frequency).
  12. Wait until the SMU has been triggered.
  13. Wait until the base station receiver has counted the specified number of blocks.
  14. Check the BLER.
  15. Repeat the test at the middle and top frequencies (M and T).
- To stop a running SMU, click the blue button *Arm Trigger* (see Figure 8.2.1\_1). The SMU is now waiting for the next trigger input.

### Test results:

Because the BLER is calculated and displayed at the individual base station or on a PC connected to the base station, no general result form can be provided here. Most BS test manager programs display the BER and BLER, and the number of counted bits and frames.

- Without a trigger, the SMU only provides the AWGN.
- If the base station does not synchronize, check the frequency and (uplink) scrambling code.

### Monitoring the uplink signal of the SMU:

With full setup in program **3G\_FSMU\_NodeB**, the analyzer can display the RMC in the frequency domain.

1. Connect the analyzer and generator RF port A (or B).
2. Use full (not small) setup. If the analyzer input fields are not visible, activate the *remote control* check box of the analyzer.
3. Click Demo Settings on program **3G\_FSMU\_NodeB**; see Figure 8.2.1\_1 above.
4. Click *Configure*.

The AWGN signals are now available. The wanted signals are provided once triggering occurs. (The 10 MHz reference is set to internal.)

To generate an external trigger

5. Connect BNC sockets Clock and Trigger 1 at the SMU front panel using a BNC cable.
6. Click *Start*. This will start the analyzer.

The wanted signal is hidden inside the AWGN. You get an analyzer screen similar to the upper curve in Figure 8.5\_1. To display the wanted signal

7. Select the Test Wizard on the SMU.
8. Switch *AWGN off*, and *Apply Settings*; see Figure 8.2.1\_2.

With AWGN off, you get the wanted signal similar to the lower curve in Figure 8.5\_1.

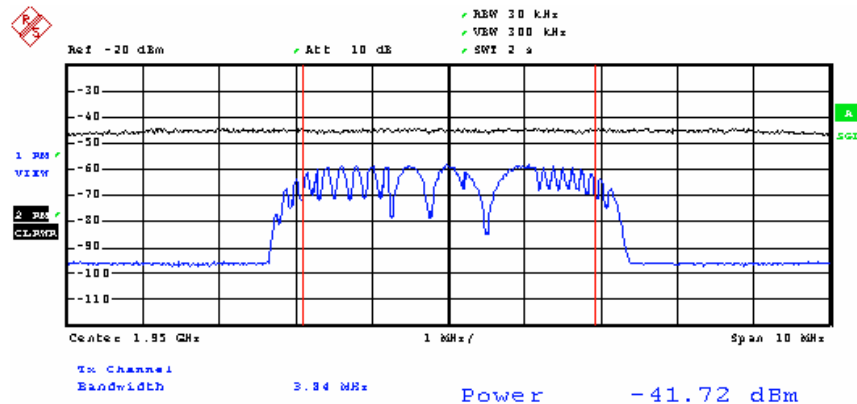


Figure 8.5\_1: Summary signal (above) and wanted signal (below) for test 8.5 Demodulation of DCH in Birth/Death Propagation Conditions using *Demo Settings*. The wanted signal is hidden inside the AWGN signal. Program 3G\_FSMU keeps the carrier-to-noise ratio constant to illustrate the signal's ratio even at a level higher than that stipulated by the standard.



## 8.6 Verification of the Internal BLER Calculation

Verification of the internal BLER calculation is performed by feeding a measurement signal with a known BLER to the inputs of the receivers.

The purpose of this test is to verify that the BLER calculation accuracy is within +/-10% of the BLER generated by the RF source.

### Recommended hardware test setup:

This test only uses one wanted signal without any impairments; the signal is applied at both RX inputs. The signal could be provided by a single generator channel. However, because a second SMU channel is required for each other performance test, we recommend using the setup shown in Figure 8\_1 (page 78). In this case, you do not need an external power divider, and you can work with one and the same hardware setup for all performance tests.

### Instruments and accessories:

- SMU (generator) in FSMU standard configuration + options FSMU-B1 (2nd RF path) + FSMU-B2 (2nd base band)
- 30 dB attenuators

### Path loss compensation:

- Make sure that the insertion loss for the two RF paths is identical. Always use cables of the same type and length.
- Measure the path losses between the base station antenna connectors and the SMU outputs.

### Test procedure:

1. Connect the base station with the SMU as shown in Fig. 8\_1.
2. Run program **3G\_FSMU\_NodeB**.

### In the program window:

3. Select *Performance Test 8.6 Verification of the Internal BLER Calculation*.
4. Click check box *Ref. Extern*.
5. Select *small Setup* (only the generator is needed).
6. Set the generator frequency *Freq* to the lowest uplink frequency within the operating frequency band (B frequency).
7. Enter the generator *Path Loss* of your hardware test setup.
8. Click *Set Level to Standard*.
9. Enter the uplink scrambling code *Scr Code*.
10. Click *Configure*.

The wanted signals are available once triggering occurs.

### On the base station:

11. Set the base station to receive and to calculate the BLER. Start with the lowest frequency within the operating frequency band (B frequency).
  12. Wait until the SMU has been triggered.
  13. Wait until at least 50000 blocks have been counted by the base station receiver.
  14. Check the BLER.
  15. Repeat the test at the middle and top frequencies (M and T).
- To stop a running SMU, click the blue button *Arm Trigger* (see Figure 8.2.1\_1). The SMU is now waiting for the next trigger input.

### Test results:

Because the BLER is calculated and displayed at the individual base station or on a PC connected to the base station, no general result form can be provided here. Most BS test manager programs display the BER and BLER, and the number of counted bits and frames.

- Without a trigger, the SMU only provides an unmodulated CW carrier.
- If the base station does not synchronize, check the frequency and (uplink) scrambling code.

### Monitoring the uplink signal of the SMU:

With full setup in program **3G\_FSMU\_NodeB**, the analyzer can display the RMC in the frequency domain.

1. Connect the analyzer and generator RF port A (or B).
2. Use full (not small) setup. If the analyzer input fields are not visible, activate the *remote control* check box of the analyzer.
3. Click Demo Settings on program **3G\_FSMU\_NodeB**; see Figure 8.2.1\_1 above.
4. Click *Configure*.

The wanted signals is available once triggering occurs. (The 10 MHz reference is set to internal.)

To generate an external trigger

5. Connect BNC sockets Clock and Trigger1 at SMU front panel using a BNC cable.
6. Click *Start*. This will start the analyzer sweep.

You get an analyzer screen similar to the curve in Figure 8.6\_1.

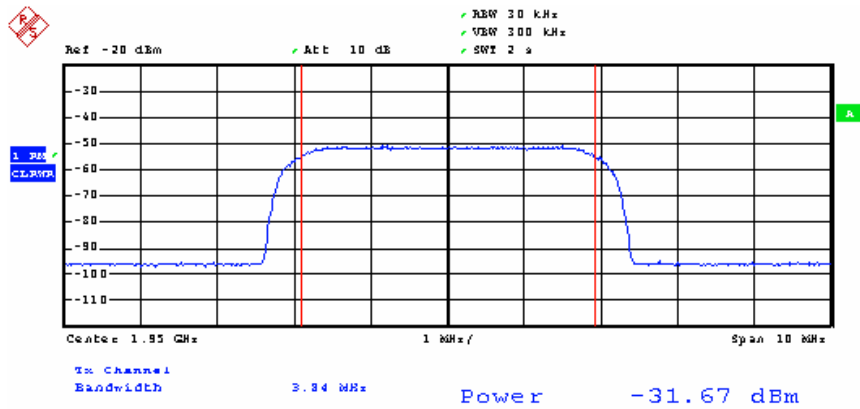


Figure 8.6\_1: Signal for test 8.6 Verification of the Internal BLER Calculation using Demo Settings.

### 8.8.1 RACH Preamble Detection in Static Prop. Conditions

Test RACH Preamble Detection in static propagation conditions uses the same hardware setup and test procedure as the other tests below.

### 8.8.2 RACH Preamble Detection in Multipath Fading Case 3

Test RACH Preamble Detection in multipath fading case 3 uses the same hardware setup and test procedure as the other tests below.

### 8.9.1 CPCH Preambles Detection in Static Prop. Conditions

Test CPCH Preamble Detection in static propagation conditions uses the same hardware setup and test procedure as the test below.

### 8.9.2 CPCH Preambles Detection in Multipath Fading Case 3

The performance requirement for preamble detection is determined by two parameters:

- The probability of correct detection of the preamble (Pd)
- The probability of false detection of the preamble (Pfa)

The actual Pd is measured in the base station during these tests. Therefore, the SMU generates periodically repeated preamble patterns for RACH / CPCH.

Pfa applies if the base station receives only noise and interference. Pfa must be  $10^{-3}$  or less (does not need to be checked here).

The RACH preamble and the CPCH access and collision detection preamble are identical to each other. The performance requirements for the corresponding tests are the same.

All four tests use the same wanted signal and AWGN interferer. For tests 8.8.2 and 8.9.2, fading is applied additionally.

The purpose of this test is to verify that the actual correct detection of the preamble is equal to or above Pd limits specified for different  $E_c/N_0$  ratios:

Test	$E_c/N_0$ for $P_{d_{min}} = 0.99$	$E_c/N_0$ for $P_{d_{min}} = 0.999$
8.8.1, 8.9.1	-20.1 dB	-19.7 dB
8.8.2, 8.9.2	-14.9 dB	-12.8 dB

Table 8.8.1:  $E_c/N_0$  ratios and minimum correct detection probabilities

The AWGN level equals -84 dBm at a bandwidth of 3.84 MHz. Calculate the power level of the wanted signal  $P_{wanted}$  as follows:

$$P_{wanted} / \text{dBm} = P_{AWGN} / \text{dBm} + E_c/N_0 / \text{dB}$$

Enter  $P_{wanted}$  as *Generator Level* in program **3G\_FSMU\_NodeB**.

**Note:**  $E_c/N_0$  is not the same as the carrier to noise ratio C/N because C/N always refers to a mean power. As the RACH preamble is a burst signal, C/N is below  $E_c/N_0$  by about 6 dB for tests 8.8.1 to 8.9.4.

The setting of C/N in the AWGN panel is automatically compensated for by this amount.

Program **3G\_FSMU\_NodeB** supports the  $E_c/N_0$  settings for  $P_{d_{min}} = 0.99$ .

**Recommended hardware test setup:**

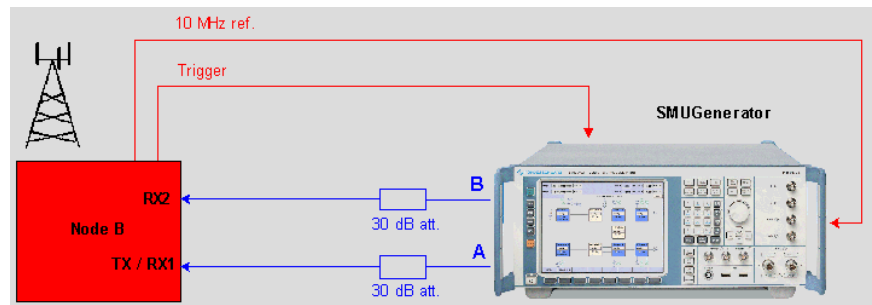


Figure 8\_1 (repeated): Hardware test setup for all performance tests. The two-channel SMU establishes two wanted signals. Depending on the test,

they come without or with added AWGN, and without or with fading. To improve the impedance matching of base station and generator (for high level accuracy), 30 dB attenuators are inserted into the RF path.

To synchronize the SMU to the base station frame timing, Node B provides a trigger that starts the generator. Connect this signal to the BNC socket *TRIGGER1* on the front panel of the SMU. The trigger could be the start of frame number (SFN) or a signal that indicates the start of a data block (e.g. transmission time interval (TTI)).

- Some base stations provide a DC bias at the RX connector to supply a mast amplifier. Make sure that the bias is disabled, or use a DC blocking circuitry between base station and SMU.

### Instruments and accessories:

- SMU (generator) in FSMU standard configuration + options FSMU-B1 (2nd RF path) + FSMU-B2 (2nd base band) + FSMU-B3 (Fading)
- Attenuators 30 dB

### Path loss compensation:

- Make sure that the insertion loss for the two RF paths is identical. Always use cables of the same type and the same length.
- Measure the path losses between the base station antenna connectors and the SMU outputs.

### Test procedure:

1. Connect the base station with the SMU as shown in Fig. 8\_1.
2. Run program **3G\_FSMU\_NodeB**.

### In the program window:

3. Select *Performance Test 8.8.1/ 8.8.2 RACH Preamble Detection* or *8.9.1 / 8.9.2 CPCH Access and Coll. Det. Preamble Detection*
4. Click check box *Ref. Extern*.
5. Select *small Setup* (only the generator is needed).
6. Set the generator frequency *Freq* to the lowest uplink frequency within the operating frequency band (B frequency).
7. Enter the generator *Path Loss* of your hardware test setup.
8. Click *Set Level to Standard*.
9. Enter the uplink scrambling code *Scr Code*.
10. Click *Configure*.

The AWGN signals are now available. The wanted signals are provided once triggering occurs.

### On the base station:

11. Set the base station to receive and calculate the preamble detection probability. Start with the lowest frequency within the operating frequency band (B frequency).
12. Wait until the SMU has been triggered.
13. Wait until enough preambles have been counted by the base station for a stable result.

14. Check the actual detection probability.
  15. Repeat the test at the middle and top frequencies (M and T).
- To stop a running SMU, click the blue button *Arm Trigger* (see Figure 8.2.1\_1). The SMU is now waiting for the next trigger input.

### Test results:

Because the detection probability  $P_d$  is calculated and displayed at the individual base station or on a PC connected to the base station, no general result form can be provided here.

- Without a trigger, the SMU only provides the AWGN.
- If the base station does not synchronize, check the frequency.

### Monitoring the uplink signal of the SMU:

With full setup in program **3G\_FSMU\_NodeB**, the analyzer can display the preamble in the frequency domain.

1. Connect the analyzer and generator RF port A (or B).
2. Use full (not small) setup. If the analyzer input fields are not visible, activate the *remote control* check box of the analyzer.
3. Click Demo Settings on program **3G\_FSMU\_NodeB**; see Figure 8.2.1\_1 above.
4. Click *Configure*.

The AWGN signals are now available. The wanted signals are provided once triggering occurs. (The 10 MHz reference is set to internal.)

To generate an external trigger

5. Connect BNC sockets Clock and Trigger1 at the SMU front panel using a BNC cable.
6. Click *Start*. This will start the analyzer.

The wanted signal is hidden inside the AWGN. You get an analyzer screen similar to the upper curve in Figure 8.8\_1 or 8.8\_2 respectively. To display the wanted signal

7. Select the Test Wizard on the SMU.
8. Switch *AWGN off*, and *Apply Settings*; see Figure 8.2.1\_2.

With AWGN off, you get the wanted signal similar to the lower curve in Figure 8.8\_1 or 8.8\_2.

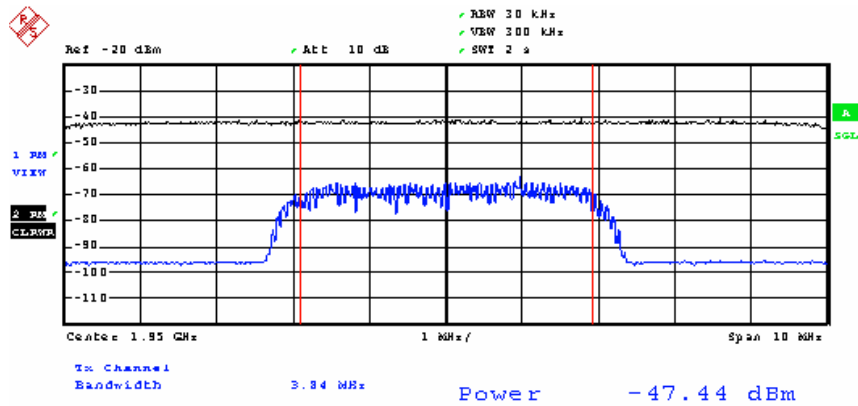


Figure 8.8\_1: Summary signal (above) and wanted signal (below) for tests 8.8.1 / 8.9.1 *Preamble Detection in Static Propagation Conditions* (using *Demo Settings*). The wanted signal is hidden inside the AWGN signal. Program 3G\_FSMU keeps the value of  $E_c/N_0$  ratio constant to illustrate the signal's ratio even at a level higher than that stipulated by the standard.

Because of the low sweep time of 2 s, you do not see that the wanted signal is bursted.

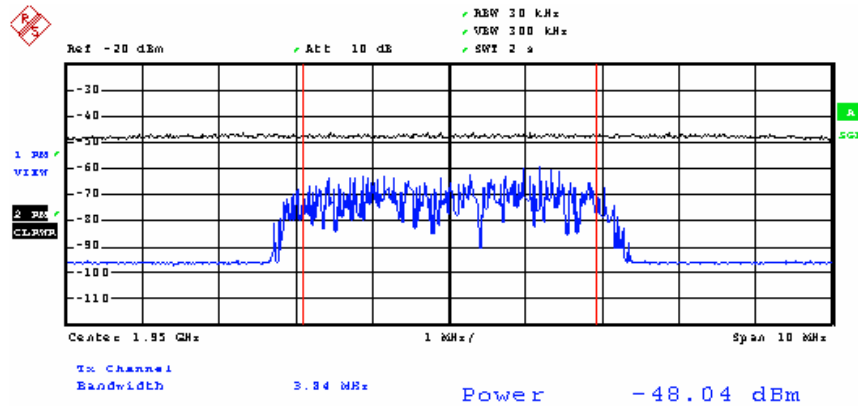


Figure 8.8\_2: Summary signal (above) and wanted signal (below) for tests 8.8.2 / 8.9.2 *Preamble Detection in Multipath Fading Case 3* (using *Demo Settings*). The wanted signal is hidden inside the AWGN signal. Program 3G\_FSMU keeps the value of  $E_c/N_0$  constant to illustrate the signal's ratio even at a level higher than that stipulated by the standard.

Figure 8.8\_3 shows the wanted signal without AWGN in zero span:

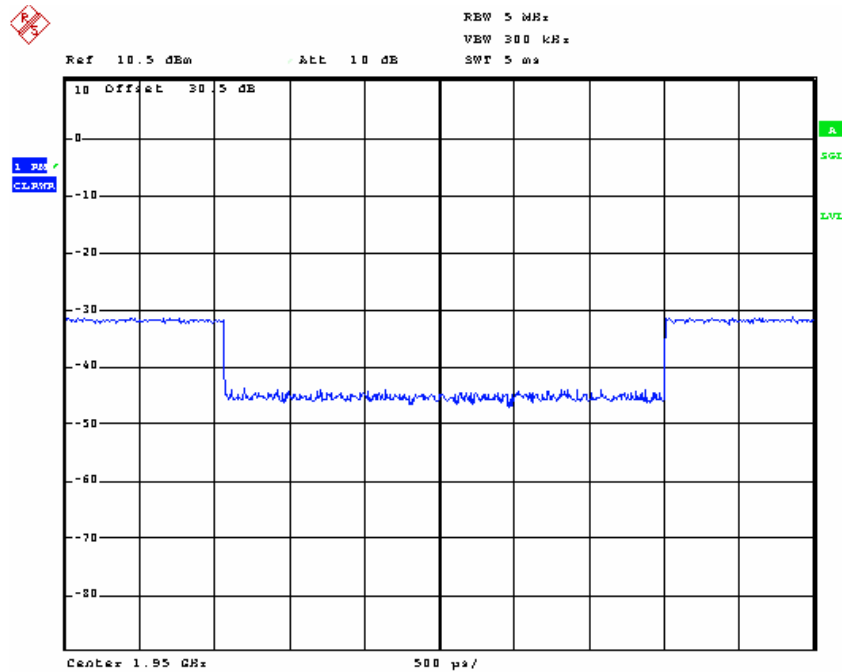


Fig. 8.8\_3: Preambles provided by the generator. The repetition rate is 4 ms (default setting).

**Note:** If you want to send only a certain amount of preambles, set Trigger to *Single* in the trigger panel, and enter the sequence length e.g. as number of frames, see Fig. 8.8\_4 below. The repetition rate of the preambles is 4 ms; 4 frames (40 ms) contain 10 preambles.

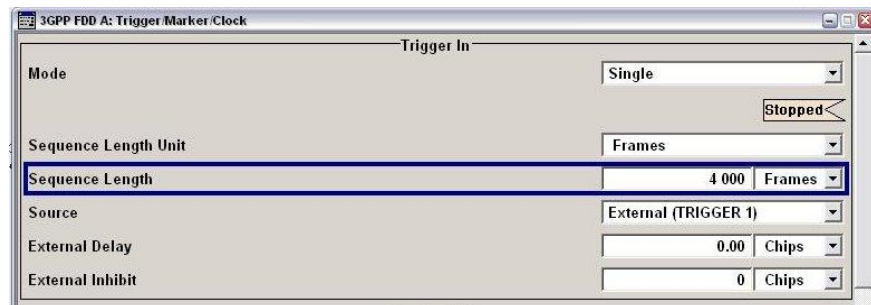


Figure 8.8\_4: Trigger *Single* and a Sequence Length of 4000 frames for generation of exactly 10000 preambles.



### 8.8.3 Demodulation of RACH Msg. in Static Prop. Conditions

Test RACH Message Detection in static propagation conditions uses the same hardware setup and test procedure as the other tests below.

### 8.8.4 Demodulation of RACH Msg. in Multipath Fading Case 3

Test RACH Message Detection in multipath fading case 3 uses the same hardware setup and test procedure as the other tests below.

### 8.9.3 Demodulation of CPCH Msg. in Static Prop. Conditions

Test CPCH Message Detection in static propagation conditions uses the same hardware setup and test procedure as the test below.

### 8.9.4 Demodulation of CPCH Msg. in Multipath Fading Case 3

The performance requirement of RACH or CPCH message demodulation is determined by the maximum BLER allowed when each of the antenna inputs receives a wanted signal with AWGN at a specified  $E_b/N_0$  limit. The BLER is calculated for each of the measurement channels supported by the base station.

For tests 8.8.4 and 8.9.4, fading is applied additionally.

The purpose of this test is to verify that the BLER does not exceed the specified limits.

The AWGN level equals -84 dBm at a bandwidth of 3.84 MHz. Calculate the power level of the wanted signal  $P_{\text{wanted}}$  as follows:

$$P_{\text{wanted}} / \text{dBm} = P_{\text{AWGN}} / \text{dBm} + 10 \cdot \log(\text{TB} / (\text{TTI} \cdot 3.84 \cdot 10^6)) / \text{dB} + E_b/N_0$$

Enter  $P_{\text{wanted}}$  as *Generator Level* in program **3G\_FSMU\_NodeB**.

TB stands for Transport Block size, TTI for Transmission Time Interval. The value of the granted  $E_b/N_0$  is listed in the standard TS 25.141.

(If you are testing a base station, simply click *Set Level to Standard*.)

Program **3G\_FSMU\_NodeB** supports the following settings:

TB = 168 bits, TTI = 20 ms. Thus

$$10 \cdot \log(\text{TB} / (\text{TTI} \cdot 3.84 \cdot 10^6)) = -26.6 \text{ dB.}$$

Test	Transport block size / Trans. time interval	$E_b/N_0$ for BLER < $10^{-1}$	$P_{\text{wanted}} / P_{\text{AWGN}}$
8.8.3	168 bits / TTI = 20 ms	4.5 dB	(-26.6 + 4.5) dB = -22.1 dB
8.8.4	168 bits / TTI = 20 ms	8.0 dB	(-26.6 + 8.0) dB = -18.6 dB
8.9.3	168 bits / TTI = 20 ms	4.5 dB	(-26.6 + 4.5) dB = -22.1 dB
8.9.4	168 bits / TTI = 20 ms	8.1 dB	(-26.6 + 8.1) dB = -18.5 dB

Table 8.8.3:  $E_b/N_0$  ratios for maximum block error rates and resulting ratio  $P_{\text{wanted}} / P_{\text{AWGN}}$ .

**Note:**  $P_{\text{wanted}} / P_{\text{AWGN}} = 10 \cdot \log(TB / (TTI \cdot 3.84 \cdot 10^6)) + E_b/N_0$  shall not be taken as a carrier to noise ratio C/N because C/N always refers to a mean power.

As the wanted signal is bursted the mean power of the wanted signal is about 6 dB below  $P_{\text{wanted}}$ . Thus C/N is below  $P_{\text{wanted}} / P_{\text{AWGN}}$  by about 6 dB as well.

The setting of C/N in the AWGN panel is automatically compensated for by this amount.

Program **3G\_FSMU\_NodeB** keeps the characteristic ratio  $P_{\text{wanted}} / P_{\text{AWGN}}$  each test constant. You enter any power level for the wanted signal in the *Generator Level* field, and the program adjusts the AWGN power  $P_{\text{AWGN}}$  automatically.

If you click *Set Level to Standard* in test 8.8.3, you get

$$P_{\text{wanted}} = -106.1 \text{ dBm, and}$$

$$P_{\text{AWGN}} = -84 \text{ dBm}$$

**Recommended hardware test setup:**

Use hardware setup as in Figure 8\_1 (page 78).

**Instruments and accessories:**

- SMU (generator) in FSMU standard configuration + options FSMU-B1 (2nd RF path) + FSMU-B2 (2nd baseband) + FSMU-B3 (Fading)
- 30 dB attenuators

### Path loss compensation:

- Make sure that the insertion loss for the two RF paths is identical. Always use cables of the same type and the same length.
- Measure the path losses between the base station antenna connectors and the SMU outputs.

### Test procedure:

1. Connect the base station with the SMU as shown in Fig. 8\_1.
2. Run program **3G\_FSMU\_NodeB**.

### In the program window:

3. Select *Performance Test 8.8.3 / 8.8.4 Demodulation of RACH Message* or *8.9.3 / 8.9.4 Demodulation of CPCH Message*.
4. Click check box *Ref. Extern*.
5. Select *small Setup* (only the generator is needed).
6. Set the generator frequency *Freq* to the lowest uplink frequency within the operating frequency band (B frequency).
7. Enter the generator *Path Loss* of your hardware test setup.
8. Click *Set Level to Standard*.
9. Enter the uplink scrambling code *Scr Code*.
10. Click *Configure*.

The AWGN signals are now available. The wanted signals are provided once triggering occurs.

### On the base station:

11. Set the base station to receive and to calculate the BLER. Start with the lowest frequency within the operating frequency band (B frequency).
  12. Wait until the SMU has been triggered.
  13. Wait until the base station receiver has counted the specified number of blocks.
  14. Check the BLER.
  15. Repeat the test at the middle and top frequencies (M and T).
- To stop a running SMU, click the blue button *Arm Trigger* (see Figure 8.2.1\_1). The SMU is now waiting for the next trigger input.

### Test results:

Because the BLER is calculated and displayed at the individual base station or on a PC connected to the base station, no general result form can be provided here. Most BS test manager programs display the BER and BLER, and the number of counted bits and frames.

- Without a trigger, the SMU only provides the AWGN.
- If the base station does not synchronize, check the frequency.

### Monitoring the uplink signal of the SMU:

With full setup in program **3G\_FSMU\_NodeB**, the analyzer can display the RMC in the frequency domain.

1. Connect the analyzer and generator RF port A (or B).
2. Use full (not small) setup. If the analyzer input fields are not visible, activate the *remote control* check box of the analyzer.
3. Click Demo Settings on program **3G\_FSMU\_NodeB**, see Figure 8.2.1\_1 above.
4. Click *Configure*.

The AWGN signals are now available. The wanted signals are provided once triggering occurs. (The 10 MHz reference is set to internal.)

To generate an external trigger

5. Connect BNC sockets Clock and Trigger 1 at the SMU front panel using a BNC cable.
6. Click *Start*. This will start the analyzer.

The wanted signal is hidden inside the AWGN. You get an analyzer screen similar to the upper curve in Figures 8.8.3\_1 / 8.8.4\_1. To display the wanted signal

7. Select the Test Wizard on the SMU.
8. Switch AWGN off, and *Apply Settings*; see Figure 8.2.1\_2.

With AWGN off, you get the wanted signal similar to the lower curve in Figures 8.8.3\_1 / 8.8.4\_1.

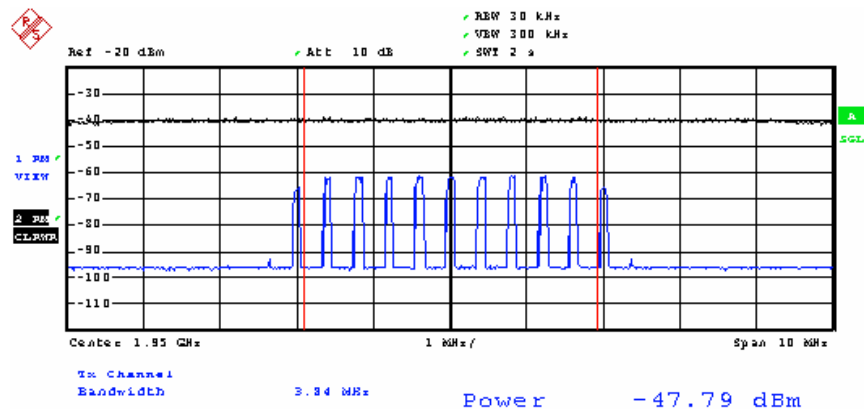


Figure 8.8.3\_1: Summary signal (above) and wanted signal (below) for test 8.8.3 Demodulation of RACH Message in Static Propagation Conditions using Demo Settings. The wanted signal is hidden inside the AWGN signal. Program 3G\_FSMU keeps the carrier-to-noise ratio constant to illustrate the signal's ratio even at a level higher than that stipulated by the standard.

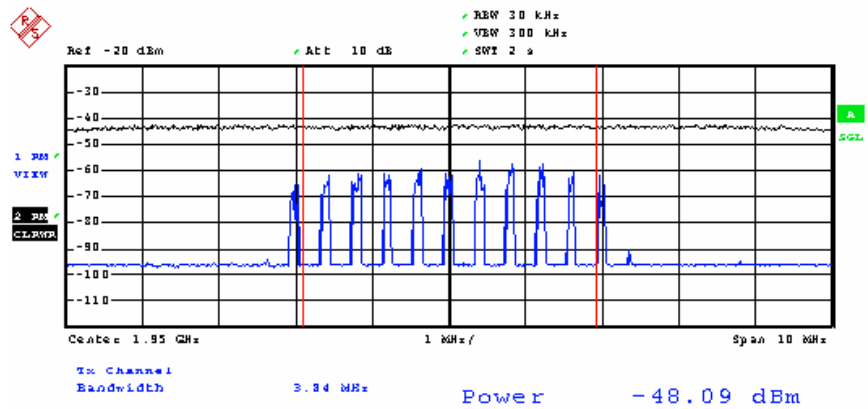


Figure 8.8.4\_1: Summary signal (above) and wanted signal (below) for test 8.8.4 Demodulation of RACH Message in Multipath Fading Case 3 using Demo Settings. The wanted signal is hidden inside the AWGN signal. Program 3G\_FSMU keeps the carrier-to-noise ratio constant to illustrate the signal's ratio even at a level higher than that stipulated by the standard.

Test results of 8.8.3 Demodulation of CPCH Message in Static Propagation Conditions and 8.8.4 Demodulation of CPCH Message in Multipath Fading Case 3 look the same as Figures 8.8.3\_1 and 8.8.4\_1 above.

Figure 8.8\_5 shows the wanted signal without AWGN in zero span:

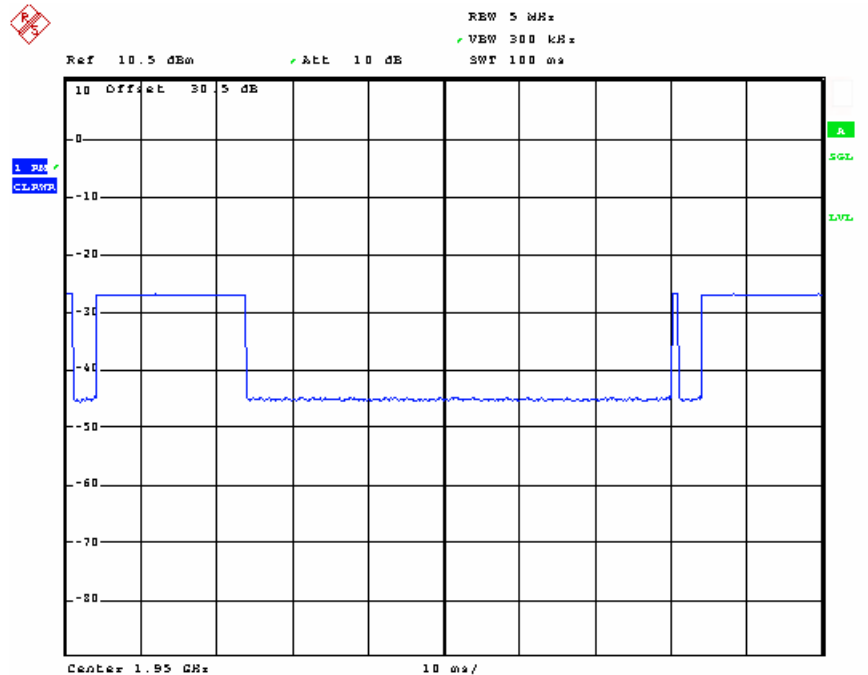


Fig. 8.8\_5: Preamble and subsequent message part provided by the generator. The repetition rate of the pairs is 80 ms (default setting).

**Note:** If you want to send only a certain amount of pairs of preamble and subsequent message part, set Trigger to *Single* in the SMU trigger panel. Enter the sequence length e.g. as number of frames, see Fig. 8.8\_6 below.

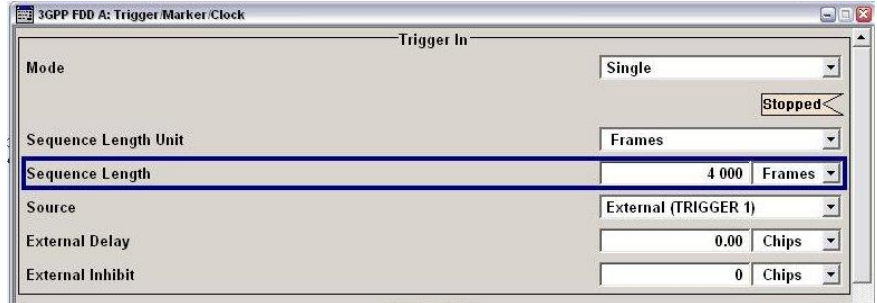


Figure 8.8\_6: Trigger *Single* and a Sequence Length of 4000 frames for generation of exactly 500 pairs of preamble and subsequent message part.

## 9 Toolbox

The toolbox is intended for storing additional tests beyond the standard, such as multicarrier measurements.

It already contains functions to determine the scrambling code of a Node B, or to generate downlink and uplink test signals quickly, see Fig. 9\_1.

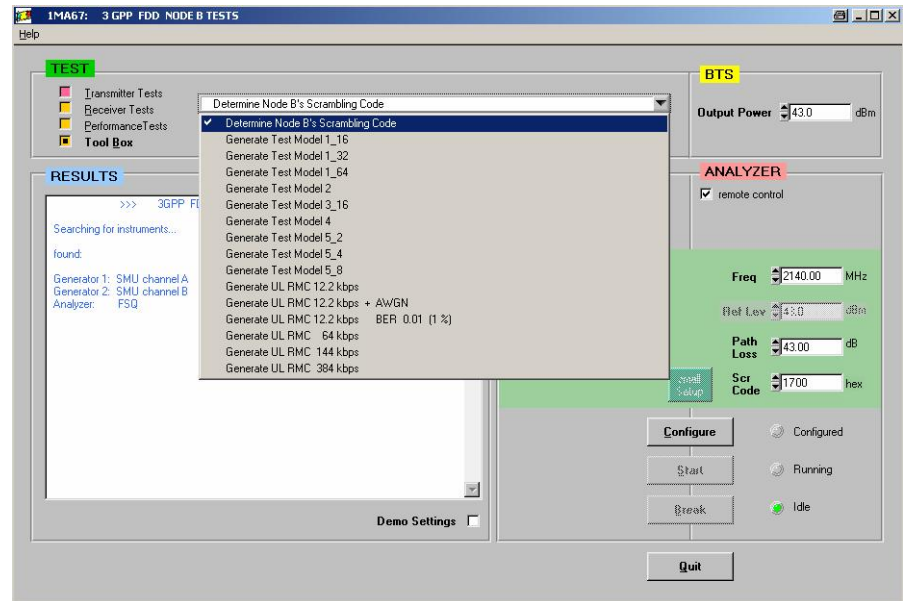


Fig. 9\_1: List of the currently available functions in the toolbox.

### Determine the Scrambling Code

This function evaluates the scrambling code of the downlink signal from a Node B. The Node B may be in normal operation, using any channel and level configuration; test models are suited as well but not mandatory.

The downlink scrambling codes are the *Primary Scrambling Codes* which are counted in increments of  $10_{16}$ . The result will be used automatically by program **3G\_FSMU\_NodeB** to set the analyzer.

#### Recommended hardware test setup:

If you want to monitor a Node B in normal operation:

- Connect an antenna with preamplifier to the analyzer's RF input. The total channel power should be at least -50 dBm.

If you run the Node B in test mode:

- Connect the analyzer via an attenuator as you do for transmitter tests, see Fig. 6.2.1\_1.

Make sure that the attenuator can handle the high output power of the base station.

### Instruments and accessories:

- FSQ (signal analyzer) with option FS-K72 installed
- FSQ firmware 3.85 or later
- Attenuator, 30 dB, 50 W min. (e.g. Suhner)

### Test procedure:

1. Connect antennae, preamplifier, or the base station TX port (via attenuator) to the FSQ.
2. Run program **3G\_FSMU\_NodeB**.

### In the program window:

3. Select *Determine Scrambling Code* out of the *Tool Box*.
4. Select *small Setup* (only the analyzer is needed).
5. Enter the BS max. rated power as *Output Power*.
6. Enter the Node B frequency into the analyzer field *Freq*.

If you are connected via attenuator to the Node B:

7. Enter the estimated analyzer *Path Loss* of your hardware test setup.
8. Click *Configure*.

### On the base station:

If not already running,

9. Set the base station to the selected frequency and output level.

### In the program window:

10. Click *Start*.
11. Check results.

### Test results:

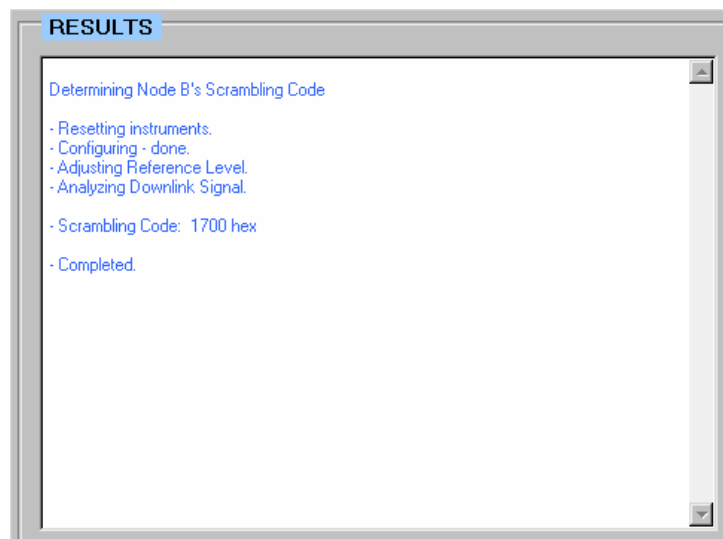


Fig. 9\_2: Numeric measurement result.



**Notes:** It is very important to enter the correct TX frequency into the program **3G\_FSMU\_NodeB**. If you don't know it exactly,

1. Switch the analyzer to *Spectrum* mode.
2. Find the Node B signal.
3. Bring it roughly to the center of the screen (span 10 MHz).
4. Switch to *3G FDD BS*.
5. Press hardkey *MEAS*, then softkey *ACLR*.
6. Press Hardkey *FREQ*, and tune the analyzer frequency till the signal is correctly centered.

Keep in mind that the Node B frequencies are always multiples of 200 kHz!

The analyzer *Reference Level* is set automatically by the program **3G\_FSMU\_NodeB**.

### Simulation of the Node B by the SMU:

1. Connect the FSQ input directly with (port A of) the SMU.
2. Run the program **3G\_FSMU\_NodeB**.

### In the program window:

3. Select *Determine Scrambling Code* out of the *tool box*.
4. Do not click *small Setup*. If the generator input fields are not visible, activate the *remote control* check box of the generator.
5. Activate *Demo Settings*.
6. Click *Configure*.
7. When the configuration has finished, click *Start*.
8. Check results.

## Generate test signals

Generate standard test models and Uplink Reference Measurement Channels quickly by selecting a signal out of the list.

An RF output is present at the SMU after clicking *Configure*. *Break* switches the RF output off.

The signals are generated with the generator trigger set to "free run".

Set the 10 MHz reference to external or internal.

## 10 Summary

The FSMU, which is the combination of the FSQ and the SMU, provides powerful features for fast and accurate base station tests in accordance with TS 25.141. All downlink signals can be measured, including the new test models for high speed downlink packet access (HSDPA). All uplink signals can be generated, including additive white Gaussian noise (AWGN).

Program **3G\_FSMU\_NodeB** allows you to run the tests via remote control. Without a base station, tests can be simulated: For transmitter tests, the SMU generates the BS downlink signal. For receiver tests, the FSQ monitors the uplink signal. You can navigate through program **3G\_FSMU\_NodeB** even if no instruments are connected.

For each of the tests, Application Note 1MA67 recommends a hardware setup. These configurations have been approved during many measurements on the spot.

As the standard is continuously evolving, Application Note 1MA67 and program **3G\_FSMU\_NodeB** will be enhanced from time to time.

For comments and suggestions regarding this application note, please contact

[TM-Applications@rsd.rohde-schwarz.com](mailto:TM-Applications@rsd.rohde-schwarz.com).

## Annex

### Literature

- [1] 3rd Generation Partnership Project; Technical Specification Group Radio Access Networks; Base Station conformance testing (FDD) - TS 25.141 (Release 5)
- [2] FSMU WCDMA Base Station Test Set / Operating Manual
- [3] Detlev Liebl, Tests on 3G-Base Station Tests to TS25.141, Application Note 1MA37
- [4] René Desquiotz, 3GPP FDD Base Station Tests with Vector Signal Generator SMIQ, Application Note 1GP41
- [5] Sander / Wolf, Spurious Emission Measurement on 3GPP Base Station Transmitters, Application Note 1EF45

### Installation guide for program 3G\_FSMU\_NodeB

#### Hardware and software requirements

3G\_FSMU-NodeB works under Windows 98, ME, 2000 or XP.

To ensure proper operation your computer shall meet the following minimum requirements.

Processor: Pentium 300

RAM: 64 Mbytes

Display: SVGA 800x600 pixels

Hard-disk storage: 50 Mbytes

Peripherals: Mouse

National Instruments GPIB bus card and driver installed

VISA library version, at least 2.5

If the VISA library is not already installed on your PC, download it from the National Instruments web-site <http://www.ni.com/visa>, search for VISA). The download is free of charge.

#### Installation:

Application Note 1MA67 consists of two parts:

- This document (1MA67\_0E.pdf)
- The **3G\_FSMU\_NodeB** software (file 1MA67\_xVx.exe, xVx is the version number)

- 1MA67\_xVx.exe is a selfextracting file. One of the unpacked files is setup.exe. It will be started automatically.
- Follow the instructions of the installer dialog.

## Abbreviations and Definitions

3GPP	Third Generation Partnership Project. Name of the organization that defines the communication standards of the Third Generation.
AWGN	Additional White Gaussian Noise.
B/M/T frequency	Bottom, middle, and top frequency within the allocated frequency band.
DCH	Dedicated Channel, collectively for DTCH and DCCH.
DTCH	Dedicated Traffic Channel. Logical transport channel mapped to the Dedicated Physical Data Channel (DPDCH) together with the DCCH.
DCCH	Dedicated Control Channel. Logical transport channel mapped to the Dedicated Physical Data Channel (DPDCH) together with the DTCH.
DPDCH	Dedicated Physical Data Channel which contains the user data (one or more DTCH and one DCCH)
DPCCH	Dedicated Physical Control Channel. Physical Channel that contains some control information. Among others, the Transmit Power Control (TPC) bits are transmitted in the DPCCH.
FDD	Frequency Division Duplex, means that uplink and downlink transmit on different frequencies.
RMC	Reference Measurement Channel. The 3GPP specifications define uplink Reference Measurement Channels for base station conformance tests. These are 3GPP signals with defined parameter values including channel coding. RMCs contain a DPCCH and a DPDCH as physical channels. As transport channels, a DTCH and a DCCH are mapped to the DPDCH.
SFN	Start of Frame Number. Trigger signal provided when Frame Number goes through zero.
TPC	Transmit Power Control. TPC bits are transmitted by a base station or mobile to tell its counterpart to increase or decrease transmit power.

## FSMU Models

### Standard Configuration

Option	Description	Consisting of	Description
R&S@FSMU-W	Standard Configuration	<b>R&amp;S@FSQ</b>	<b>Signal Analyzer</b>
		R&S@FSP-B10	External Generator Control
		R&S@FS-K72	3GPP-FDD-WCDMA Base Station Test
		R&S@FS-K74	3GPP-FDD-HSDPA Base Station Test
		<b>R&amp;S@SMU 200 A</b>	<b>Vector Signal Generator</b>
		R&S@SMU-B103	HF-Path 100 kHz to 3 GHz
		R&S@SMU-B11	Universal Coder with 16 / 64 M samples
R&S@SMU-B13	Base band module		
R&S@SMU-K42	3GPP-FDD WCDMA personality		
R&S@SMU-K43	3GPP-FDD HSDPA personality		
R&S@SMU-K62	Additive White Gaussian Noise		
		<b>Documentation</b>	
		CD-ROM - R&S@FSMU-W	CD-ROM with demonstration programs and operating manuals of R&S@FSMU -W
		Op. Man. - R&S@FSMU-W	Operating Manual of BTS test set R&S@FSMU-W
		Op. Man. - R&S@FSQ	Operating Manual of signal analyzer R&S@FSQ
		Op. Man. - R&S@FS-K72/K74	Operating Manual of 3GPP FDD base station test personality R&S@FS-K72/K74
		CD-ROM - R&S@SMU	CD-ROM with operating manuals of SMU
		Quick Start Guide R&S@SMU	quick start guide of signal generator SMU

### Extension Options

Option	Description	Consisting of	Description
R&S@FSMU-B1	Package for 2nd signal generator RF path	R&S@SMU-B203 R&S@SMU-B13 R&S@SMU-K62 R&S@SMU-B36	2nd RF path (3.0 GHz) Base band main module Additive white Gaussian noise High output power
R&S@FSMU-B2	Package for 2nd signal generator base band	R&S@SMU-B11 R&S@SMU-K42 R&S@SMU-K43	Base band generator Digital standard 3GPP FDD Enhanced BS tests for 3GPP FDD incl. HSDPA
R&S@FSMU-B3	Package for fading	R&S@SMU-B14 R&S@SMU-B15 2xR&S@SMU-K71	Fading simulator Fading simulator extension Dynamic Fading

## Required Options

Transmitter tests		
6.2.1	Base station maximum output power	R&S@FSMU-W
6.2.2	CPICH power accuracy	R&S@FSMU-W
6.3	Frequency error	R&S@FSMU-W
6.4.2	Power control steps	R&S@FSMU-W
6.4.3	Power control dynamic range	R&S@FSMU-W
6.4.5	Total power dynamic range	R&S@FSMU-W
6.5.1	Occupied bandwidth	R&S@FSMU-W
6.5.2.1	Spectrum emission mask	R&S@FSMU-W
6.5.2.2	Adjacent channel leakage ratio (ACLR)	R&S@FSMU-W
6.5.3	Spurious emissions	R&S@FSMU-W
6.6	Transmit intermodulation	R&S@FSMU-W
6.7.1	Error vector magnitude (EVM)	R&S@FSMU-W
6.7.2	Peak code domain error	R&S@FSMU-W
Receiver Characteristics		
7.2	Reference sensitivity level	R&S@FSMU-W
7.3	Dynamic range	R&S@FSMU-W
7.4	Adjacent channel selectivity	R&S@FSMU-W + R&S@FSMU-B1 + R&S@FSMU-B2
7.5	Blocking characteristics	R&S@FSMU-W + R&S@FSMU--B1 + R&S@FSMU-B2 + R&S@SMR
7.6	Intermodulation characteristics	R&S@FSMU-W + R&S@FSMU--B1 + R&S@FSMU-B2 + R&S@SMR
7.7	Spurious emissions	R&S@FSMU-W
7.8	Verification of internal BER calculation	R&S@FSMU-W + R&S@FSMU-B1
Performance requirement		
8.2	Demodulation in static propagation conditions	R&S@FSMU-W + R&S@FSMU-B1
8.3	Demodulation of DCH in multi path fading conditions	R&S@FSMU-W + R&S@FSMU-B1 + R&S@FSMU-B3
8.4	Demodulation of DCH in moving propagation conditions	R&S@FSMU-W + R&S@FSMU-B1 + R&S@FSMU-B3
8.5	Demodulation of DCH in birth/death propagation conditions	R&S@FSMU-W + R&S@FSMU-B1 + R&S@FSMU-B3
8.6	Verification of internal BLER calculation	R&S@FSMU-W + R&S@FSMU-B1
8.8.1	RACH preamble detection in static propagation conditions	R&S@FSMU-W + R&S@FSMU-B1 <sup>3)</sup>
8.8.2	RACH preamble detection in multi path fading case 3	R&S@FSMU-W + R&S@FSMU-B1 + R&S@FSMU-B3 <sup>3)</sup>
8.8.3	Demodulation of RACH message in static propagation conditions	R&S@FSMU-W + R&S@FSMU-B1
8.8.4	Demodulation of RACH message in multi path fading case 3	R&S@FSMU-W + R&S@FSMU-B1 + R&S@FSMU-B3
8.9.1	CPCH AP/CD preamble detection in static propagation condition	R&S@FSMU-W + R&S@FSMU-B1 <sup>3)</sup>
8.9.2	CPCH AP/CD preamble detection in multi path fading case 3	R&S@FSMU-W + R&S@FSMU-B1 + R&S@FSMU-B3 <sup>3)</sup>
8.9.3	Demodulation of CPCH message in static propagation conditions	R&S@FSMU-W + R&S@FSMU-B1
8.9.4	Demodulation of CPCH message in multi path fading case 3	R&S@FSMU-W + R&S@FSMU-B1 + R&S@FSMU-B3

Ordering Numbers

<b>FSMU WCDMA base station test set</b>		
Based on FSQ3 signal analyzer 3 GHz	R&S@FSMU-W3	1166.1554.03
Based on FSQ8 signal analyzer 8 GHz	R&S@FSMU-W8	1166.1554.08
Based on FSQ26 signal analyzer 26 GHz	R&S@FSMU-W26	1166.1554.26
<b>Options for R&amp;S-FSMU-W</b>		
Package for 2nd RF path	R&S@FSMU-B1	1404.2008.02
Package for 2nd base band	R&S@FSMU-B2	1404.2308.02
Package for fading	R&S@FSMU-B3	1404.2608.02
<b>Extension to the following standards</b>		
GSM/EDGE	R&S@FS-K5	1141.1496.02
	R&S@SMU-K40	1160.7609.02
CDMA2000@	R&S@FS-K82	1157.2316.02
	R&S@SMU-K46	1160.9876.02
1xEV-DO	R&S@FS-K84	1157.2851.02
	R&S@SMU-K17	1160.7009.02
TD-SCDMA	R&S@FS-K76	1300.7291.02
	R&S@SMU-K14 <sup>1)</sup>	1160.6202.02
<b>Options for R&amp;S-SMU200A</b>		
Multi Carrier CW Signal Generation	R&S@SMU-K61	1160.8505.02
Digital standard CDMA2000@ incl. 1xEV-DV	R&S@SMU-K46 <sup>1)</sup>	1160.9876.02
Digital standard IS-95	R&S@SMU-K11 <sup>1)</sup>	1160.5335.02
Digital standard 3GPP TDD	R&S@SMU-K13 <sup>1)</sup>	1160.5906.02
Digital standard TD-SCDMA	R&S@SMU-K14 <sup>1)</sup>	1160.6202.02
Digital standard IEEE 802.11(a/b/g)	R&S@SMU-K19 <sup>1)</sup>	1160.8805.02
User-defined OFDM signals	R&S@SMU-K15 <sup>1)2)</sup>	1160.6402.02
Digital standard 3GPP FDD incl. HSDPA	R&S@SMU-K20 <sup>1)</sup>	1160.9460.02
<b>Options for R&amp;S-FSQ</b>		
Noise measurement software	R&S@FS-K3	1057.3028.02
Phase noise measurement software	R&S@FS-K4	1108.0088.02
FM measurement demodulator	R&S@FS-K7	1141.1796.02
Bluetooth application firmware	R&S@FS-K8	1157.2568.02
Power sensor measurements	R&S@FS-K9	1157.3006.02
Application firmware for noise figure and gain measurements	R&S@FS-K30	1300.6508.02
3GPP UE FDD application firmware	R&S@FS-K73	1154.7252.02
3 GPP TD-SCDMA UE application firmware	R&S@FS-K77	1300.8100.02
CDMA2000@ MS application Firmware	R&S@FS-K83	1157.2416.02
CDMA2000@ 1xEV-DO MS application Firmware	R&S@FS-K85	1300.6689.02
Vector signal analysis	R&S@FSQ-K70	1161.8038.02
WLAN 802.11 a/b/g/j application firmware	R&S@FSQ-K91	1157.3129.02
<b>SMR</b>		
Signal Generator 1 to 20 GHz	R&S@SMR	1104.0002.20
Frequency Extension 0.01 to 1 GHz	R&S@SMR-B11	1104.4250.02

<sup>1)</sup>With WinIQSIMTM

<sup>2)</sup>With WinIQOFDM



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