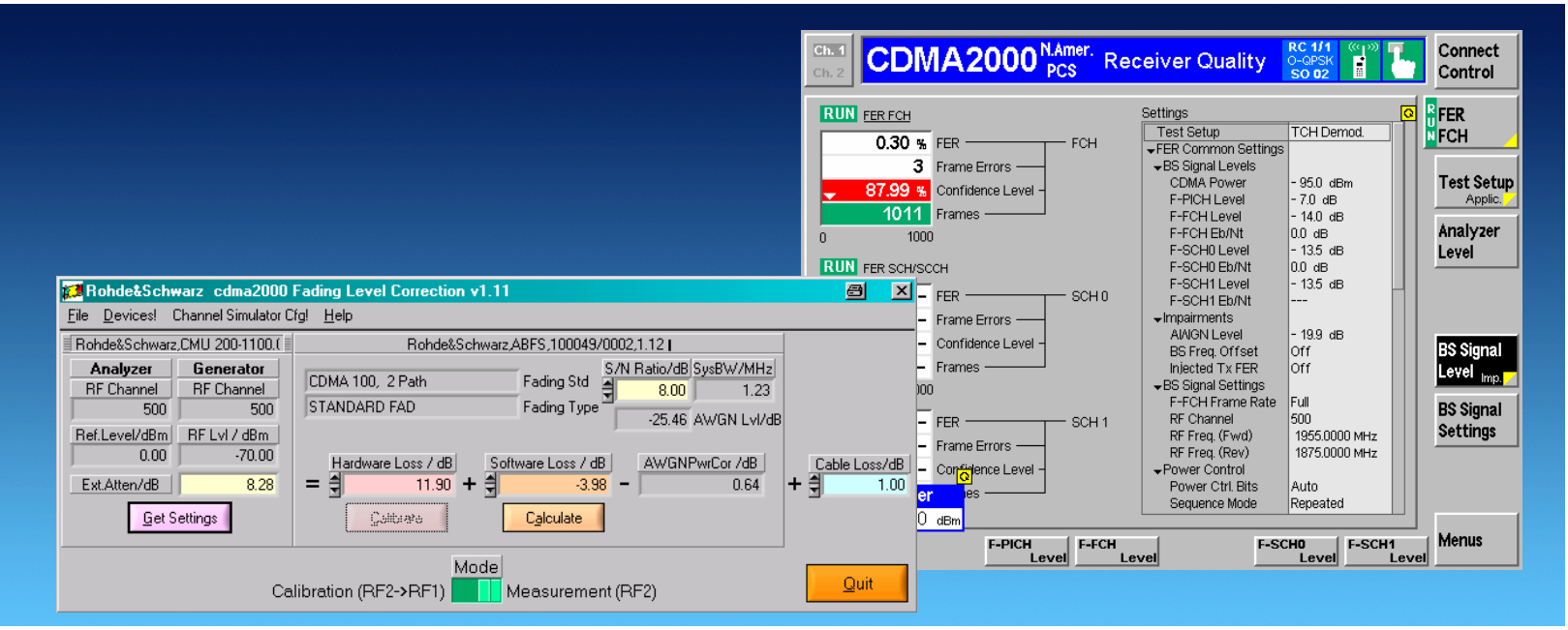


Products: CMU, ABFS, CMU-B17, CMU-B83, CMU-Z10, CMU-Z11

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 a semi automatic level correction of the power fed to the Device Under Test (DUT).

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. The supplied program cdma2kFadLevCor calibrates the hardware 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 optionally perform an automatic level correction.

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 calibration IQ hardware 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 300MHz 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 9X/NT/2000/XP	Microsoft operating system
NI-488.2 V1.6 (or above)	IEC/IEEE – bus driver from National Instruments. See http://www.natinst.com for latest revision.
NI-VISA V2.5 (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 a 1100.6993 cable. The DUT (mobile telephone or base station) is connected to the RF2 connector of the CMU which is set to bidirectional operating mode (input/output).

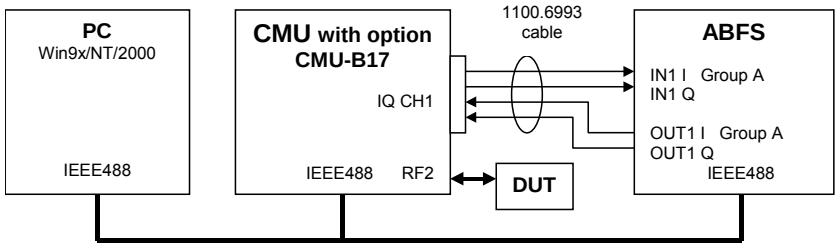


Fig. 1 CMU and ABFS Connection

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 DUT the CMU generator level setting must compensate the hardware loss. This can be achieved by setting the EXTERNAL ATTENUATION parameter of the CMU generator to the value of this hardware loss.

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

A power component (software loss) resulting from the sum of the power of each path must be added to the hardware loss in order to obtain the correct total insertion loss of the ABFS.

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.

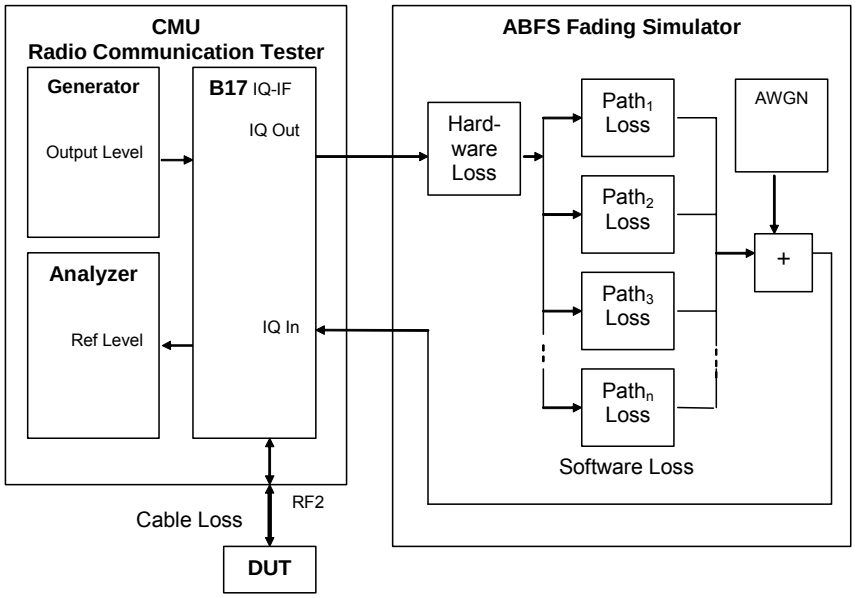


Fig. 2 Fading with IQ IF Loop

In the section *AWGN Power Correction* the absolute AWGN level is converted into correction factor (AWGNPWRCOR) by which the External Attenuation must be decreased.

Hardware Loss

The hardware loss (HWLoss) is defined in the program **CDMA2KFADLEVCOR.EXE** as the attenuation of the ABFS IQ path without fading or AWGN plus the IQ cable attenuation (approx. 12dB). It must only be measured only once for a certain hardware configuration.

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

Software Loss

The software loss (SWLoss) is the attenuation caused by the sum of various fading paths. For standard fading profiles (at least one path with 0dB loss) the SWLoss is usually negative, meaning a gain. The SWLoss must be updated each time the fading profile is changed and is calculated as follows:

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

$P_{n}LOSS$ = Loss of n-th path. Must be calculated as negative amplification.

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 Power Correction

The AWGN Power Correction (AWGNPWRCOR) is the additional amount of power applied to the DUT by adding White Gaussian Noise with a specified signal to noise ratio to the faded signal. The following schematic and formulas shows the functional layout of the IQ path its calculation.

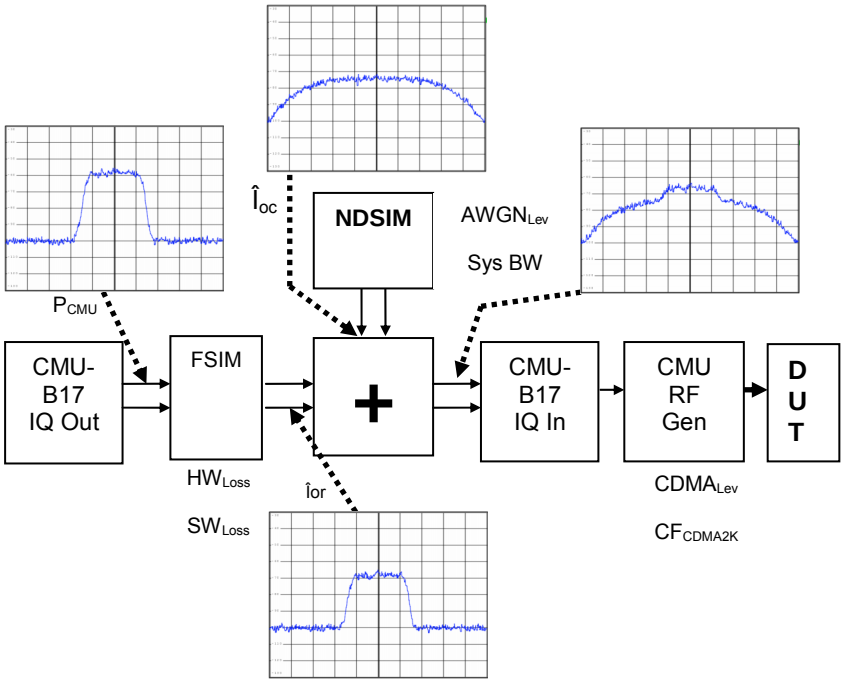


Fig. 3 IQ Path

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

$$Upp = 0.5V$$

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

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

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

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

The dynamic margin for cdma2000 signals is factory set to

$$DynMar = 9.46dB$$

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

$$\begin{aligned} Pcmu &= P\max - DynMar \\ &= 7dBm - 9.46dB \\ &= -2.54dBm \end{aligned}$$

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

$$\hat{I}or/dB = Pcmu - HWloss - SWloss$$

The power supplied by the noise and distortion simulator NDSIM (Îoc) is referenced to 0.5Vpp = 7dBm. 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:

$$\begin{aligned} SNR &= \hat{I}or - \hat{I}oc \\ &= Pcmu - HWloss - SWloss - P\max \\ &\quad - AWGNlev + 10*\log\left(\frac{SysBw}{1.23MHz}\right) \end{aligned}$$

The ABFS accepts only the (absolute) AWGN level so the formula above needs to be solved accordingly (SWLoss for CDMA 100 fading profile with 3 paths = 3.98dB).

$$\begin{aligned} AWGNlev &= Pcmu - HWloss - SWloss - P\max - SNR \\ &= -2.54dBm - 11.9dB + 3.98dB - 7dB - 8dB \\ &= -25.46dBm \end{aligned}$$

We need to change the absolute AWGN level into a correction factor AWGNPOWCOR which must be subtracted in the External Attenuation formula, since additional power is added to the DUT input.

$$AWGNPwrCor = -\hat{I}or - 10 * \log\left(10^{\frac{\hat{I}or}{10}} + 10^{\frac{\hat{I}oc}{10}}\right)$$

$$= -\hat{I}or - 10 * \log\left(10^{-1.83} + 10^{-1.03}\right)$$

$$= -9.66dB + 10.3dB$$

$$= 0.64dB$$

Example: CDMA 100 fading profile and SNR 8dB. The Hardware Loss has been measured according to the calibration routine (e.g. 11.90dB) described in the section "Calibrating the Hardware Loss" and the cable loss is usually specified by the manufacturer. The external attenuation is calculated as:

$$ExtAtten = HardwareLoss + SoftwareLoss + CableLoss - AWGNPowCor$$

$$= \left(11.90 - 10 * \log\left(10^{\frac{-0}{10}} + 10^{\frac{-0}{10}} + 10^{\frac{-3}{10}}\right) + 1.0 - 0.64\right)dB$$

$$= (11.90 - 3.98 + 1.0 - 0.64)dB$$

$$= 8.28dB$$

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

Cable Loss

The cable loss from CMU RF2 output connector to the DUT must be known or measured separately. It applies for the CMU RF output to the DUT and the DUT to the CMU RF input. The Cable Loss may be measured manually with a power meter or simply by measuring the maximum EIRP (= 23dBm) of a reference MS (golden device).

1. On the CMU press **MENU SELECT** -> **IMT-2000 MOBILE STATION** -> **CDMA2000 PCS** -> **SIGNALLING** -> **POWER** -> **MAXIMUM OUTPUT O-QPSK**.
2. Turn the ABFS fading and AWGN path OFF (**CONNECT CONTROL** -> **2** -> **I/Q-IF** -> **I/Q-IF INTERFACE** -> **RX/TX BYPASS**)
3. Tweek the program's **CABLE LOSS** until **AVG. TOTAL POWER** shows 23dBm.

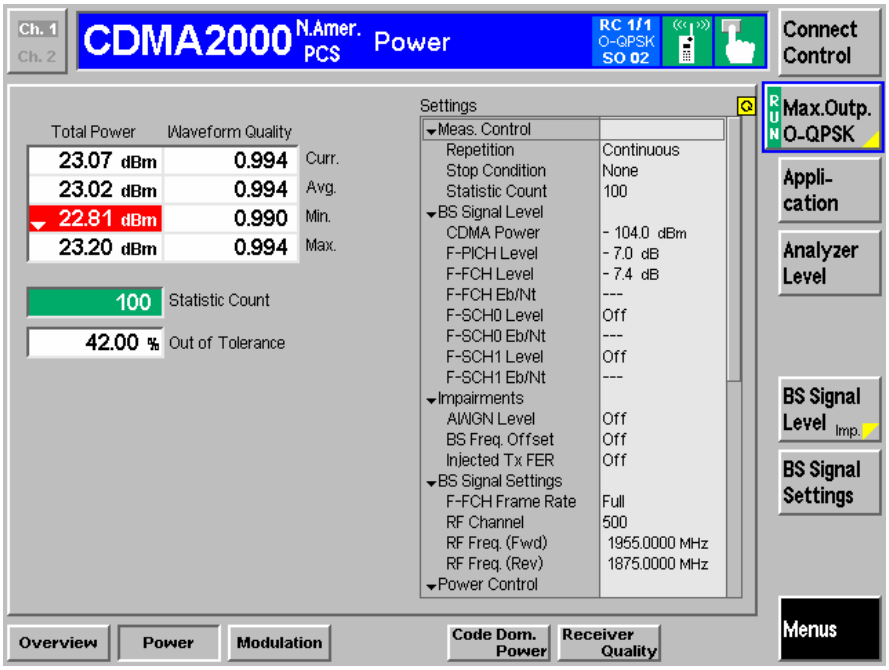


Fig. 4 Maximum EIRP

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.

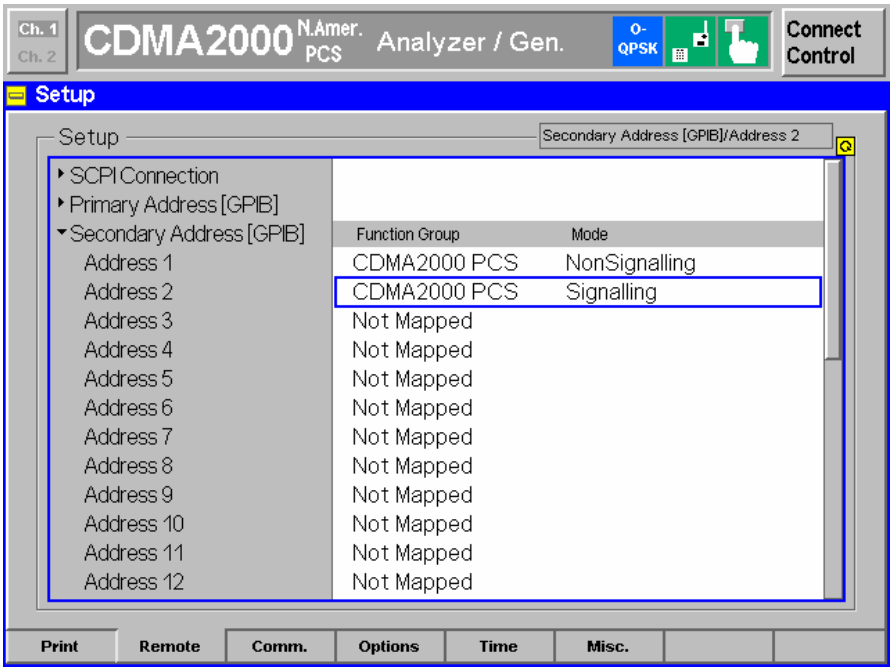


Fig. 5 CMU GPIB secondary address setup

Running the Level Correction Software

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 power actually applied to the DUT.

Menu

File

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

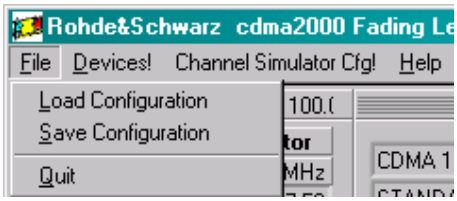


Fig. 6 Menu Items

- **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

  Hardware Loss

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

  SNR

- **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.

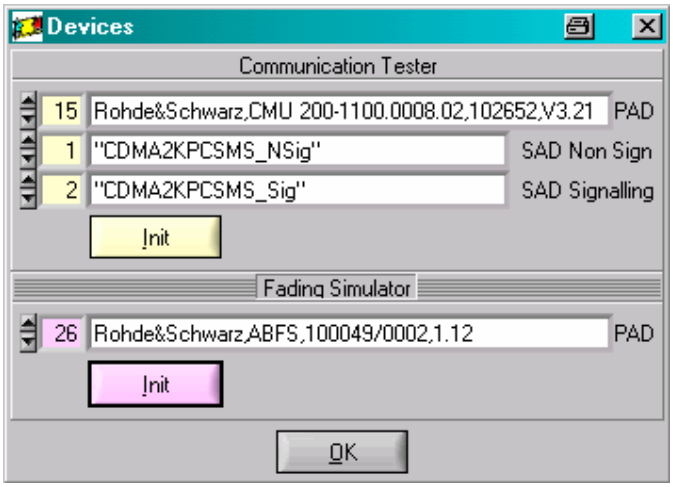


Fig. 7 Select Devices

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

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.

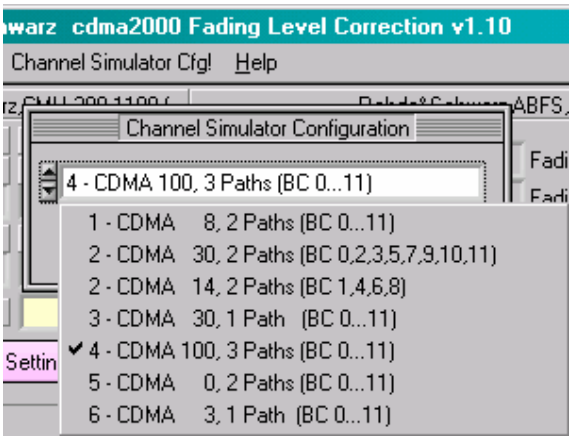


Fig. 8 Channel Simulator Configuration

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

Please remember to update the **SOFTWARE LOSS** 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

In **CALIBRATION MODE** the **HARDWARE LOSS** and **CALIBRATE** controls are highlighted and the CMU **EXT**ernal **ATTEN**uation is turned **OFF**.

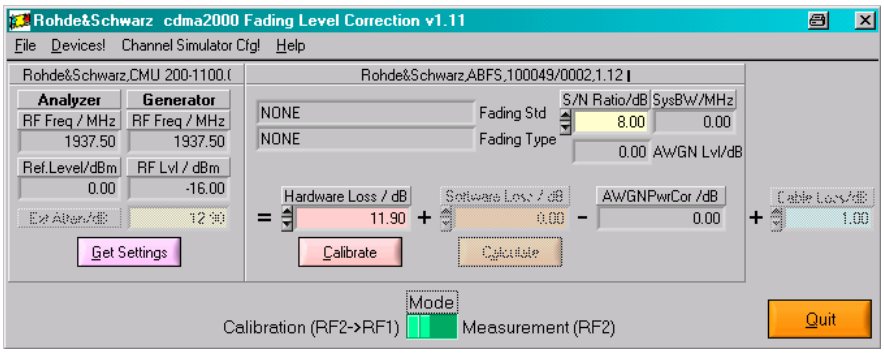


Fig. 9 Main Window Calibration Mode

- **GET SETTINGS** reads the following CMU generator and analyzer settings.
  - Analyzer **RF FREQUENCY**
  - Analyzer **REF**erence **LEVEL**
  - 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.
  - Generator **CDMA POWER**.
- **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.
- **HARDWARE LOSS** – Attenuation of the IQ path as determined manually or by pressing the **Calibrate** button (see section 'CALIBRATING HARDWARE LOSS' on page 6).
- **CALIBRATE** – Performs full automatic calibration and update of the **HARDWARE LOSS** indicator.

In **MEASUREMENT MODE** the **CALCULATE** and **SOFTWARE LOSS** controls are highlighted and the CMU **EXT**ernal **ATTEN**uation is turned **ON**.

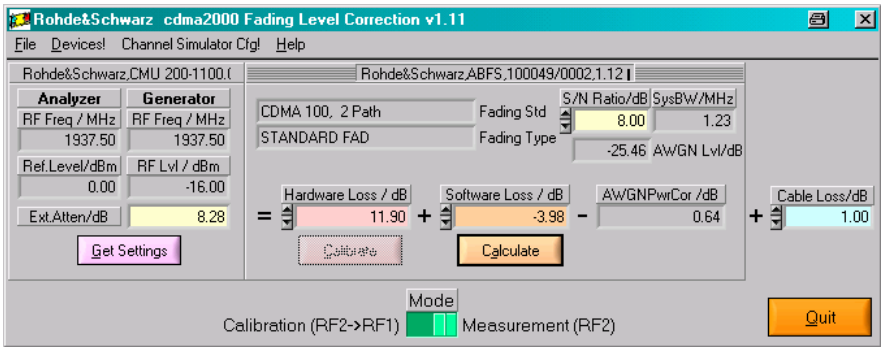


Fig. 10 Main Window Measurement Mode

- **SOFTWARE LOSS** – Fading path loss inserted by the fading simulator. It is calculated by pressing **CALCULATE** 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. **SOFTWARE LOSS** is updated with the calculated value.
- **FADING TYPE** – Displays the current fading type after pressing **CALCULATE**. Range: STANDARD FAD.
- **FADING STANDARD** – Displays the current fading standard after pressing **CALCULATE**. Cdma2000 fading profiles can be selected in the menu **CHANNEL SIMULATOR CFG** or on the ABFS by pressing.

GROUPA FSIM

STANDARD

CDMA 8, 2 PATH

CDMA 30, 1 PATH

CDMA 100, 3 PATH

- **S/N RATIO** – Signal / AWGN ratio prescribed by test standard.
- **SYSBW** – Indicator for AWGN systen bandwidth as defined in ABFS.
- **AWGN LVL** – AWGN level in relation to IQ fullscale (= $0.5V_{pp}$). If it is out of range (-50dBm <= AWGN level <= -17dBm) an error message appears and the control turns red indicating an incorrect AWGN Power correction value.
- **CABLE LOSS** – the user specified attenuation for the cable from the RF2 connector to the DUT. The **CABLE LOSS** is added to the level offset **EXT ATTEN**.

- **EXT ATTEN** – Indicator for level offset which is applied to the output power to compensate for **HARDWARE LOSS**, **SOFTWARE LOSS** and **CABLE LOSS**.

$$ExtAtt = HWLoss + SWLoss + CableLoss + AWGNLoss$$

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

Fig. 11 Level Warning

Note: The **EXT ATTEN** display is automatically updated when the **CALIBRATE** or **CALCULATE** buttons are pressed or the **HARDWARE LOSS**, **SOFTWARE LOSS** and **CABLE LOSS** values are changed manually. In **MEASUREMENT** Mode the **EXT ATTEN** value is immediately transferred to the CMU.

Calibrating the Hardware Loss

The hardware loss (HWLoss) 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. The Calibrate button of the program cdma2kFadLevCor performs the procedure (which can also be performed manually) described on the following pages:

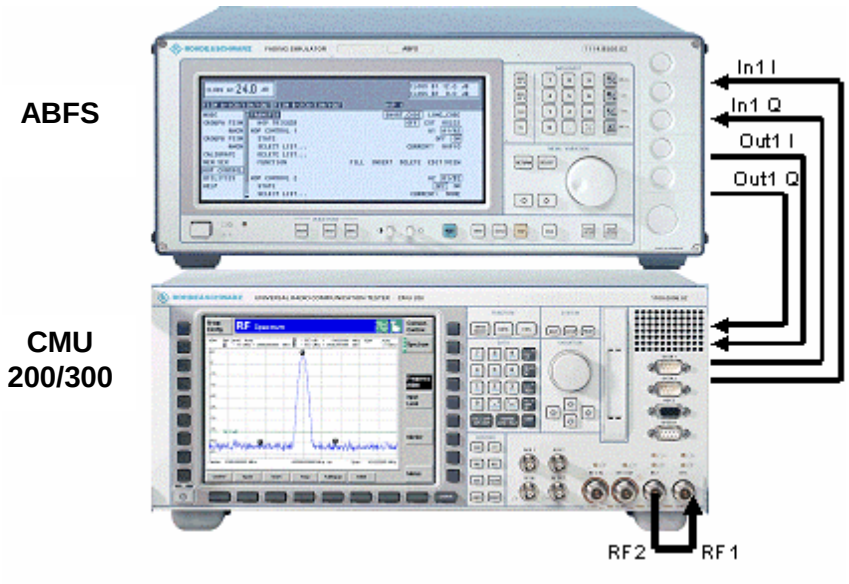


Fig. 12 Calibration Configuration

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

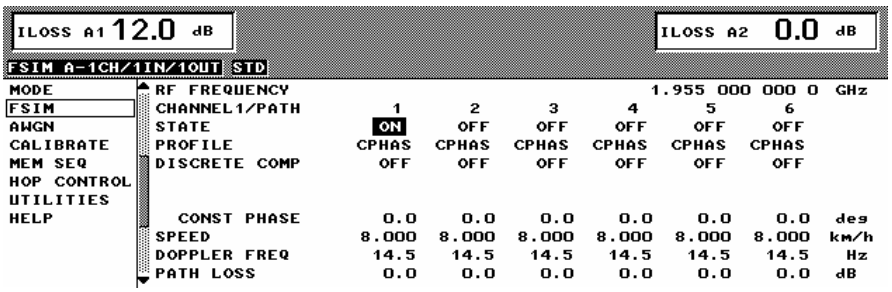


Fig. 13 ABFS Calibrating Mode

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

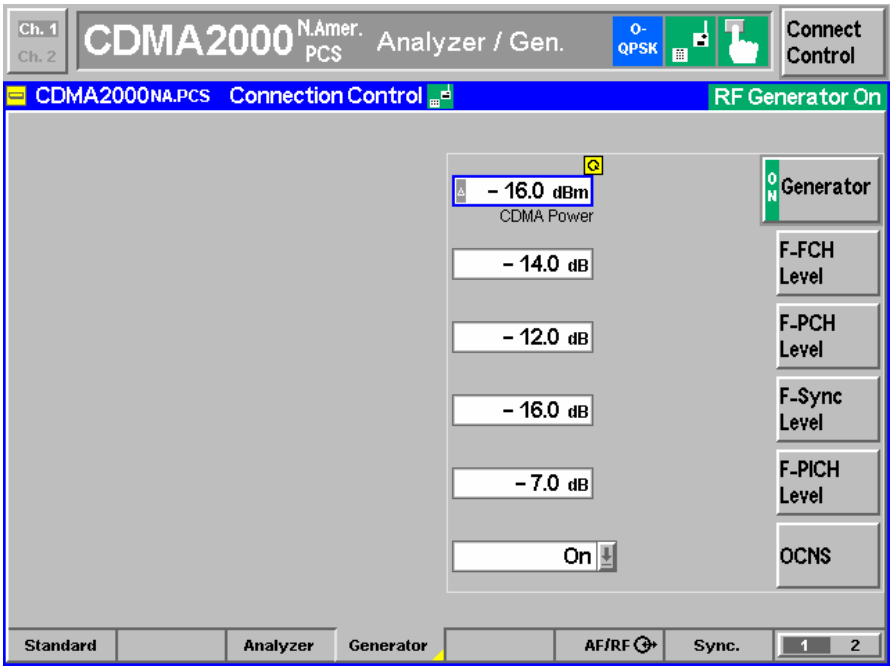


Fig. 14 CMU Generator Setup

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

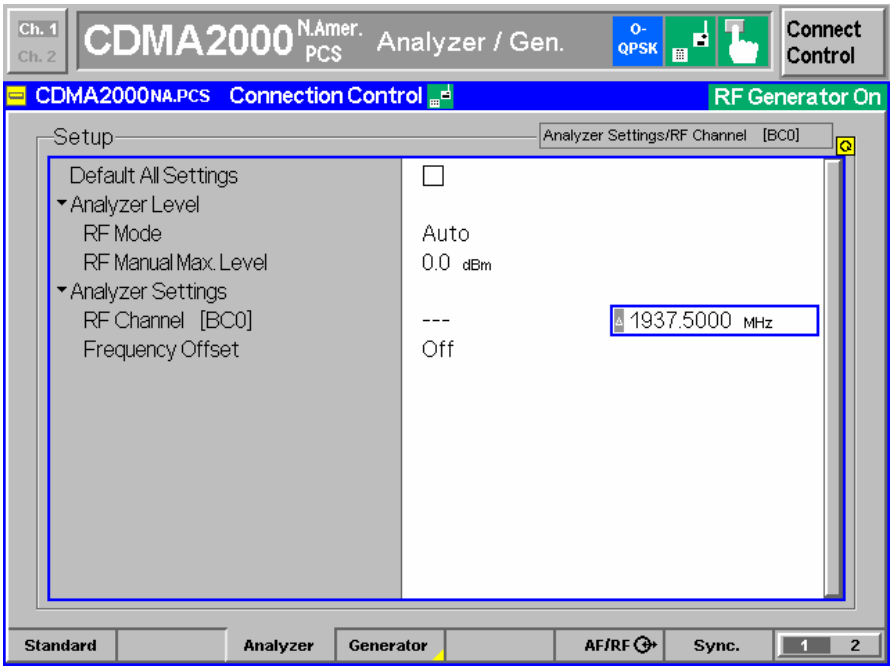


Fig. 15 CMU Analyzer Setup

4. Set the IQ/IF board to Bypass mode (Fig. 16) in order to obtain the reference Average Burst Power **PREF** (Fig. 17).

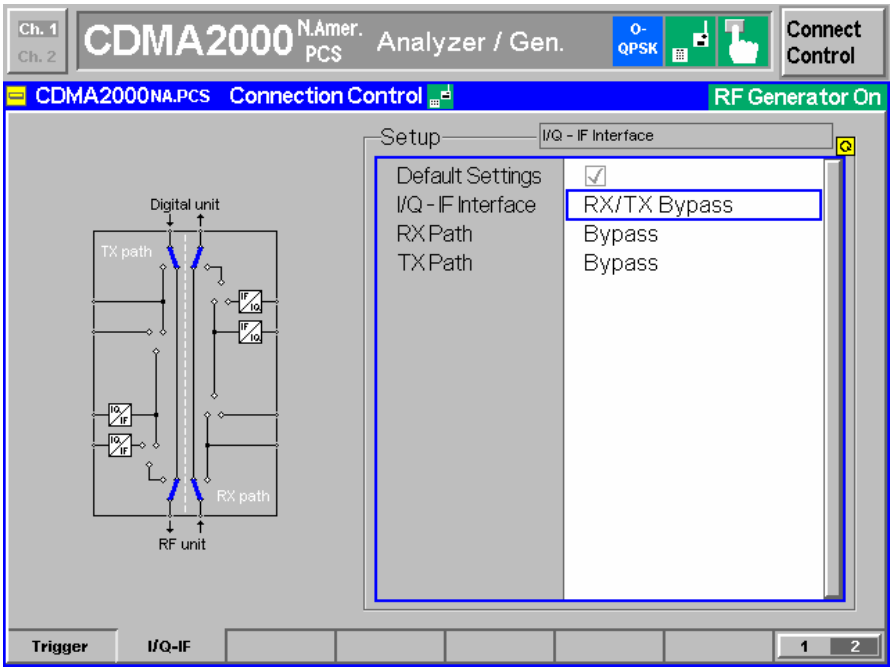


Fig. 16 IQ/IF Bypass Configuration

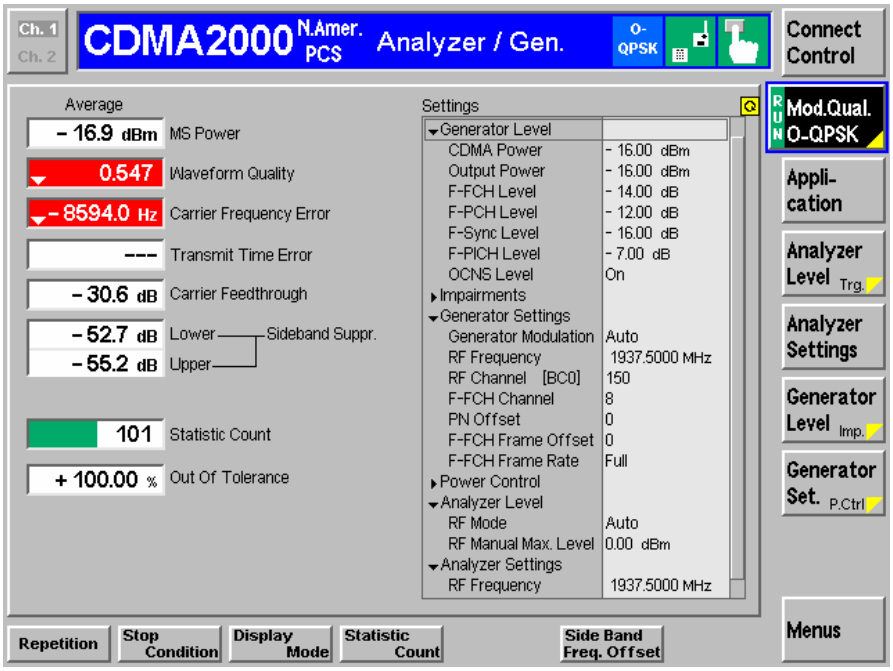


Fig. 17 Power in Bypass Mode

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

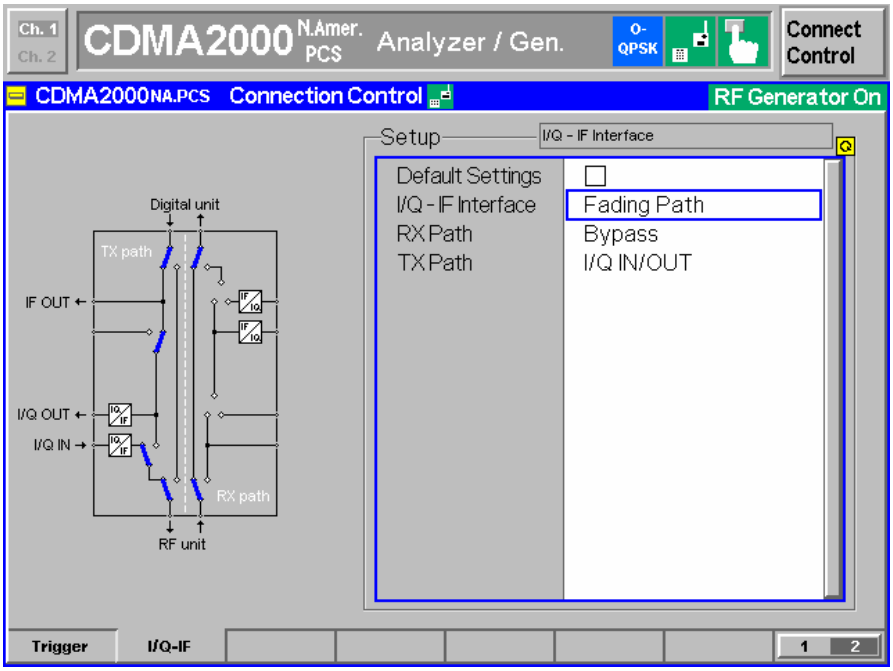


Fig. 18 IQ/IF Fading Configuration

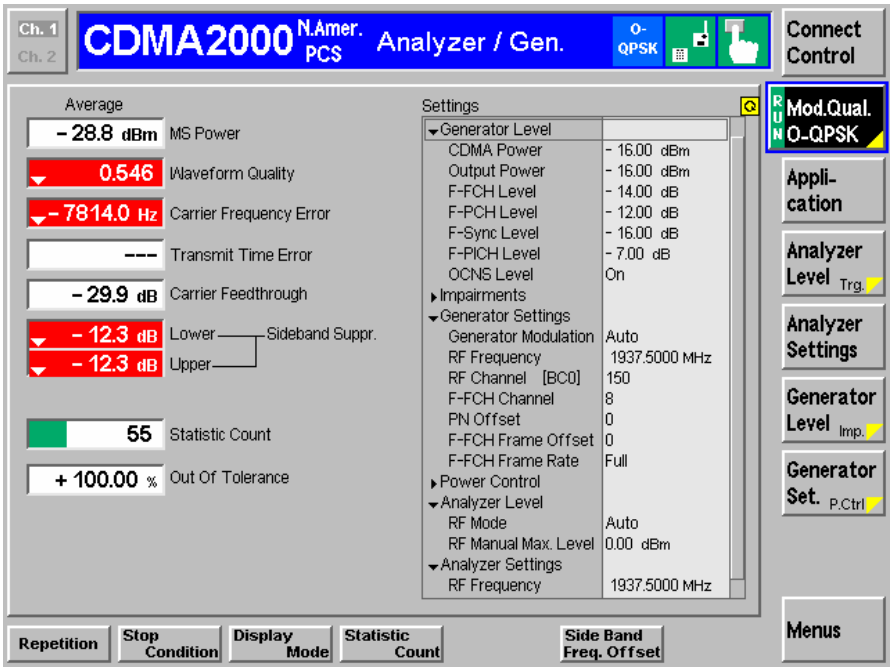


Fig. 19 Power with Calibration Mode Standard Fading

6. The resulting Average MS Power $\mathbf{P}_{MEAS}$ (Fig. 19) must be subtracted from the reference power $\mathbf{P}_{REF}$ (Fig. 17) to obtain the hardware loss (HWLoss) of the IQ path.

$$HWLoss = P_{REF} - P_{MEAS} = -16.9dB + 28.8dB = 11.9dB$$

The **CDMA2KFADLEVCOR** control **HARDWARE LOSS** can be automatically updated by pressing **CALIBRATE** or entered manually. This value is valid for signalling and non-signalling measurements.

5 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 base and mobile 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 named above).

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. 20 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		
$\frac{\text{Pilot } E_c}{I_{or}}$	dB	-7		
$\frac{\text{Traffic } E_c}{I_{or}}$	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. 21 Table A.2..2.1-1

$\hat{I}_{or}/I_{oc}$ 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 difference between nominal and actual value.

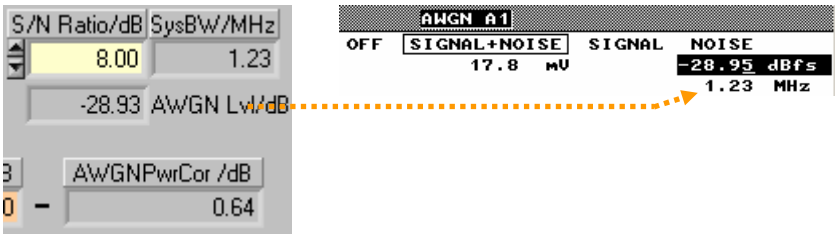


Fig. 22 AWGN Level

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.

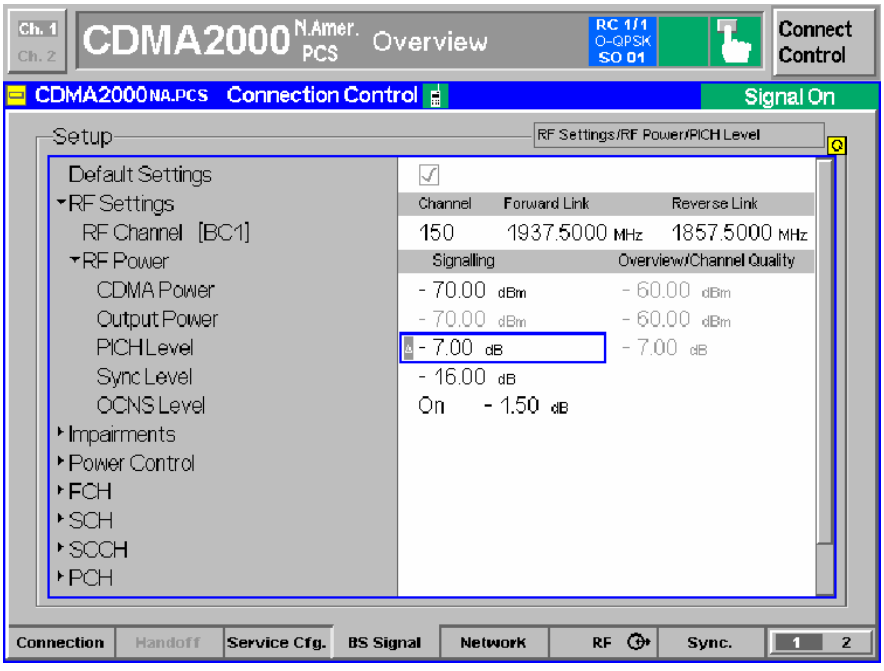


Fig. 23 PICH Level

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.

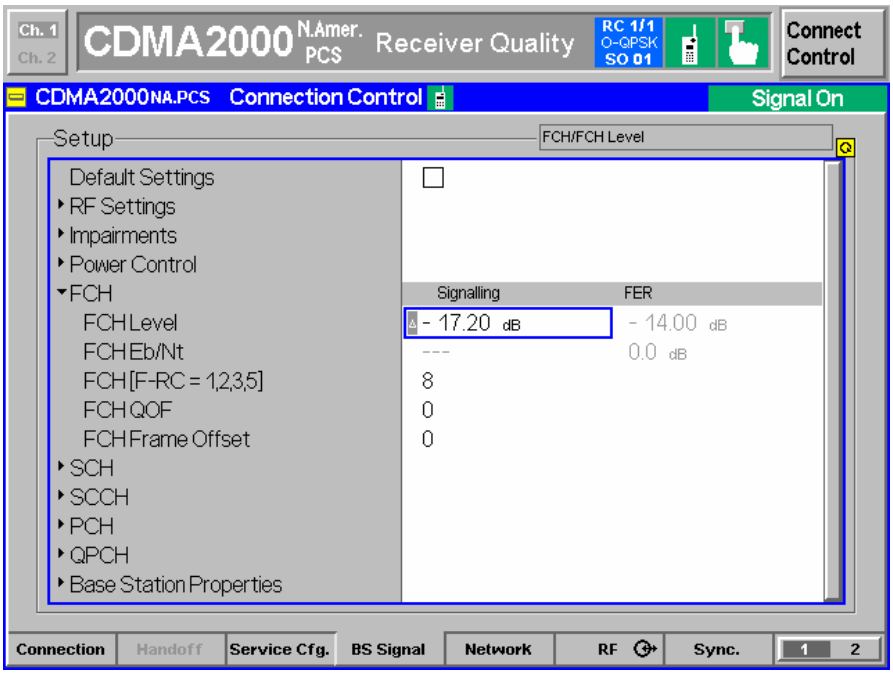


Fig. 24 FCH Level

$\hat{I}_{oc}$ 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**.

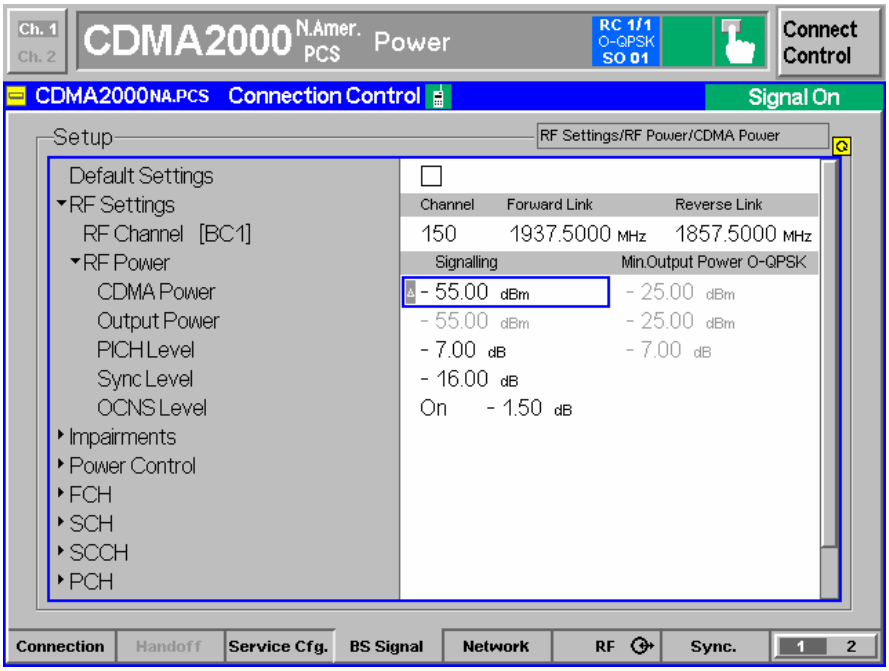


Fig. 25 CDMA Power

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**.

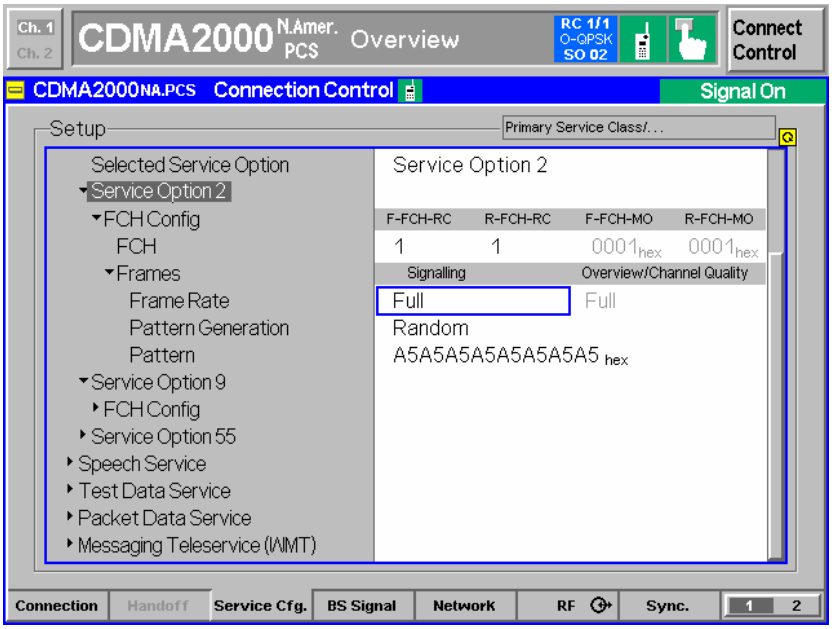


Fig. 26 FCH Frame Rate

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. 27 Correction Factors

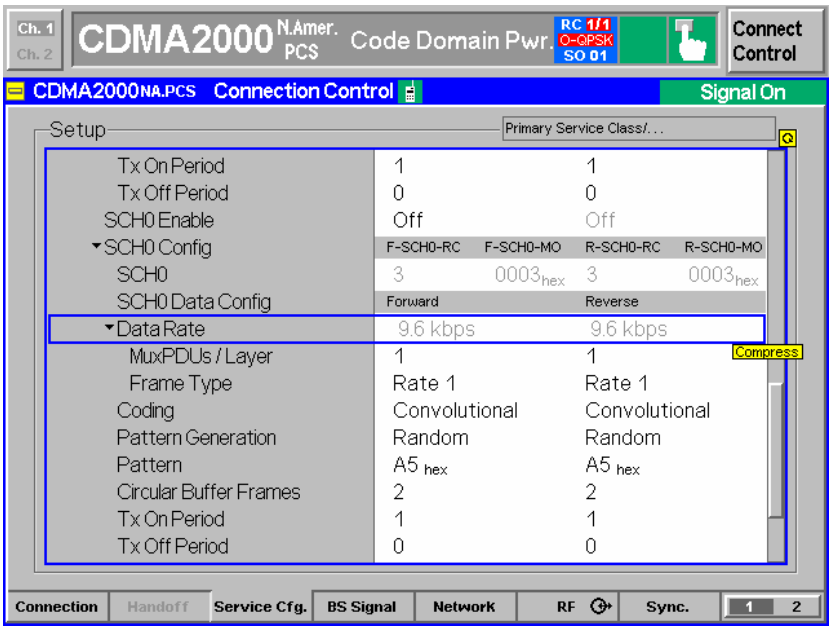
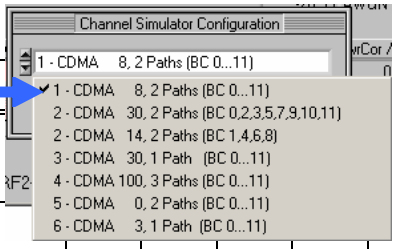


Fig. 28 SCH0 Data Rate

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 internal AWGN without fading.

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							
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. 29 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.

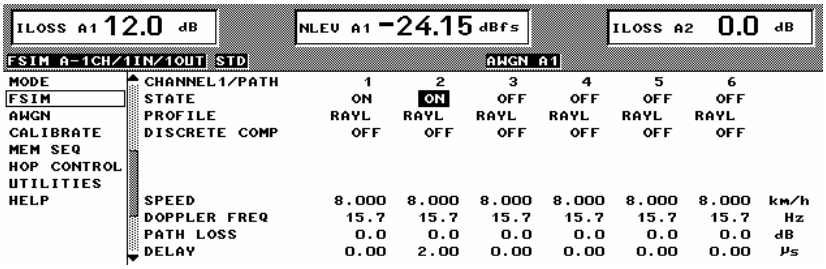


Fig. 30 ABFS Channel Simulator Configuration

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 Software Loss may change when the fading profile is varied and needs to be updated in cdma2kFadLevCor (see p.7 for details on the Software Loss calculation). Appendix A-3 shows the remote command sequence for the automatic software loss calculation.

Calibration and Test Procedure

1. For the calibration procedure connect **RF2$_{OUT}$** with **RF1$_{IN}$** on the CMU. This setup allows higher generator level and a more sensitive analyzer input than RF2OUT and RF2IN.
2. Start **CDMA2KFADLEVCOR.EXE** and press the **INIT** buttons (see section DEVICES, p.13).
3. Switch to **CALIBRATION MODE** in **CDMA2KFADLEVCOR**. This will set the CMU **CDMA POWER** to the maximum level -16dBm.
4. Set equal generator and analyzer frequencies on the CMU, e.g. 1955.0MHz. This may be checked by pressing the **GET SETTINGS** button in the program.
5. Determine the **HARDWARE LOSS** by pressing the **CALIBRATE** button in **CDMA2KFADLEVCOR**. The calibration takes approx. 40s and is ready when the **CALIBRATE** button is no longer dimmed.
6. Switch to **MEASUREMENT MODE** in **CDMA2KFADLEVCOR** which automatically updates the CMU external attenuation with the **EXT ATTEN** value and switches the CMU-B17 Fading path ON.

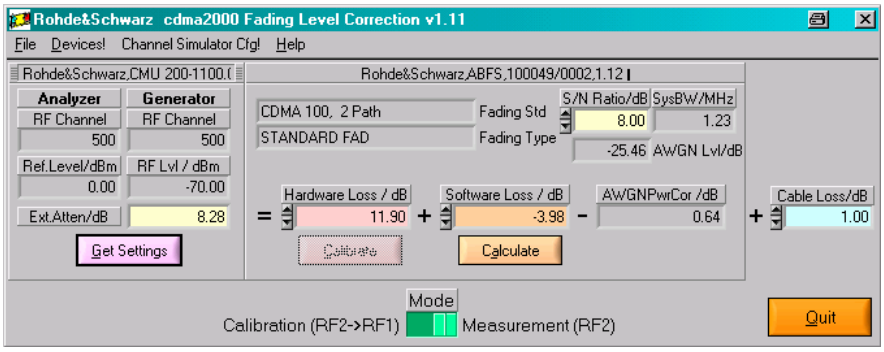


Fig. 31 cdma2kFadLevCor Setup

By switching to Measurement Mode the ABFS **RF FREQUENCY** is also automatically set equal 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**

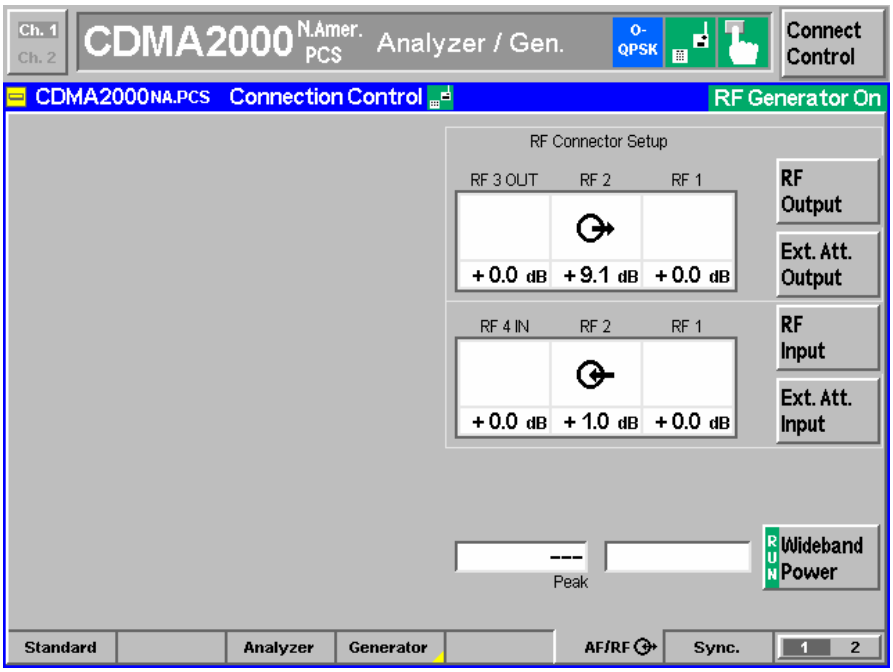


Fig. 32 RF Connector Setup

7. Select the desired fading profile in the cdma2kFadLevCor program (**CHANNEL SIMULATOR CFG** -> e.g. **CDMA 8, 2 PATH** i.e. **CDMA 100, 3 PATH)**. -> **SET**. Close this menu with **QUIT**).
8. Calculate the **SOFTWARE LOSS** by pressing the program's **CALCULATE** button (-3.01 for CDMA 8, 2 Path i.e. -3.98dB for CDMA 100, 3Path, which is negative attenuation or gain). This also updates the **AWGNPWRCOR**, **AWGNLVL** and **SYSBW** (make sure SysBw ≥ 1.23MHz) displays.
9. Optionally edit the **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** 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**

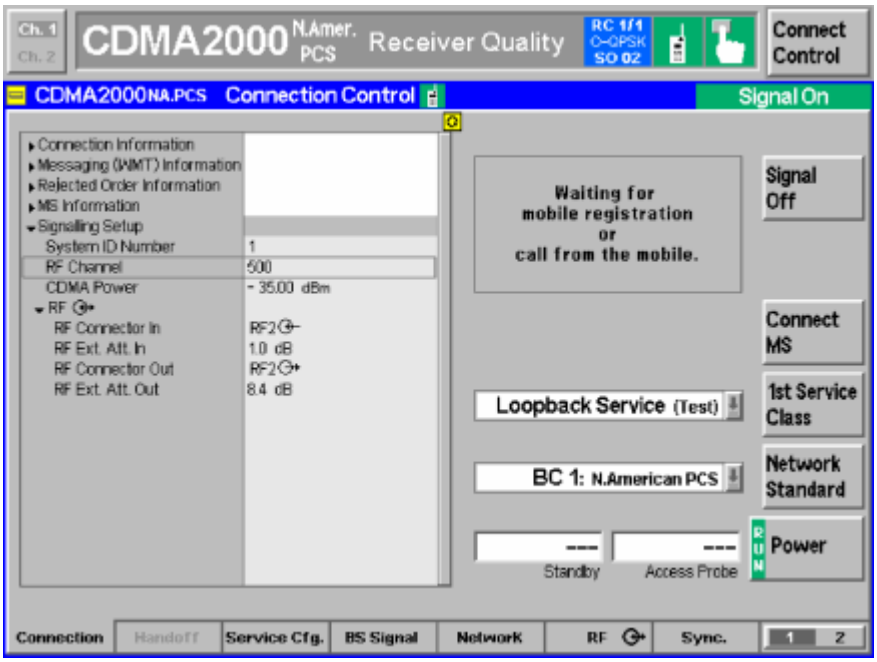


Fig. 33 Connection Control

14. Select **CONNECT CONTROL** -> **BS SIGNAL SETTINGS** -> **RF CHANNEL**, e.g. 500 (Foward Link 1955MHz, Reverse Link 1875MHz).
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).

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

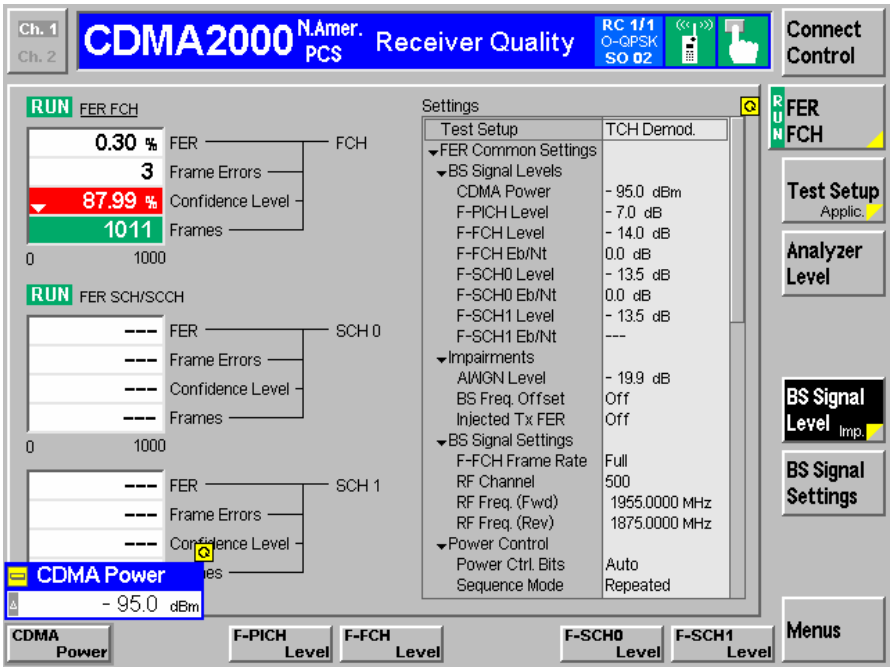


Fig. 34 FER-FCH Measurement

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. CDMA Power characteristic. 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.

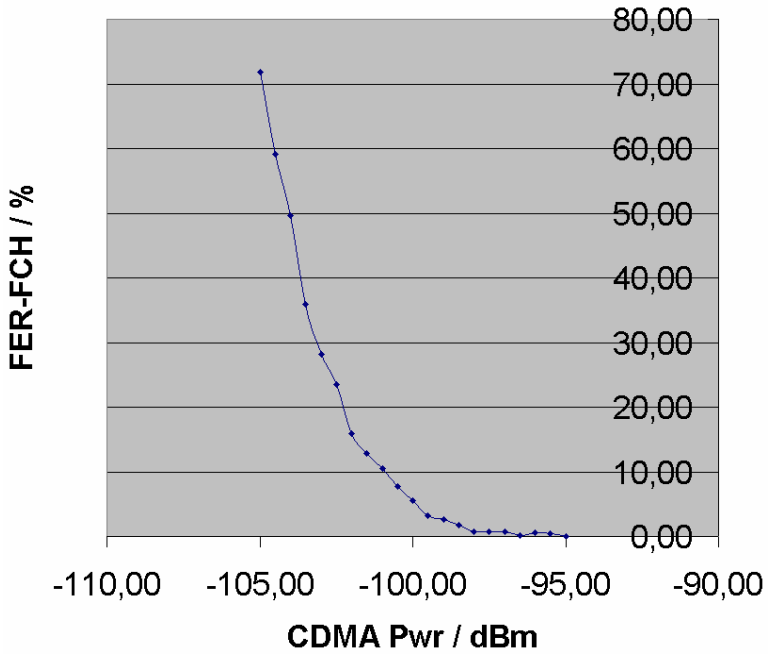


Fig. 35 FER-FCH vs. CDMA Pwr

6 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
```

7 Additional Information

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

8 Ordering information

Communication Tester		
CMU 200		1100.0008.02
CMU 300		1100.0008.03
Fading Simulator		
ABFS	Base Band Fading Simulator	1114.8506.02
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

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