Products: CMU, ABFS, CMU-B17, CMU-B83, CMU-Z10, CMU-Z11

cdma2000 Receiver Tests Under Fading Conditions with R&S®CMU and R&S®ABFS

Application Note

This application note describes how to generate cdma2000 signals for wide ranging receiver tests under fading conditions for cdma2000 450/Cellular/PCS/IMT-2000 mobile and base station equipment. The test setup requires an R&S®CMU200 / CMU300 Universal Radio Communication Tester with option R&S®CMU-B17 IQ-IF interface and a R&S®ABFS Base Band Fading Simulator. The cdma2kFadLevCor program included with this application note performs an automatic level correction of the power fed to the User Equipment (UE) by adding a RF power offset equivalent to the IQ path loss.

ROHDE&SCHWARZ

Contents

1 Overview

The signal strength and quality of signals received by Base Stations (BS) and Mobile Stations (MS) can be influenced by effects resulting from the movement of the mobile, and the overlay of numerous delayed signals caused by reflections. This phenonemon is called fading and is classified in profiles such as Constant Phase, Pure Doppler, Rice, Rayleigh and Moving Propagation fading. This application note describes how to connect a R&S® Radio Communication Tester CMU with IQ-IF interface option CMU-B17 to a R&S® ABFS baseband fading simulator for generating cdma2000 signals suitable for tests under fading conditions according to specification C.S 0011-B. The supplied program cdma2kFadLevCor calibrates the attenuation of an external fading simulator ABFS connected to the CMU IQ loop. cdma2kFadLevCor can also calculate the mathematical signal loss resulting from various fading profiles and noise influence and automatically adds an equivalent offset to the CMU RF power.

The following abbreviations are used in the following text for R&S® test equipment:

- The R&S®CMU200/CMU300 Universal Radio Communication Tester is referred to as CMU.

- The R&S®ABFS Base Band Fading Simulator is referred to as ABFS.

- R&S® means Rohde & Schwarz GmbH und Co KG

2 Software Features

- Program and device configuration storage

- Auto detection of ABFS fading model and active paths

- Variable CMU GPIB secondary address setup

- Automatic Insertion Loss calibration routine

- Quick calculation of the RF power compensation factor affected by fading effects and Additive Gaussian White Noise.

3   Hardware and Software Requirements

Hardware Requirements

The software runs on a PC with

CPU	Pentium 330MHz or better
RAM	128 MBytes or more
MONITOR	SVGA color monitor 800x600 or better
IEC/IEEE BUS	IEC/IEEE bus interface Rohde & Schwarz IEEE-488.2 bus interface **PS-B4**, 1006.6207.04, or National Instruments **AT-GPIB, PCI-GPIB** or **PCMCIA-GPIB** card.

Software Requirements

WINDOWS 98SE/NT/2000/XP	Microsoft operating system
NI-488.2 V1.7 (or above)	IEC/IEEE – bus driver from National Instruments. See http://www.natinst.com for latest revision.
NI-VISA V3.0 (or above)	VISA driver from National Instruments. See http://www.natinst.com for latest revision.
MICROSOFT INSTALLER	Versions for Windows 95/98/NT are available at http://www.rohde-schwarz.com. Not required for Windows 2000/XP.

Note: In case only the NI-488.2 GPIB driver is installed but no VISA driver the program will react as if there were no device connected to the GPIB bus.

4   cdma2000 Fading on Baseband Level (IQ) with CMU and ABFS

Connecting the Instruments

CMU and ABFS

Connect the controlling PC to the CMU and ABFS with a GPIB bus cable. The ABFS is additionally connected to the CMU in the IQ RX (mobile station) or TX (base station) loop with the cable no. 1100.6993 which is included in the CMU-B17 option. The UE (user equipment) or BS (base station) is connected to the RF2 connector of the CMU which is set to bidirectional operating mode (input/output).
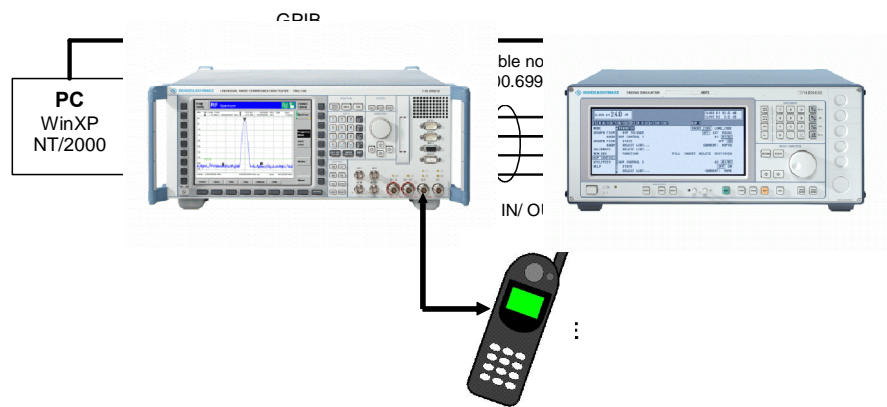
Fig. 1 CMU and ABFS Connection

Basics of Fading Tests with IQ IF Loop

The ABFS adds fading and noise effects to the CMU signal on the IQ level (baseband). When an ABFS is inserted into the CMU IQ loop by switching the CMU-B17 option, the signal power decreases due to the losses on the switched path. The ABFS displays a general insertion loss depending on the number of active fading channels and appropriate channel losses which applies to the worst case (all channels turned on) to avoid overdrive at the CMU IQ input. In order to maintain a defined signal level at the UE the CMU generator level setting must compensate this insertion loss. This is achieved by setting the EXTERNAL ATTENUATION parameter of the CMU generator to the value of this insertion loss.

The ABFS fading simulator supports several cdma2000 fading standards (CDMA 8, CDMA 30, CDMA 100) with multiple paths and profiles (Rayleigh, Pure Doppler, etc.).

A power component (Fading Gain) resulting from the sum of the power of each path must be added to the Insertion Loss loss in order to obtain the correct total loss of the ABFS IQ path.

Additive white Gaussian noise (AWGN) is added to simulate the presence of communication traffic at the input of the receiver under test.

The following schematic shows the signal paths and their calculation.
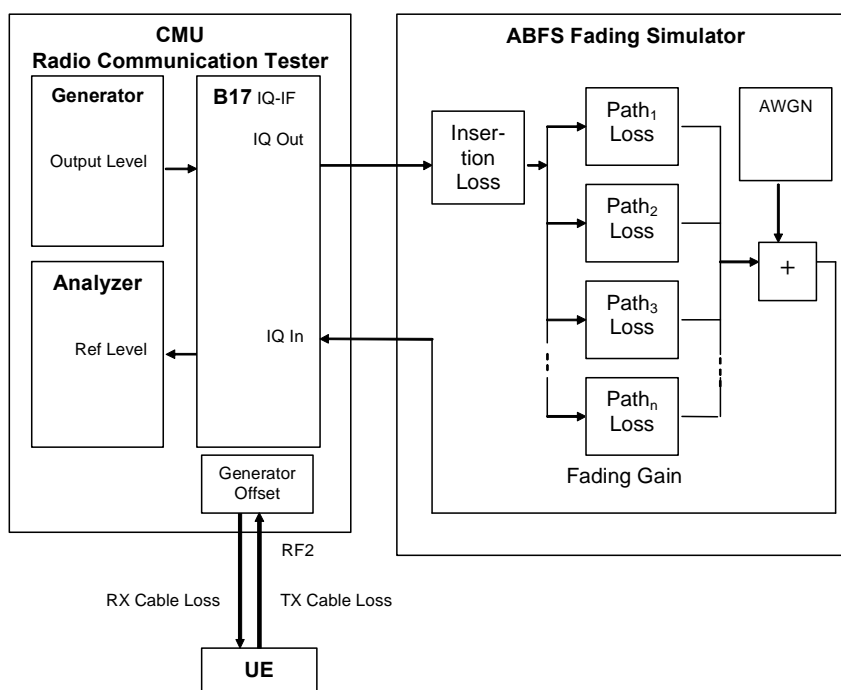

Fig. 2 Fading with IQ IF Loop

Insertion Loss

The **INSERTION LOSS** is defined in the program **CDMA2KFADLEVCOR.EXE** as the ABFS insertion loss plus of the loss of the IQ cable to and from the CMU. It must be measured only once for each hardware configuration.

Note: *The ABFS insertion loss is 12dB with **INSERTION LOSS SETTING MODE -> AUTO** and can be varied from 6 to 24dB with **INSERTION LOSS SETTING MODE -> MANual**.*

Fading Gain

The **FADING GAIN** is the gain caused by the sum of various fading paths power components. This value is usually positive for standard fading profiles with at least one path with 0dB loss. The **FADING GAIN** must be updated each time the fading profile is changed and is calculated as follows:

$$FadingGain \quad = 10*\log\left(\sum_{n=1}^{N}10^{\frac{-PnLoss}{10}}\right)$$

P_nLOSS = Loss of n-th path (appears as negative gain in the formula). The maximum number of paths is N = 12 for the ABFS.

Since the paths are switched together in parallel, the sum of the power amplification factors (delogarithmized path losses) must be added and the resulting sum logarithmized.

Note: *The formula above applies to fading profiles consisting of non correlated signal paths (usually Raleigh for all standards). The calculated result will not be precise as soon as the fading profile contains at least two correlated paths (e.g. CPHAS), since their calculation is voltage instead of power based.*

AWGN Level

The AWGN Level is the additional amount of power applied to the UE by adding White Gaussian Noise with a specified signal to noise ratio to the faded signal. The following schematic and formulas show the functional layout of the IQ path and its calculation.
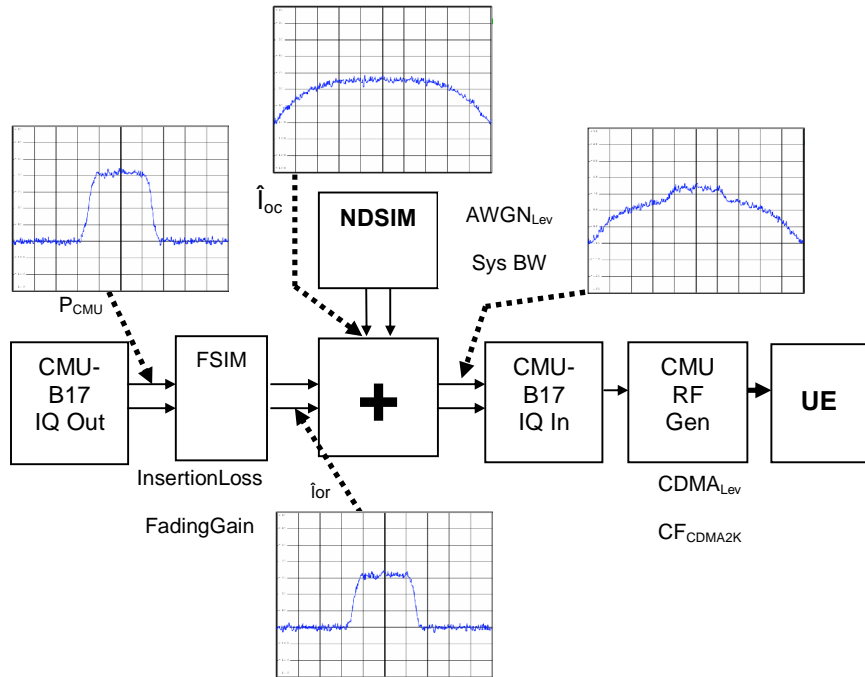

Fig. 3 IQ Path

The CMU I or Q output supplies a peak voltage of:

$$Upp \qquad = 0.5V$$

The corresponding level P_{MAX} at a 50 Ohm terminated lead is:

$$P\max \qquad = 10*\log\left(\frac{Upp^2}{50\Omega*1mW}\right)$$

$$= 10*\log\left(\frac{0.25W}{0.05W}\right)$$

$$\approx +7dBm = 0dBfs$$

The dynamic margin for cdma2000 signals is factory set to

$$DynMar \qquad = 9.00dB$$

The cdma2000 IQ baseband power level P_{CMU} at the CMU-B17 outputs is factory adjusted to:

$$Pcmu = P\max - DynMar$$
$$= 7dBm - 9.00dB$$
$$= -2.00dBm$$

The output power of the fading simulator FSIM (Îor) is calculated as:

$$\hat{I}or / dB = Pcmu - InsertionLoss - FadingGain$$

The power supplied by the noise and distortion simulator NDSIM (Îoc = AWGNLevel) is referenced to 0.5Vpp = +7dBm. The maximal AWGNLevel possible on the ABFS is -17dBfs = -10dBm. The basic system bandwidth (SysBw) is 1.23MHz:

$$\hat{I}oc / dB = P\max + AWGNlev - 10 * \log\left(\frac{SysBw}{1.23MHz}\right)$$

The signal to noise ratio SNR is defined in the cdma2000 test standard (e.g. SNR = 8dB) and depends on following formula:

$$SNR / dB = \hat{I}or / dBm - \hat{I}oc / dBm$$
$$= Pcmu - InsertionLoss - FadingGain - P\max$$
$$- AWGNlev + 10 * \log\left(\frac{SysBw}{1.23MHz}\right)$$

Note: *The noise spectral density of ABFS is flat within 1.4 times the set system bandwidth. This means, with a system bandwidth of 1.23MHz you obtain flat noise within 1.722 MHz. IS98 however specifies 1.8 MHz noise bandwidth. In our opinion, 1.722 MHz is sufficient for all hardware tests. This needs no further correction to the formulas given. For all cases, where a noise bandwidth of 1.8 MHz is mandatory, we suggest to set the system bandwidth of ABFS to 1.8 MHz / 1.4 = 1.286 MHz. In cdma2kFadLevCor AWGNLev is compensated depending on the System Bandwidth.*

The ABFS accepts only the (absolute) AWGN level so the formula above needs to be solved accordingly (e.g. InsertionLoss determined by calibration=11.99dB, FadingGain for CDMA 100 fading profile with 3 paths = 3.98dB).

$$
\begin{aligned}
AWGNLvl \quad &= Pcmu - InsertionLoss - FadingGain - P\max - SNR \\
&= -2.00dBm - 11.99dB + 3.98dB - 7dB - 8dB \\
&= -25.02dBm
\end{aligned}
$$

After adding AWGN to the signal the output power is:

$$
\begin{aligned}
OutputPower &= 10 * \log\left(10^{\frac{\hat{I}or}{10}} + 10^{\frac{\hat{I}oc}{10}} \right) \\
&= 10 * \log\left(10^{-1.83} + 10^{-1.03} \right) \\
&= -9.66dB
\end{aligned}
$$

Example: CDMA 100 fading profile (3 paths with 0dB, 0dB and 3dB path losses) and SNR 8dB. The **INSERTION LOSS** has been measured according to the calibration routine (e.g. 11.99dB) described in the section "Calibrating the Insertion Loss". The **FADING GAIN** is calculated as shown on p.7 and the **RX/TX CABLE LOSS** has been measured or is specified by the manufacturer (e.g. 1.0 dB). The **EXT**ernal **ATTEN**uation **OUTPUT** is calculated as:

$$
\begin{aligned}
ExtAttenOutput &= InsertionL\,oss - FadingGain + RxCableLos\,s \\
&= InsertionLoss - \\
&\quad \left(10 * \log\left(10^{\frac{-Path1Loss}{10}} + 10^{\frac{-Path2Loss}{10}} + 10^{\frac{-Path3Loss}{10}} \right) + 1.0 \right) dB \\
&= \left(11.90 - 10 * \log\left(10^{\frac{-0}{10}} + 10^{\frac{-0}{10}} + 10^{\frac{-3}{10}} \right) + 1.0 \right) dB \\
&= (11.99 - 3.98 + 1.0) dB \\
&= 9.01 dB
\end{aligned}
$$

This precise calculation method makes an additional power measurement at the UE input obsolete after changing the fading profile.

Rx and Tx Cable Loss

The **Rx CABLE LOSS** is the attenuation of the cable from CMU RF2 output connector to the UE and must be specified or measured separately. The same applies for the **Tx CABLE LOSS** which is the attenuation from the UE to the CMU RF2 input. When the combined CMU input/output RF2 is used with one cable connected to the UE, the **Rx** and **Tx CABLE LOSS** are equal. When using a custom UE adaptor with directional coupler they will differ.

Note: *When the CMU reaches its calibration deadline it may occur that the RF generator level is close to the specified limits. An offset of 0.5dB, for instance, enormously effects all types of error rate measurements (BLER, FER). In case the actual CMU RF output power is less than the nominal level, this may be compensated by increasing the **Rx CABLE LOSS** by the difference. In case the measured power is higher than the nominal value the **Rx CABLE LOSS** must be decreased by the difference.*

5 Installing the Level Correction Software

The following installation files are required to install the level correction software CDMA2KFADLEVCOR on the controlling PC.

CDMA2KFADLEVCOR V1.XX.MSI

DISTFILE.CAB

Execute **cdma2kFADLEVCOR V1.XX.MSI** and select the installation directory. A new menu item **CDMA2KFADLEVCOR** is created in **START -> PROGRAM FILES**. The installation directory contains the files named below:

CDMA2KFADLEVCOR.EXE   Executable

CDMA2KFADLEVCOR.CFG   Configuration file

CDMA2KFADLEVCOR.CHM   Online help manual

Before running **CDMA2KFADLEVCOR** assign at least one of the desired CDMA **SIGNALLING** and **NON-SIGNALLING** function groups to one or more of the 29 possible GPIB secondary addresses (1..29) on the CMU.
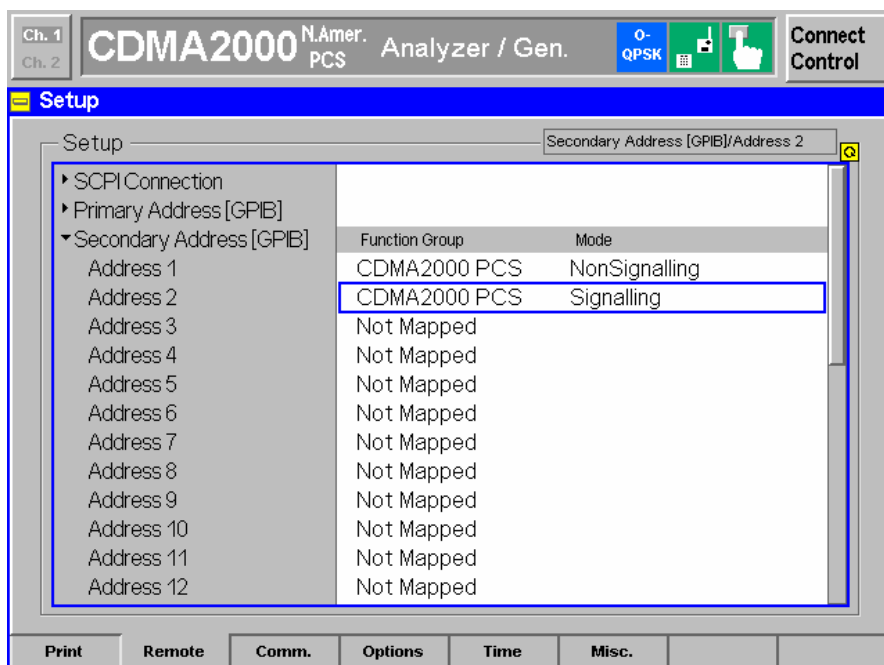

Fig. 6 CMU GPIB secondary address setup

6   Running the Level Correction Software

This section describes the program's menu items and controls. Start **CDMA2KFADLEVCOR.EXE** on the PC. The program's purpose is to set the CMU external generator attenuation to the calculated ExtAtten value so the CMU generator output level display shows the signal power actually applied to the UE.

Menu

File

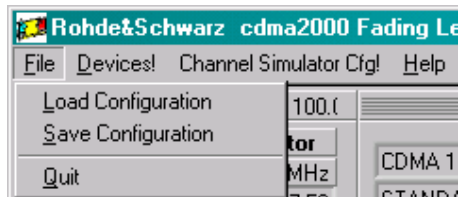All program and device specific data can be saved and loaded from a configuration file.

Fig. 7 Menu Items

- **LOAD CONFIGURATION** - the default file extension is *.cfg*. The configuration file contains the following parameters:

  X = last horizontal window position

  Y = last vertical window position

  CMU GPIB primary address

  CMU GPIB sec. address of CDMA2000 PCS non signalling module

  CMU GPIB sec. address of CDMA2000 PCS signalling module

  ABFS GPIB primary address

  Cable Loss

  Insertion Loss

  Calibration / Measurement Mode flag (0=Cal, 1=Meas)

  Signal / Noise Ratio

- **SAVE CONFIGURATION** - the default file extension is *.cfg*. Similar file dialog as *Load Configuration*.

Devices

In the **DEVICES** menu the primary (**PAD**) and secondary non signalling and signalling secondary addresses (**SAD**) according to the CMU settings must be selected. Initialize the CMU and ABFS by pressing the corresponding **INIT** buttons.
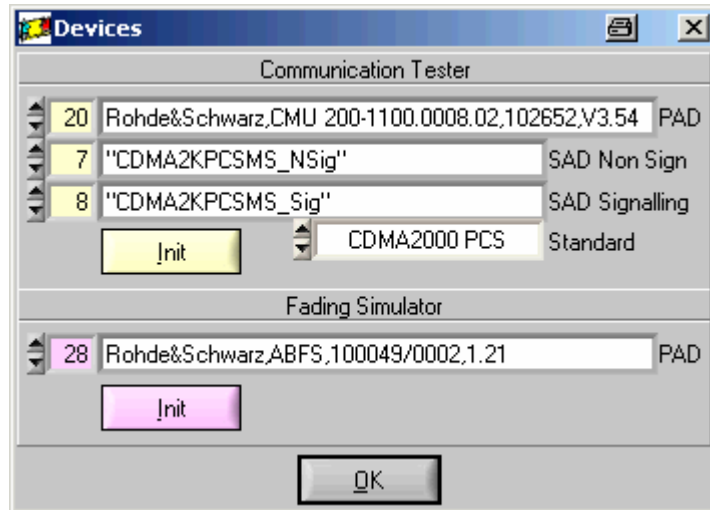

Fig. 8 Select Devices

- CT (communication tester) **PAD** – GPIB primary address of the CMU. Range: 0 to 30.

- CT **SAD Non Sign** – GPIB secondary address of the CMU option to be used for Calibration Mode. Range: 1 to 29.

- CT **SAD Signalling** – GPIB secondary address of the CMU option to be used for Measurement Mode. Range: 1 to 29.

- CT **STANDARD** – CDMA2000 communication standard. Range: CDMA2000 450, CDMA2000 Cellular, CDMA2000 PCS, CDMA2000 IMT-2000.

- CT **INIT** – Checks for the presence of a device and displays the identification string of a device found in the text field.

Note: In case the selected standard is presently configured on the CMU CDMA2KFADLEVCOR will prefer to use it and simple the the according Non Signalling / Signalling SAD.

- FS (Fading Simulator) **PAD** – GPIB primary address of the ABFS. Range: 0 to 30.

- FS **INIT** – Checks for the presence of a device and displays the identification string of a device found in the text field. It also turns the fading and AWGN option ON and sets AWGN system bandwidth (SysBw) to 1.23MHz.

After both instruments have been initialized correctly the identification strings of the devices are displayed. By pressing **OK** the program returns to the main windows and also sets the ABFS RF frequency to the same frequency the CMU generator has in signalling mode.

Channel Simulator Configuration

The menu **CHANNEL SIMULATOR CFG** provides predefined fading profiles according to cdma2000 test specification *3GPP2 C.S0011-B*. The abbreviation **BC** stands for Band Class.
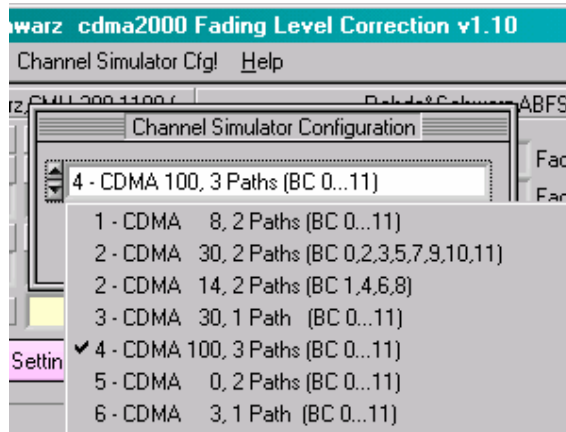

Fig. 9 Channel Simulator Configuration

- **SET** – Sets the ABFS to the selected fading profile
- **QUIT** – Closes this window and returns to main window.

Please remember to update the **FADING GAIN** and **EXT. ATTEN.** display by pressing the **CALCULATE** button in the main program window after changing the fading profile in the menu or on the ABFS.

Help

- **HELP** – displays online help
- **ABOUT** – displays revision and copyright information

Controls and Indicators

cdma2kFadLevCor has two different operating modes, the **CALIBRATION MODE** which is used obtain the **INSERTION LOSS** and the **MEASUREMENT MODE** which allows calculation of the **FADING GAIN**.

Calibration Mode

The **CALIBRATION MODE** is used to measure the hardware dependant **INSERTION LOSS** resulting from the nominal ABFS ILOSS (insertion loss) setting and the loss of the IQ connection cables. The **INSERTION LOSS** is usually ILOSS ± 0.05dB depending on the hardware configuration. In **CALIBRATION MODE** the **INSERTION LOSS** and **CALIBRATE** controls are highlighted and the CMU **EXT**ernal **ATTEN**uation is turned **OFF**.

Note: Allow sufficient warm-up time for the CMU and ABFS in order to obtain correct measurement results.
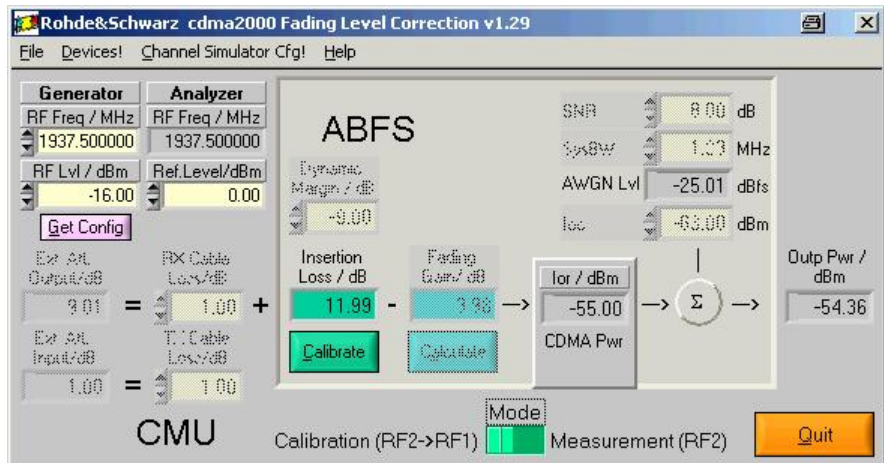

Fig. 10 Main Window Calibration Mode

- Generator **RF FREQ** – Control for CMU generator frequency. The analyzer **RF FREQ**uency indicator is automatically set to the same value. Range 10MHz to 2700MHz.

- Generator **RF LVL** – CMU Generator RF level. Range -120dBm to -16dBm.

- Analyzer **RF FREQ** – Indicator for the CMU analyzer frequency.

- Analyzer **REF.LEVEL** – Control for CMU analyzer reference level. Range -43dBm to 44dBm.

- **GET CONFIG** reads the following CMU generator and analyzer settings.

    o Generator **RF FREQUENCY** (non signalling) or **CHANNEL** (signalling). The ABFS is automatically set to the RF frequency corresponding to the CMU generator CHANNEL in signalling mode.

    o Generator **RF LEVEL**

    o Analyzer **RF FREQ**UENCY

    o Analyzer **REF**erence **LEVEL**

- **MODE** – chooses between **CALIBRATION** and **MEASUREMENT** Mode. The ABFS is automatically set to the RF frequency corresponding to the CMU generator CHANNEL in signalling mode.

- **INSERTION LOSS** – Attenuation of the IQ path as determined manually or by pressing the **Calibrate** button (see section 'INSERTION LOSS' on page 6 for further details).

- **CALIBRATE** – Performs full automatic calibration and updates the **INSERTION LOSS** indicator.

Measurement Mode

The **MEASURMENT MODE** is used to calculate the **FADING GAIN**, switch the CMU to signalling mode and turn on the CMU-B17 fading path. In **MEASUREMENT MODE** the **CALCULATE** button and **FADING GAIN** indicator are highlighted and the CMU **EXT**ernal **ATTEN**uation is turned **ON**.
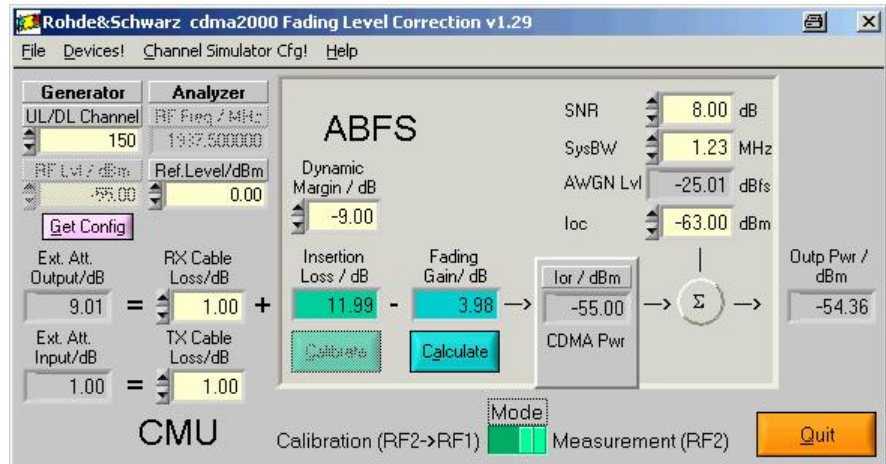

Fig. 11 Main Window Measurement Mode

- Generator **UL/DL CHANNEL** – Control for the **U**pLink/**D**ownLink Channel.

- **DYNAMIC MARGIN** – CMU I/Q baseband RMS output power ratio to full scale. 0 dBfs = +7dBm. The baseband power P_{CMU} = +7 dBm – 9dB (factory default) = -2 dBm (see p.9).

- **FADING GAIN** – Gain resulting from sum of various fading paths. It is calculated by pressing the **CALCULATE** button as shown in the section 'Basics of Fading Tests with IQ/IF Loop' (page 5).

- **CALCULATE** – Reads the current fading parameters and updates the appropriate indicators as necessary. **FADING GAIN** is updated with the calculated value.

- **SNR** – Signal / AWGN ratio control prescribed by test specification.

- **SYSBW** – ABFS AWGN system bandwidth control.

- **AWGN LVL** – AWGN level in relation to IQ full-scale (= $0.5V_p$). If the calculated value (by pressing **CALCULATE** or changing **Îor/Ioc** or **SYSBW**) is out of range (-50dBm <= AWGN level <= -17dBm) a warning appears and by pressing **OK** the active ABFS path losses are increased accordingly.
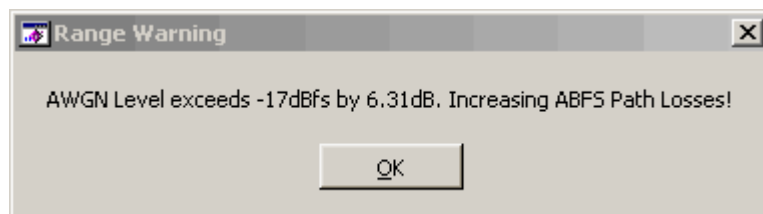

Fig. 12 AWGN Level Range Warning

Note: The ABFS path losses are reset as soon as you choose a fading profile from the **PROPAGATIONS CONDITIONS** menu in UtraFadCal or manually on the ABFS.

- **IOC** – Control for absolute AWGN power as defined in the cdma2000 specification.

- **RX CABLE LOSS** – the user specified attenuation for the cable from the RF2 connector to the UE including the coupling loss for test adaptors. The **RX CABLE LOSS** is added to the level offset **EXT ATTEN**. This control may be used to compensate CMU RF level offsets (see p.10).

- **TX CABLE LOSS** – the user specified attenuation for the cable from the UE to the RF2 connector. **EXT ATTEN INPUT** is automatically set to **TX CABLE LOSS**.

- **EXT ATTEN OUTPUT** – Indicator for level offset which is applied to the output power to compensate for **INSERTION LOSS**, **FADING GAIN**, and **RX CABLE LOSS**.

$$ExtAttenOutput = InsertionLoss - FadingGain + CableLoss$$

CDMA2KFADLEVCOR displays the following error message in case the CMU generator exceeds its maxium output level due to the **EXT ATTEN OUTPUT** value. If this error occurs press **OK** and enter the correct parameters.

Fig. 13 Level Warning

- **EXT ATTEN INPUT** – Indicator for the level offset which is applied to the input power to compensate for **TX CABLE LOSS**.

Note: *The **EXT ATTEN OUTPUT** and **INPUT** displays are automatically updated when the **CALIBRATE** or **CALCULATE** buttons are pressed or the **RX** or **TX CABLE LOSS** values are changed manually. In **MEASUREMENT** Mode the **EXT ATTEN OUTPUT** and **INPUT** values are immediately transferred to the CMU.*

Calibrating the Insertion Loss

The program **CDMA2KFADLEVCOR** performs an automatic calibration of the **INSERTION LOSS** after pressing the **CALIBRATE** button. This sections describes how this procedure may be done manually.

The **INSERTION LOSS** is device dependant and must be determined only once for an individual setup (CMU + ABFS + IQ connection cables, see fig. 2). This measurement setup uses RF2 as output and RF1 as input.

Fig. 14 Calibration Configuration

1. Switch the fading simulator to **STANDARD...** -> **CALIBRATION MODE** (1 path, CPHAS profile, 0.0dB path loss). This sets the **FADING GAIN** to zero and the measured value will only reflect the **INSERTION LOSS**.

Fig. 15 ABFS Calibration Mode

2. Configure the CMU generator to CDMA2000 PCS non-signalling mode and ModQual O-QPSK
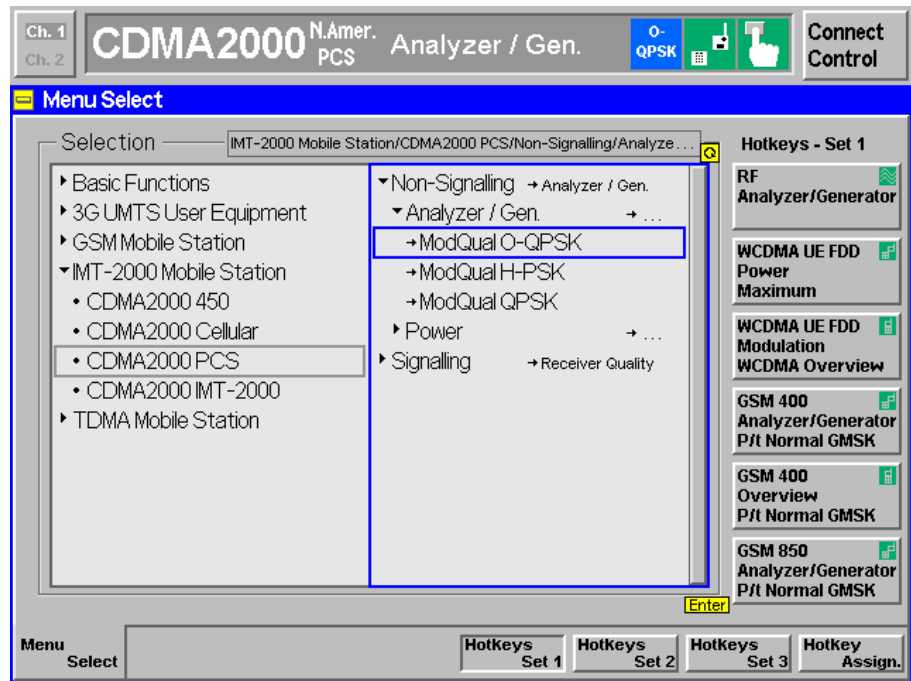

Fig. 16 CMU Mode
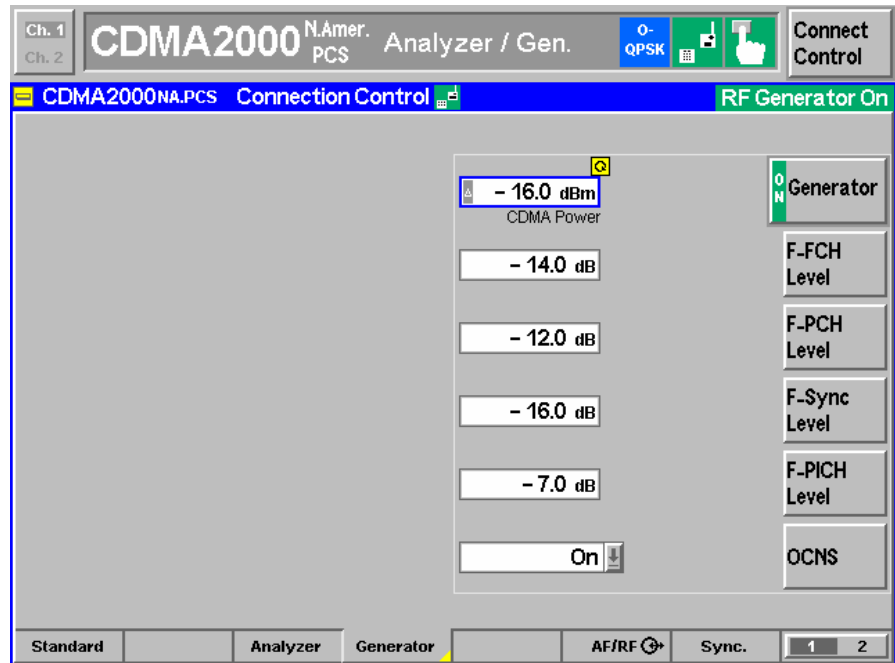
with the following generator settings.

Fig. 17 CMU Generator Setup

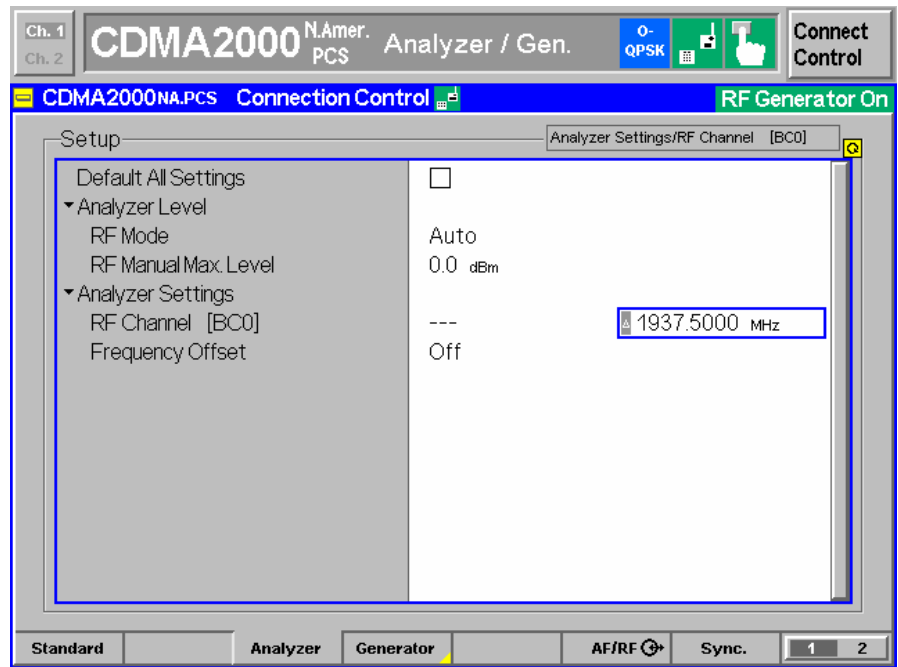3. Set the CMU analyzer to the same frequency (not channel) as the generator.

Fig. 18 CMU Analyzer Setup

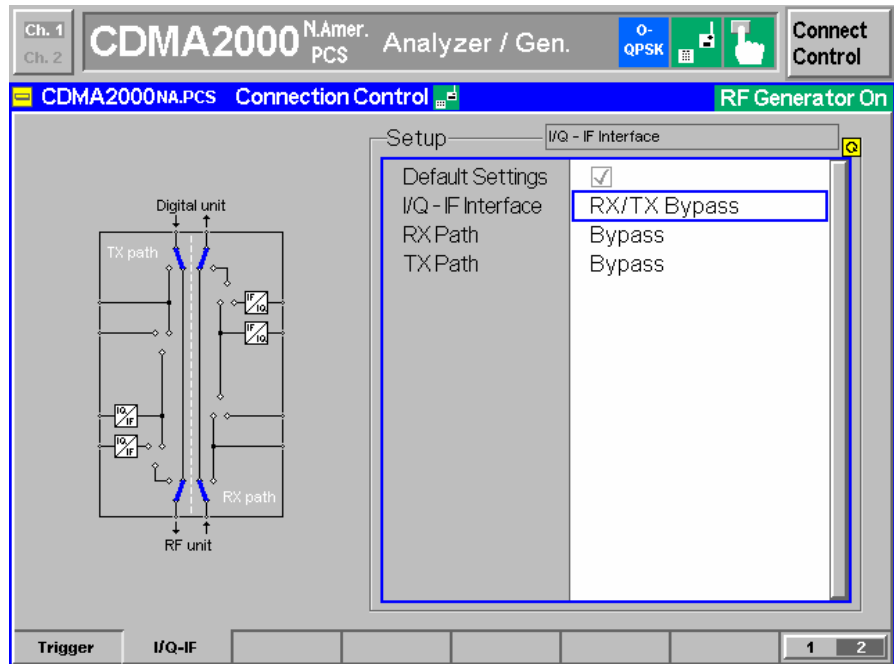4. Set the IQ/IF board to Bypass mode

Fig. 19 IQ/IF Bypass Configuration

in order to obtain the reference Average MS Power **PREF**.
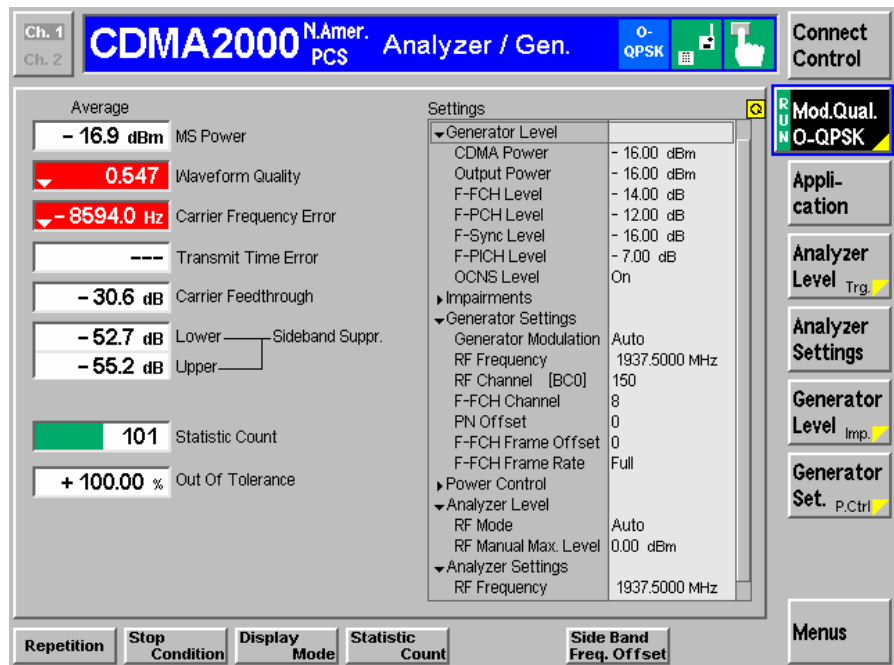
Fig. 20 Power in Bypass Mode

5. Activate the IQ loop and send the signal through the fading simulator.

Fig. 21 IQ/IF Fading Configuration

Fig. 22 Power with Calibration Mode Standard Fading

6. The resulting Average MS Power **P_{MEAS}** (Fig. 23) must be subtracted from the reference power **P_{REF}** (Fig. 21) to obtain the **INSERTION LOSS** of the IQ path.

$$InsertionLoss = \text{P}_{REF} - \text{P}_{MEAS} = -16.9dBm + 28.8dBm = 11.9dB$$

7 Testing MS Receiver Quality with FER-FCH Measurements Under Fading Conditions and AWGN

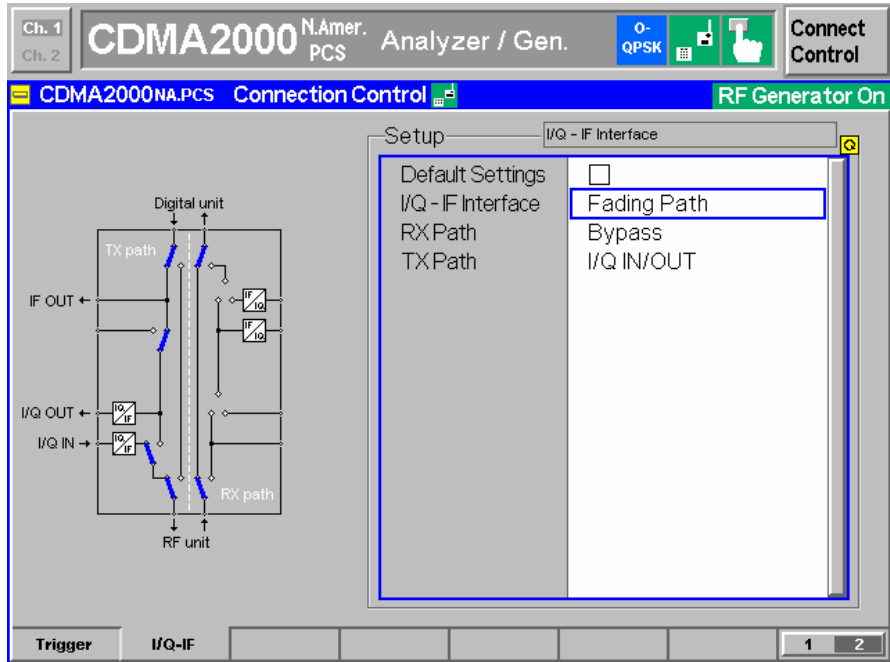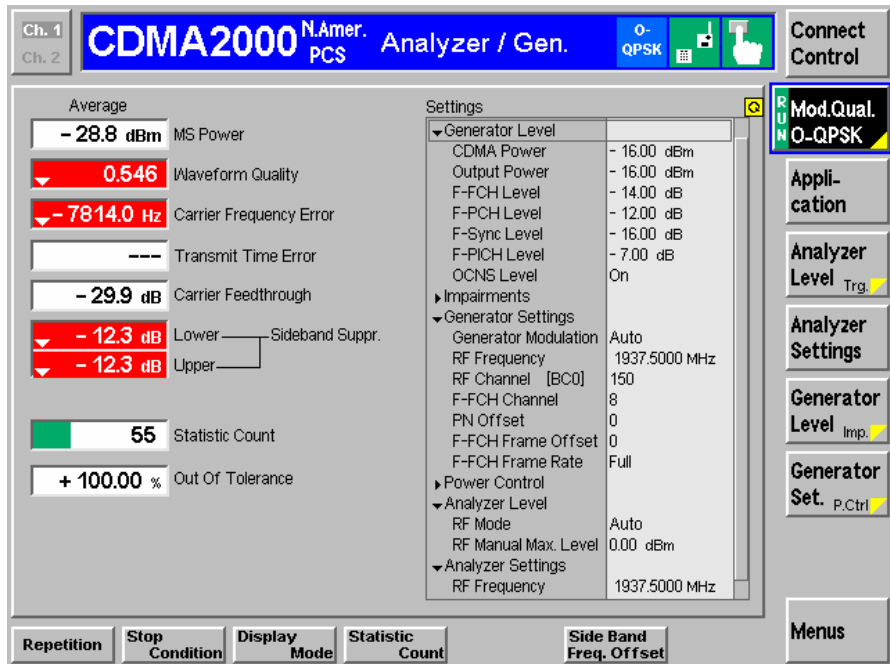A criteria for MS or BS receiver quality is the frame error rate of the fundamental channel (FER-FFCH) which is specified in the cdma2000 test specification *3GPP2 C.S0011-B* for mobile stations and in *3GPP2 C.S0011-B* for base stations.

How To Use the Test Specification

The following example describes the relevant parameters for performing the test case **3.4.2 DEMODULATION OF FORWARD FUNDAMENTAL CHANNEL** with **RADIO CONFIGURATION 1** with **CASE 1** (see table below taken from the test specification 3GPP2 C.S0011-B).

Case	Radio Configuration	Channel Simulator Configuration Number
1	1	1 (8 km/h, 2 paths)
2	1	3 (30 km/h, 1 path)
3	1	4 (100 km/h, 3 paths)
4	2	1 (8 km/h, 2 paths)
5	2	3 (30 km/h, 1 path)
6	2	4 (100 km/h, 3 paths)

Fig. 23 Channel Simulator Configuration Table

The test parameters for this test case are summarized in the according table A.2.2.1-1 and are highlighted.

Parameter	Units	Test 1	Test 2	Test 3
$\hat{I}_{or}/I_{oc}$	dB		8	
$\dfrac{\text{Pilot } E_c}{I_{or}}$	dB		-7	
$\dfrac{\text{Traffic } E_c}{I_{or}}$	dB	(1): -16.1 (2): -16.2 (3): -17.2	(1): -13.5 (2): -13.5 (3): -16.0	(1): -11.5 (2): -11.5 (3): -15.2
$\hat{I}_{oc}$	dBm/ 1.23 MHz		-63	
Data Rate	Bps		9600	
Traffic E_b/N_t	dB	(1): 6.8 (2): 6.8 (3): 5.7	(1): 9.4 (2): 9.4 (3): 6.9	(1): 11.4 (2): 11.4 (3): 7.7
Channel Simulator Configuration			1	
(1): BC 5 and 11; (2): BC 0, 2, 3,7, 9, 10 and 12; (3) BC 1, 4, 6 and 8				

Fig. 24 Table A.2..2.1-1 of C.S001-B

$\hat{I}_{or}/I_{oc}$ is the Signal to Noise Ratio (SNR) between the CDMA Power $\hat{I}_{or}$ and the AWGN signal level I_{oc}. This value (8dB) must be entered in the CDMA2KFADLEVCOR program which automatically calculates the **AWGN LEVEL** (see p.8 for details on its derival) and sends it to the ABFS. Since the ABFS AWGN level allows only 0.05 dB steps there may be a small difference between nominal and actual value.
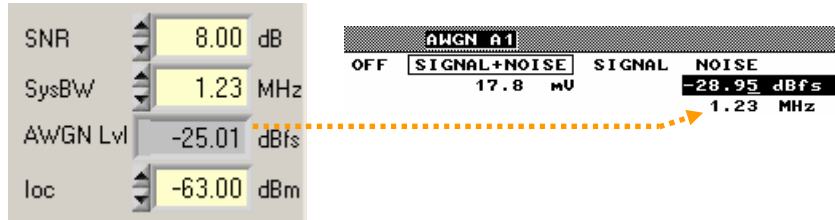

Fig. 25 AWGN Level

The source code for remote ABFS AWGN level setting is shown in appendix A-1.

Pilot E_c / I_{or} is the ratio between the pilot signal (**PICH LEVEL**) and the CDMA Power I_{or}. It must be set manually on the CMU as shown below.

Fig. 26 PICH Level

Traffic E_c / I_{or} is the ratio between the traffic signal (**FCH LEVEL**) and the CDMA Power I_{or}. It must be set manually on the CMU as shown below.

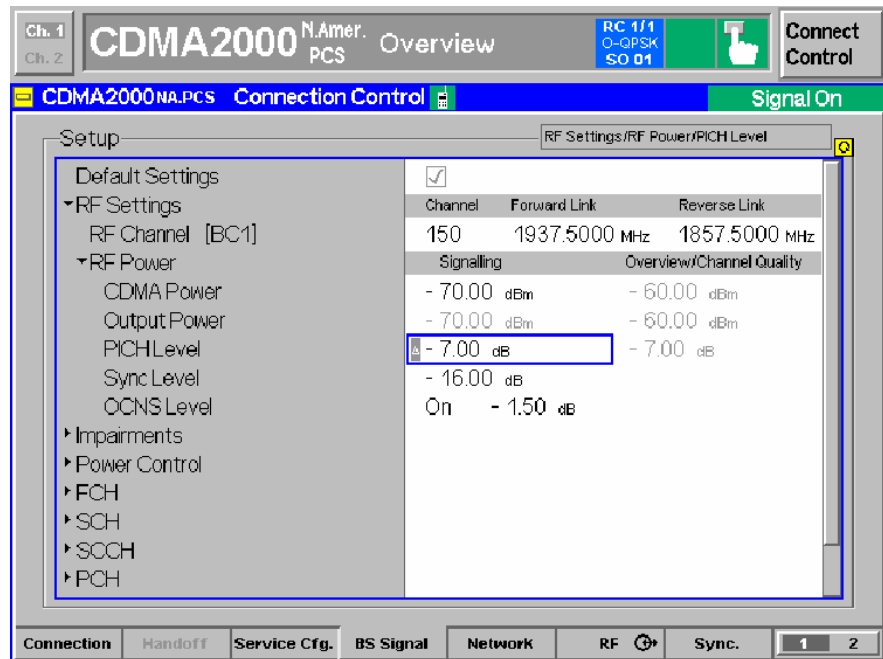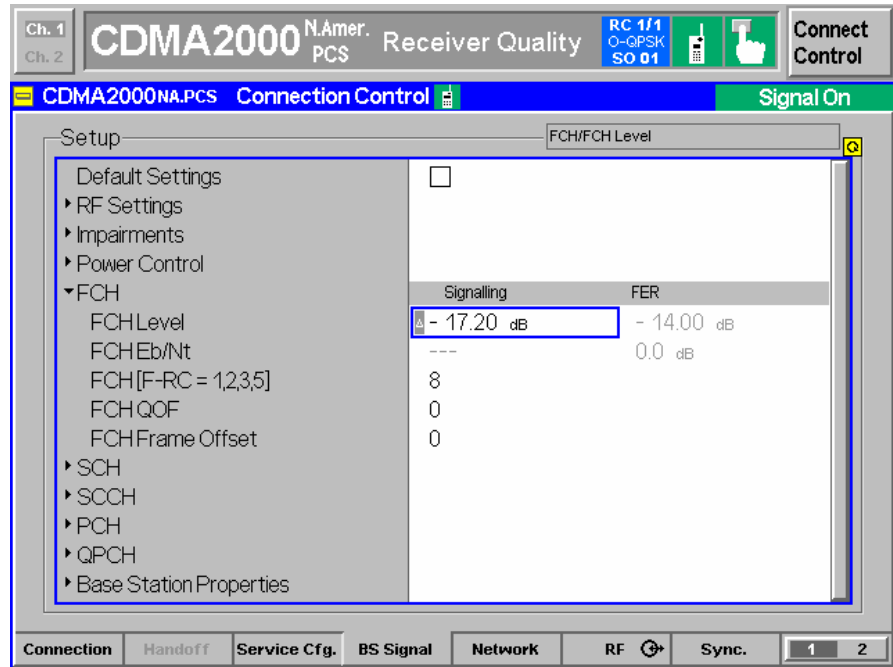Fig. 27 FCH Level

$\hat{I}_{oc}$ is the AWGN level at 1.23MHz system bandwidth (-63dBm). Depending on $\hat{I}_{or}/I_{oc}$ the **CDMA POWER** is calculated as:

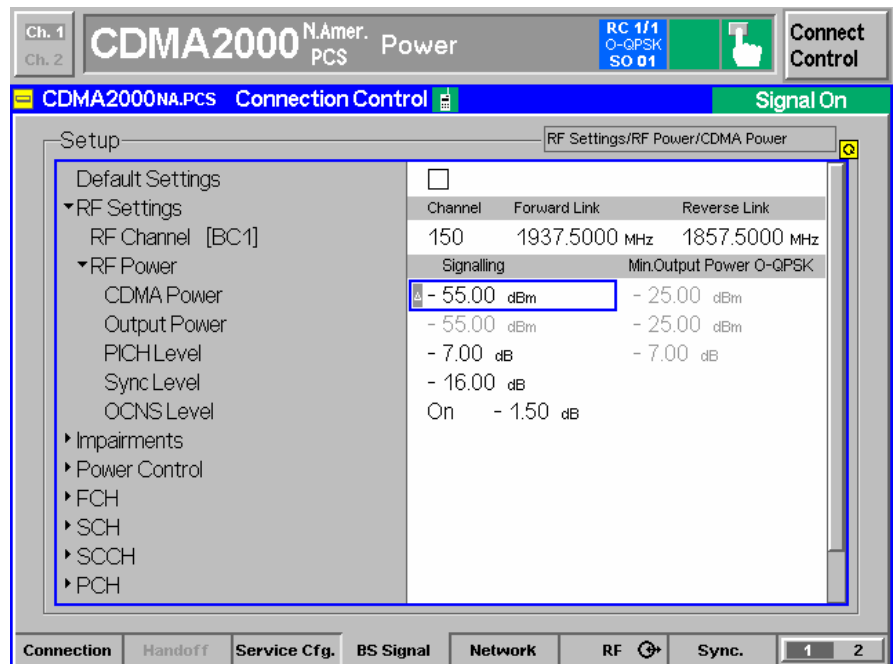**CDMA POWER** = $\hat{I}_{oc}$ + SNR = -63dBm + 8dB = -**55dBm**.

Fig. 28 CDMA Power

The **DATA RATE** used in our example is **9.6 kbps** which corresponds to the CMU specific parameter **FRAME RATE FULL** which is selected in **SERVICE OPTION 2**.
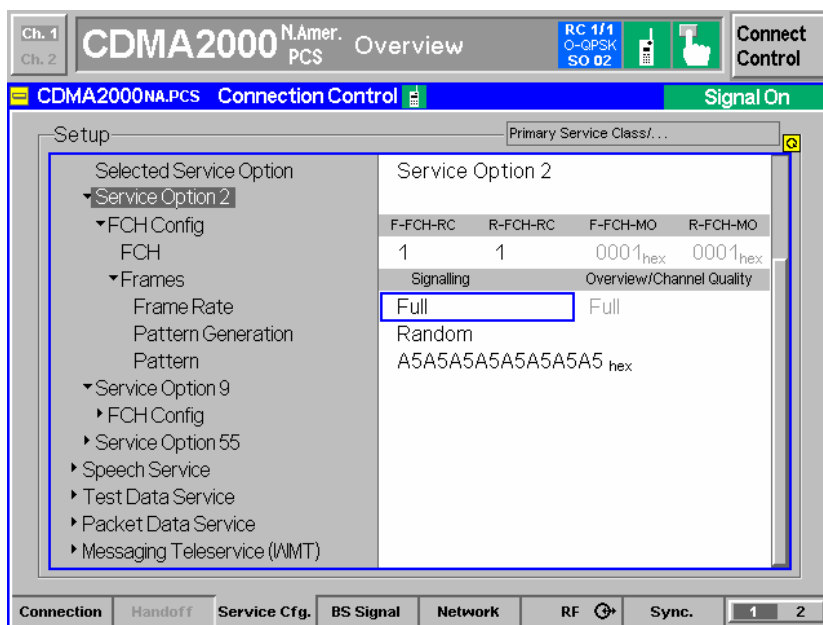

Fig. 29 FCH Frame Rate

When **FRAME RATE HALF** or less is selected, use the appropriate correction factors in order compensate the data rate decrease to maintain constant speech coder quality (see fig. 27 taken from CMU operation manual)..

	RC 1		RC 2		RC 3, 4		RC 5	
	bps	Corr./ dB	bps	Corr./ dB	bps	Corr./ dB	bps	Corr./ dB
Full	9600	0	14400	0	9600	0	14400	0
Half	4800	−3	7200	−3	4800	−3	7200	−3
Quarter	2400	−6	3600	−6	2700	−5.5	3600	−6
Eighth	1200	−9	1800	−9	1500	−8	1800	−9

Remote control
SOURce:RFGenerator:LEVel:FFCH <FFCH Level>
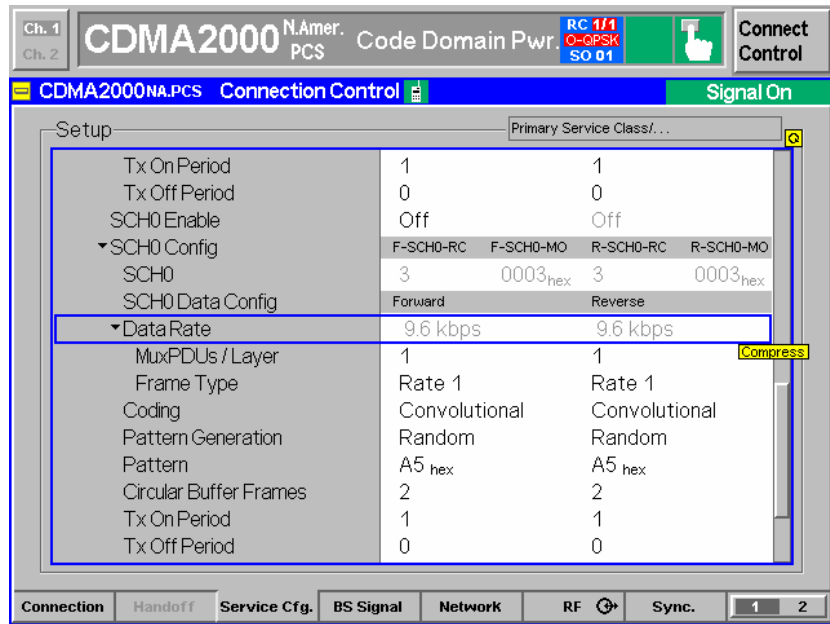
Fig. 30 Correction Factors

Fig. 31 SCH0 Data Rate

Traffic E_b / N_t is for information purposes only and is not relevant for the test. The corresponding value on the CMU does not apply because it is related to CMU internal AWGN without fading.

Now the **CHANNEL SIMULATOR CONFIGURATION** number must be selected with cdma2kFadLevCor. **CDMA 8, 2 Paths (BC0..11)** stands for simulation of a CDMA MS moving with 8 km/h speed, receiving the signal from two separate paths (direct and reflected path). BC0..11 applies for band classes 0 to 11.

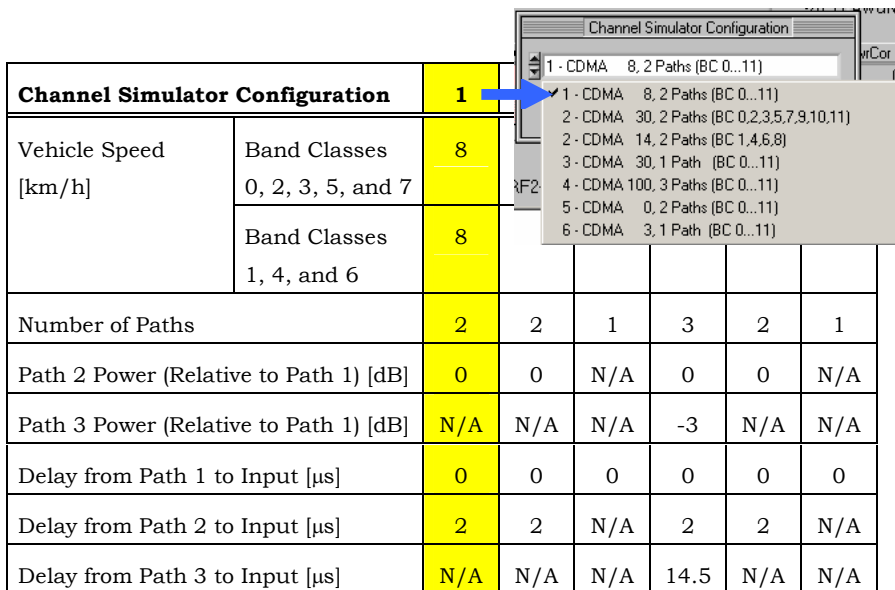| Channel Simulator Configuration		1					
Vehicle Speed [km/h]	Band Classes 0, 2, 3, 5, and 7	8					
	Band Classes 1, 4, and 6	8					
Number of Paths		2	2	1	3	2	1
Path 2 Power (Relative to Path 1) [dB]		0	0	N/A	0	0	N/A
Path 3 Power (Relative to Path 1) [dB]		N/A	N/A	N/A	-3	N/A	N/A
Delay from Path 1 to Input [μs]		0	0	0	0	0	0
Delay from Path 2 to Input [μs]		2	2	N/A	2	2	N/A
Delay from Path 3 to Input [μs]		N/A	N/A	N/A	14.5	N/A	N/A

Fig. 32 Channel Simulator Configuration

While the ABFS offers three channel simulator configuration types via quick selection buttons (CDMA 8 - 2 Path, CDMA 30 – 1 Path, CDMA 100 – 3 Paths) cdma2kFadLevCor allows quick selection of all channel simulator configurations defined in the specification.
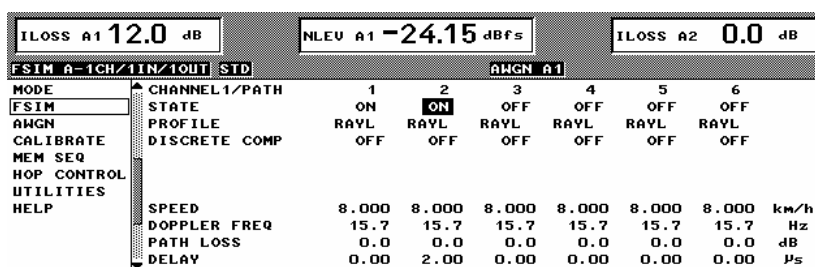

Fig. 33 ABFS Channel Simulator Configuration

The source code on appendix A-2 shows how to select channel simulator configuration 5 (CDMA 0 – 2 Paths) in an own test application.

Keep in mind that the **FADING GAIN** may change when the fading profile is varied and needs to be updated in **CDMA2KFADLEVCOR** (see p.7 for details on the **FADING GAIN** calculation). Appendix A-3 shows the remote command sequence for the automatic **FADING GAIN** calculation.

Calibration and Test Procedure

This section contains a step by step guide that shows how to calibrate the **INSERTION LOSS**, prepare and perform a FER measurement under condition of fading as prescribed in the CDMA2000 test specifications for user equipment.

1. For the calibration procedure connect **RF2** (defined as output) with **RF1** (defined as input) on the CMU. The RF1 input signal is not attenuated by a directional 20dB coupler as it would be in RF2 and is therefore more sensitive.

2. Start **CDMA2KFADLEVCOR.EXE** and press the **INIT** buttons (see section DEVICES, p.14).

3. Switch to **CALIBRATION MODE** in **CDMA2KFADLEVCOR**. This will set the CMU **CDMA POWER** to the maximum level -16dBm.
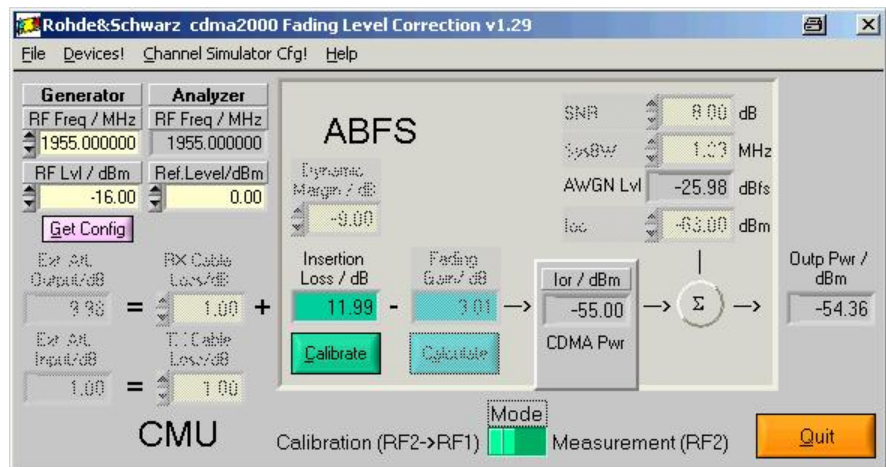

Fig. 34 cdma2kFadLevCor Calibration Setup

4. Set Generator **RF FREQ**uency and **RF LEVEL** to desired value, e.g. 1955 MHz and -16.00 dBm. The Analyzer RF Frequency is automatically set to the same value. This may be checked by pressing the **GET SETTINGS** button.

5. Determine the **INSERTION LOSS** by pressing the **CALIBRATE** button. The calibration takes approx. 40s and is ready when the **CALIBRATE** button is no longer dimmed.

6. Switch to **MEASUREMENT MODE** which automatically updates the CMU external attenuation with the **EXT ATTEN** value and switches the CMU-B17 Fading path ON.
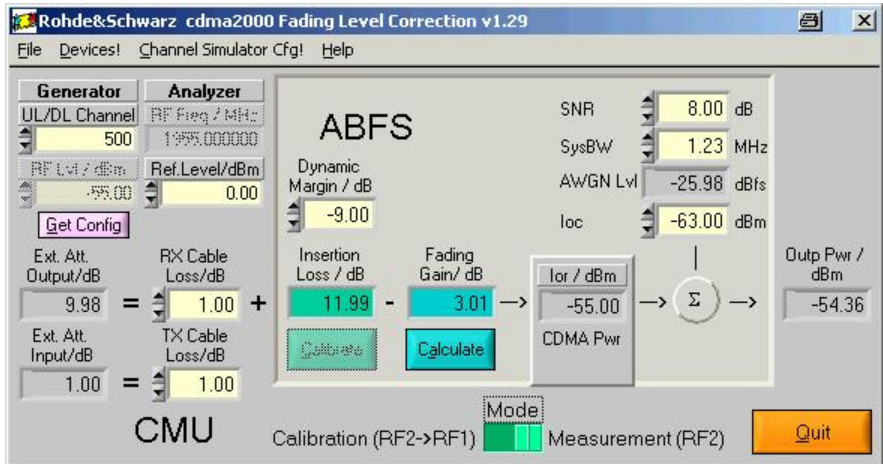

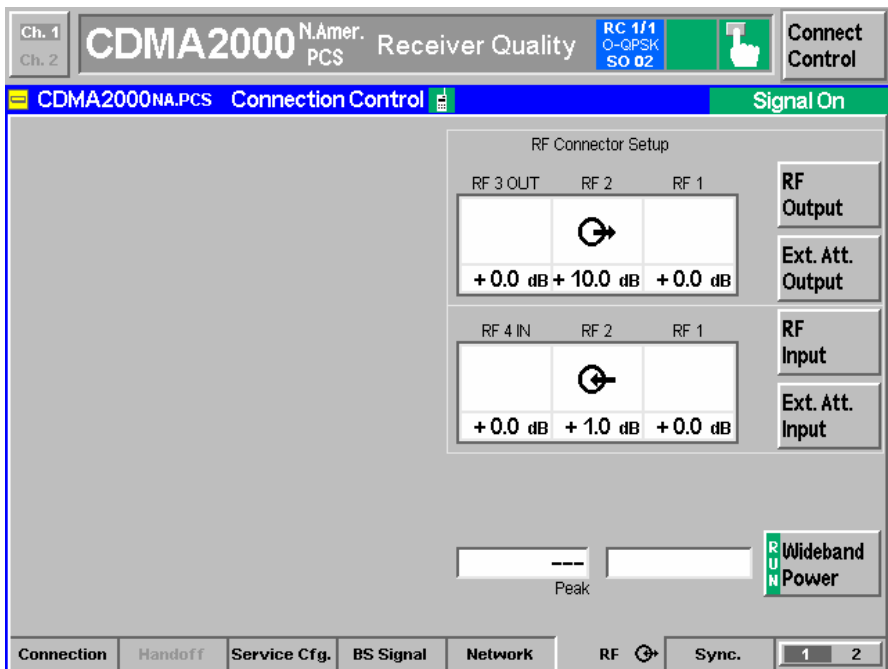Fig. 35 cdma2kFadLevCor Measurement Setup

Fig. 36 RF Connector Setup

By switching to **MEASUREMENT MODE** the ABFS **RF FREQUENCY** is also automatically set to the CMU generator (BS) RF frequency. This corresponds to the following manual procedure on the ABFS:

GROUPA FSIM -> **STANDARD FAD** -> **RF FREQUENCY** -> e.g. **1955.0MHz**

7. Select the desired fading profile. **CHANNEL SIMULATOR CFG** -> **1- CDMA 8, 2 PATHS (BC 0…11)** -> **SET**. Close this menu with **QUIT**.

8. Calculate the **FADING GAIN** by pressing the **CALCULATE** button (= 3.01dB for CDMA 8, 2Paths). This also updates the **AWGNLVL** display. Make sure that **SYSBW** ≥ 1.23MHz.

9. Optionally edit **RX** and **TX CABLE LOSS**, e.g. 1.00dB. It can be determined as described in section *Controls and Indicators*, page 17.

10. Disconnect the cable from **RF1** (in) and connect it to the MS.

11. To select the FER-FCH test choose **MENU SELECT** -> **IMT-2000 MOBILE STATION -> CDMA2000 PCS -> SIGNALLING** mode -> **RECEIVER QUALITY** -> **FER-FCH** on the CMU.

12. Select **1ST SERVICE CLASS** -> **LOOPBACK SERVICE (TEST)**.

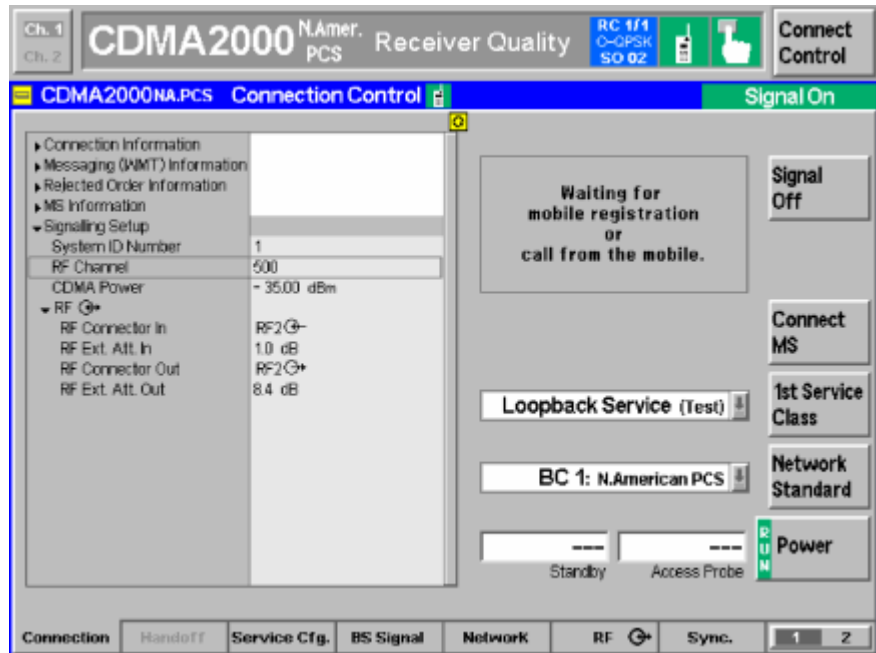13. Select **NETWORK STANDARD** -> e.g. **BC1** (Bandclass 1): **N.AMERICAN PCS**

Fig. 37 Connection Control

14. Select **CONNECT CONTROL** -> **BS SIGNAL SETTINGS** -> **RF CHANNEL**, e.g. 500 (Foward Link 1955MHz, Reverse Link 1875MHz). You may also set the channel in cdma2kFadLevCor by setting the **GENERATOR RF U**p**L**ink/**D**own**L**ink **CHANNEL**.

15. Select **CONNECT CONTROL** -> BS Signal -> **CDMA POWER** (Signalling) -> e.g.-35dBm (a higher level is required for mobile registration).

16. Register the mobile by switching the power on.

17. Establish a cdma2000 PCS connection dialing a number on the MS or by pressing **CONNECTION** -> **CONNECT MOBILE** on the CMU and accepting the call on the MS.

18. Optionally set **FER-FCH** -> **STOP CONDITION** -> **NONE** in case precise measurement values are required for statistical reasons.

19. Set **FER-FCH** -> **FRAMES** -> i.e. **9000 FRAMES** for conformance tests.

20. Select **CONNECT CONTROL** -> **BS SIGNAL LEVEL** -> **CDMA POWER** -> -**55** dBm (see p. 26 for description). You may also change the CDMA Power by editing **SNR**, **SYSBW** or **IOC** in **CDMA2KFADLEVCOR MEASUREMENT MODE**.

21. The resulting FER-FCH is displayed on the CMU.
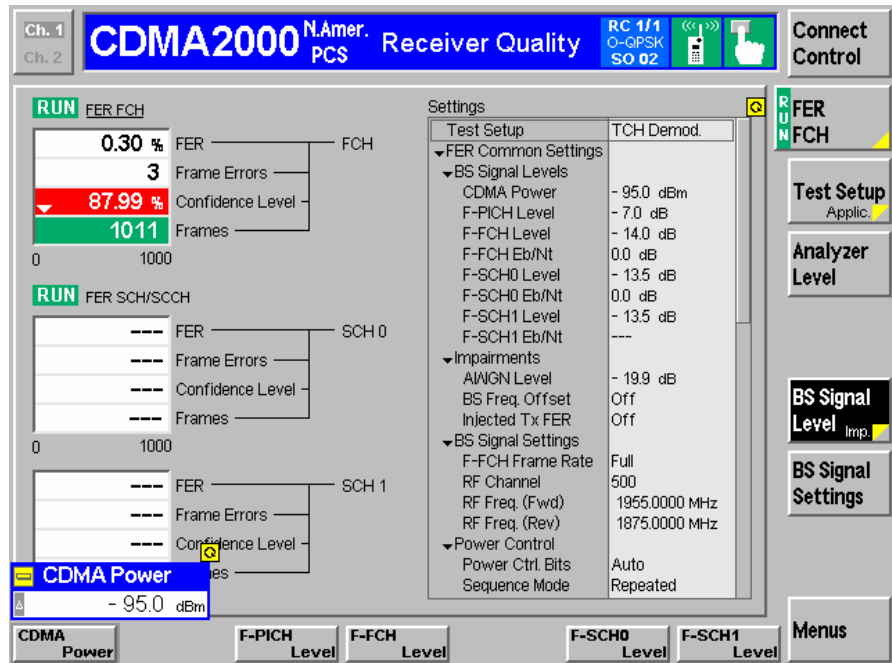

Fig. 38 FER-FCH Measurement

Measuring FER Characteristic

While the specification mainly applies for production tests, developers may need more information in order to classify devices such as a FER-FCH error rate vs. the S/N Ratio. The example below was performed with a CMU200, ABFS and a CMU-Z10 shielded chamber for mobile stations. If no mobile station RF adapter is available use the CMU-Z11 antenna coupler.
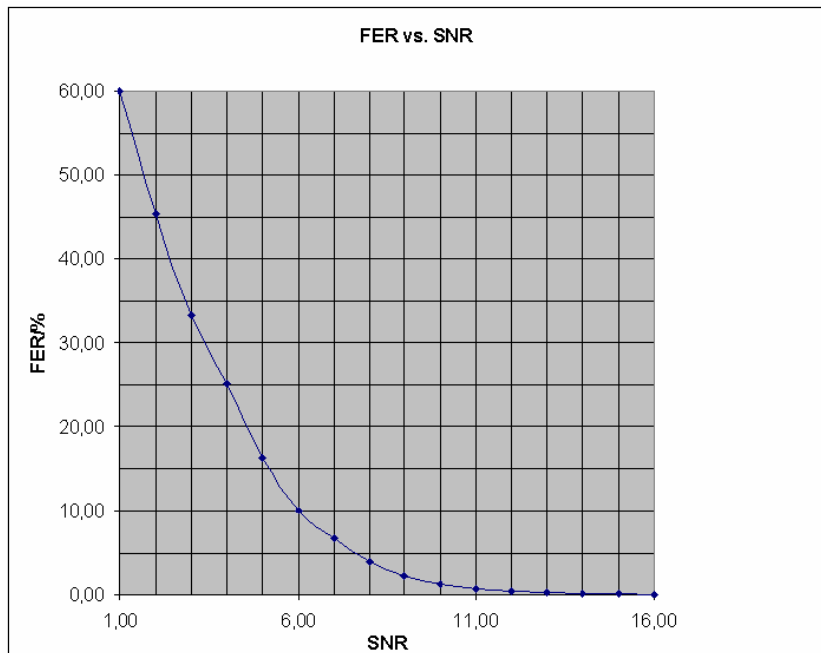

Fig. 39 FER-FCH vs. S/N Ratio

8   Appendix A: Remote Control Command Sequences

A-1 Turn AWGN ON (ABFS)

```
viPrintf (hFSim, "AWGN:STAT ON"); // AWGN ON
viPrintf (hFSim, "AWGN:MODE SN"); // Signal+Noise
viPrintf (hFSim, "AWGN:SNR %0.2lf", AwgnLev);
```

A-2 Fading Profile Configuration (ABFS)

```
switch (FadCfg)
{
  case 1: viPrintf (hFSim, "FSIM:STAN CDMA8");   break;
  case 2: viPrintf (hFSim, "FSIM:STAN CDMA30");
          viPrintf (hFSim, "FSIM:PATH2:STAT ON");
          viPrintf (hFSim, "FSIM:PATH2:LOSS 0");
          viPrintf (hFSim, "FSIM:PATH2:DEL 2E-6");
          break;
  case 3: viPrintf (hFSim, "FSIM:STAN CDMA30");
          viPrintf (hFSim, "FSIM:PATH2:STAT ON");
          viPrintf (hFSim, "FSIM:PATH2:LOSS 0.0");
          viPrintf (hFSim, "FSIM:PATH2:DEL 2E-6");
          viPrintf (hFSim, "FSIM:SPE:UNIT KMPH");
          viPrintf (hFSim, "FSIM:PATH1:SPE 14.0");
          viPrintf (hFSim, "FSIM:PATH2:SPE 14.0");
          break;
  case 4: viPrintf (hFSim, "FSIM:STAN CDMA30");  break;
  case 5: viPrintf (hFSim, "FSIM:STAN CDMA100"); break;
  case 6: viPrintf (hFSim, "FSIM:STAN CDMA30");
          viPrintf (hFSim, "FSIM:PATH2:STAT ON");
          viPrintf (hFSim, "FSIM:PATH2:LOSS 0.0");
          viPrintf (hFSim, "FSIM:PATH2:DEL 2E-6");
          viPrintf (hFSim, "FSIM:PATH1:PROF CPH");
          viPrintf (hFSim, "FSIM:PATH2:PROF CPH");
          viPrintf (hFSim, "FSIM:SPE:UNIT KMPH");
          viPrintf (hFSim, "FSIM:PATH1:SPE 0.054");
          viPrintf (hFSim, "FSIM:PATH2:SPE 0.054");
          break;
  case 7: viPrintf (hFSim, "FSIM:STAN CDMA30");
          viPrintf (hFSim, "FSIM:SPE:UNIT KMPH");
          viPrintf (hFSim, "FSIM:PATH1:SPE 3.0");
}
```

A-3 Automatic SWLoss Calculation (ABFS)

```
viQueryf (hdl, "FSIM:STAN?", "%s", szStd);
for (i=1; i<=12; i++)                    // max. 12 paths
{
  viQueryf (hFSim, "FSIM:PATH%d:STAT?", "%d",&mod);
  if (mod)                               //n-th path ON?
  {
    //--- n-th path loss? ---
    viQueryf (hFSim, "FSIM:PATH%d:LOSS?","%lf",i,&los);
    amp = pow (10.0, -los * 0.1);     // delogarithmize
    sum += amp;                       // add to sum
  }
}
SwLoss = 10.0 * log10 (sum);         //logarithmize
```

9 Additional Information

Please contact TM-Applications@rsd.rohde-schwarz.com for comments and further suggestions.

10 Ordering information

Communication Tester

CMU 200		1100.0008.02
CMU 300		1100.0008.03

Options

CMU-B17	IQ-IF Interface	1100.6906.02
CMU-B83	cdma2000 Signalling Unit	1150.0301.12

Accessories

CMU-Z11	Shielded Cover	1150.1008.02
CMU-Z10	Antenna Coupler	1150.0801.02

Fading Simulator

ABFS	Base Band Fading Simulator	1114.8506.02

ROHDE & SCHWARZ

ROHDE & SCHWARZ GmbH & Co. KG · Mühldorfstraße 15 · D-81671 München · P.O.B 80 14 69 · D-81614 München ·
Telephone +49 89 4129 -0 · Fax +49 89 4129 - 13777 · Internet: http://www.rohde-schwarz.com