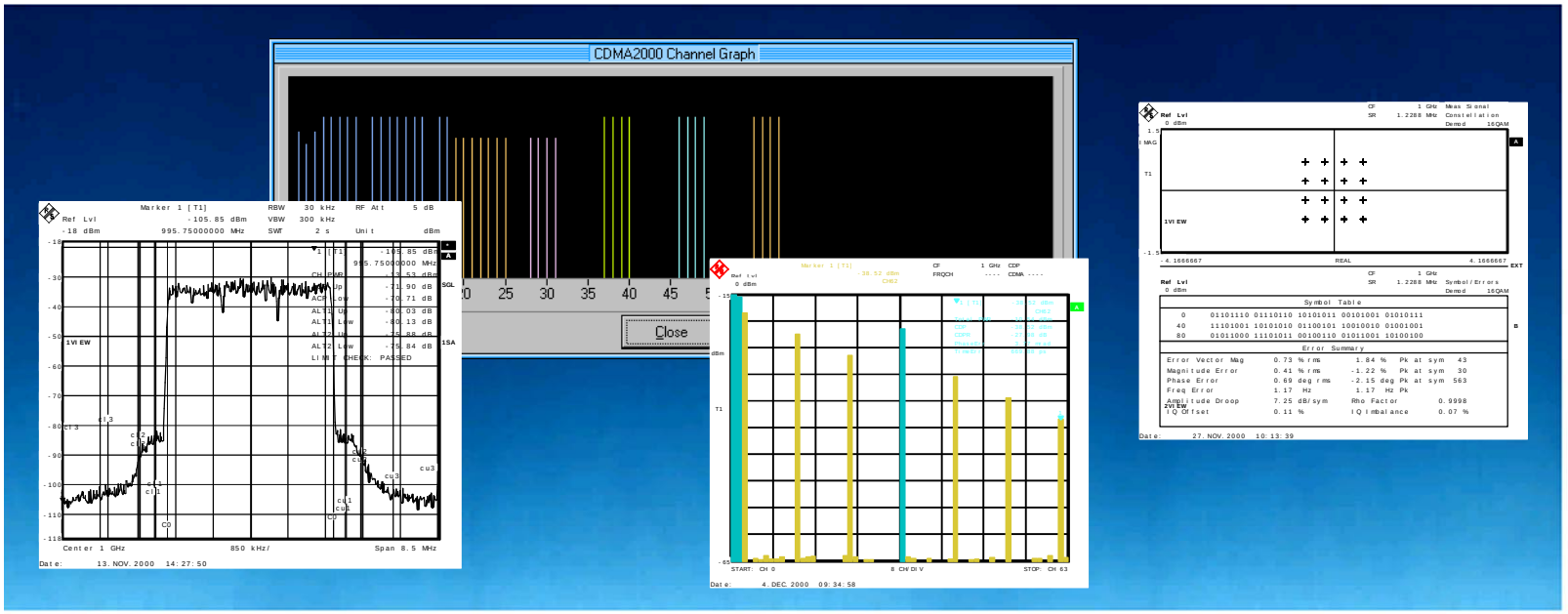



Products: AMIQ, SMIQ, FSIQ, FSP

# Generating and analyzing cdma2000 Signals: Solutions from Rohde & Schwarz

## Application Note

This application note describes measurements compliant with the cdma2000 standard described in TIA/EIA-97-C and TIA/EIA-98-C.

The primary focus is on solutions for generating and analyzing cdma2000 signals with equipment from Rohde & Schwarz. The special characteristics that make the signal generators and signal analyzers eminently suitable for this purpose are detailed.

ROHDE&SCHWARZ

Subject to change– M. Weiß 03.2001 –1MA34_0e

# Contents



# 1 Overview

cdma2000 as described by Third Generation Partnership 2 (3GPP2) is an access method intended for use in the IMT-2000 proposal for Third Generation (3G) cellular phone systems. The system is based on spread-spectrum codes and provides high and variable data rates.

This Application Note opens with a brief introduction to the cdma2000 standard. Its main focus, is on solutions for generating and analyzing cdma2000 signals using equipment from Rohde & Schwarz. The features that make the SMIQ signal generators and the FSIQ and FSP signal analyzers eminently suitable for this purpose are detailed.

# 2 cdma2000 – Basics and Background

## General

cdma2000 is an evolutionary development of IS-95 (cdmaOne) and its development has been divided into 2 phases (cdma2000 – phase I and cdma2000 – phase II). The major distinguishing features of cdma2000 are the maximum data rate and the way in which the air interface is accessed Direct Sequence (DS) or Multi Carrier (MC) access methods are used in the forward link. DS methods, at 2 spreading rates, are used in the reverse link.

## Frequencies

cdma2000 distinguishes between 2 frequency groups:

- Band Class 0, also known as “cellular band”
- Band Class 1, also known as “PCS band”

The corresponding frequency ranges are listed in the table below:

| Band Class (BC) | Transmitter | Channel numbers | Frequencies [MHz] |
|---|---|---|---|
| 0 (Cellular) | Mobile station (RL) | 1 .. 777, 1013 ... 1023 | 824.7 ... 848.31 |
| | Base station (FL) | 1 .. 777, 1013 ... 1023 | 869.7 ... 893.31 |
| 1 (PCS) | Mobile station (RL) | 0 .. 1199 | 1850 ... 1909.95 |
| | Base station (FL) | 0 .. 1199 | 1930 ... 1989.95 |

## Data Rate and Chip Rate, Radio Configuration

cdma2000 is based on Code Domain Multiple Access (CDMA) to the air interface. This means that the individual channels are separated from each other by individual codes (the codes used for cdma2000 are known as Walsh codes).

The basic chip rate, on which all other data, symbol and bit rates are based, is 1.2288 MHz. A rate three times as high as this, 3.6864 MHz is also used for cdma2000-II.

cdma2000-I is compatible with cdmaOne and supports only DS access at 1.2288 Mchips/s.

cdma2000-II supports higher data rates and offers new possibilities in coding. MC Forward Link access at 3 x 1.2288 MHz is used along with Reverse-Link DS access with a chip rate of 3.6864 MHz.

The basics of the air interface are described by the Radio Configuration (RC). RCs differ in the data rates they support, in the mode of access to the air interface (DS or MC), modulation type, and error protection coding methods.

The various radio configurations are outlined in the table below:

| RC | | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
|---|---|---|---|---|---|---|---|---|---|---|
| SR | FL | 1x | 1x | 1x | 1x | 1x | 3x | 3x | 3x | 3x |
| | RL | 1x | 1x | 1x | 1x | 3x | 3x | ---- | ---- | ---- |
| R | FL | ½ | ½ | ¼ | ½ | ¼ | $^1/_6$ | $^1/_8$ | ¼ / $^1/_8$ | ½ / $^1/_8$ |
| | RL | $^1/_3$ | ½ | ¼ | ¼ | $^1/_4$ | ¼ | ---- | ---- | ---- |
| Mod. | FL | BPSK | BPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK | QPSK |
| | RL | 64-array | 64-array | BPSK | BPSK | BPSK | BPSK | ---- | ---- | ---- |
| 1200 | | | | | | | | | | |
| 1350 | | | | | | | | | | |
| 1500 | | | | | | | | | | |
| 1800 | | | | | | | | | | |
| 2400 | | | | | | | | | | |
| 2700 | | | | | | | | | | |
| 3600 | | | | | | | | | | |
| 4800 | | | | | | | | | | |
| 7200 | | | | | | | | | | |
| 9600 | | W64 | | W64 | W128 | | W128 | W256 | | |
| 14400 | | | W64 | | | W64 | | | W128 | W256 |
| 19200 | | | | W32 | W64 | | W64 | W128 | | |
| 28800 | | | | | | W32 | | | W64 | W128 |
| 38400 | | | | W16 | W32 | | W32 | W64 | | |
| 57600 | | | | | | W16 | | | W32 | W64 |
| 76800 | | | | W8 | W16 | | W16 | W32 | | |
| 115200 | | | | | | W8 | | | W16 | W32 |
| 153600 | | | | W4 | W8 | | W8 | W16 | | |
| 230400 | | | | | | W4 | | | W8 | W16 |
| 307200 | | | | 1) | W4 | 2) | W4 | W8 | | |
| 460800 | | | | | | | | | W4 | W8 |
| 614400 | | | | | | 2) | | W4 | | |
| 1036800 | | | | | | | 1) | | | W4 |
| | | | | | | | | | | |
| | | RL | | FL | | | RL+FL | | | |

1) with R = ½ 2) with R = $^1/_3$ 3) with R = ½

Key:

FL / RL = Forward Link / Reverse Link
SR = Symbol Rate (1x = 1.2288 MHz, 3x = 3.6864 MHz)
R = Rate of the code
Mod = Modulation

W = Walsh code. The suffixed index is the number of chips per sample (= spread factor).

This table is no more than a rough guide to the code channels and channel configurations. More information can be obtained using WinIQSIM. This IQ simulation software computes possible channel configurations quickly and easily. It is available as a free download from the Rohde & Schwarz homepage (www.rohde-schwarz.com).

## Test Models

Unlike the test models developed for the 3GPP standard, cdma2000 describes a nominal base station model. It is similar to the model described in the original IS-95 text, and leaves code number selection undefined. Individual manufacturers have developed test models based on their own needs. This loosely defined model can lead to variations in distortion measurements, such as Adjacent Channel Power (ACP), when performed with varying code selections. This requires that the test equipment selected must be capable of simulating a broad range of varying test conditions.

The nominal test model defined for base-station tests is structured as follows:

| **Channel** | **No.** | **Fraction of power** | | **Comment*** |
|---|---|---|---|---|
| | | **linear** | **log** | |
| Pilot (F-PICH) | 1 | 20 % | -7.0 dB | $W_0^{128}$ |
| Paging (F-PCH) | 1 | 4.71 % | -7.3 dB | $W_1^{64}$ |
| Sync (F-SYNC) | 1 | 18.82 % | -13.3 dB | $W_{32}^{64}$ |
| Traffic (F-FCH + F-SCH) | 6 | 9.412 % each | -10.3 dB each | Full rate, equal power |

*The comment is primarily a designator for the code. $W_{32}^{64}$, for example, stands for the 32nd Walsh code of the Walsh code group, used with a spread factor of 64.

An example file for WinIQSim is supplied (BSMode.iqs).

# 3 Rohde & Schwarz Solutions for cdma2000

## Signal Generation

The **SMIQ** signal generators are particularly suitable for generating cdma2000 signals. High-performance modulators are used, so the baseband signal input to the SMIQ can be modulated with minimal distortion into the RF band.

The SMIQ can be used for channel simulation, as a result of the wide range of options such as a fading simulator and additive white gaussian noise (AWGN) generator. Channel simulation is required, for example, for receiver sensitivity measurements and is often needed for customer-specific measurements.

Baseband signals are generated by the SMIQ's internal Arbitrary Waveform Generator (ARB) (**SMIQ-B60**) with the **WinIQSIM** simulation software. This combination can generate cdma2000 signals of any configuration and superimpose faults such as fading, clipping, etc. Excellent values for EVM and ACP are characteristic of this solution.

The AMIQ modulation generator is an alternative to the internal ARB in SMIQ. With its high-end technical specifications (100 MHz clock rate, 14-bit D/A converter, 16 Msamples memory depth, differential outputs, digital outputs), AMIQ provides improved performance for receiver test, baseband test and out-of-standard applications.

The various options for signal generation are listed in the table below:

| **Parameter** | **SMIQ + SMIQ-B60** | **SMIQ + AMIQ** [1)] |
|---|---|---|
| Frequency range | 300 kHz ... 6.4 GHz | 300 kHz ... 6.4 GHz |
| Level range | -140 ... +13 dBm PEP | -140 ... +13 dBm PEP |
| Memory depth | *512 ksamples* | *16 Msamples* |
| Memory depth [frames] [2)] | 1 ... *2* | 1 ... *40* |
| Chip rate [3)] | *1 kcps ... 40 Mcps* | *10 cps ... 100 Mcps* |
| Spreading rate | *1x (SR1), 3x (SR3)* | *1x (SR1), 3x (SR3)* |
| Carrier spacing | 0 ... *2* MHz | 0 ... *10* MHz |
| Radio configuration | FL: 1-9, RL: 1-6 | FL: 1-9, RL: 1-6 |
| Channel power | 0 ... –60 dB | 0 ... –60 dB |
| Data sources | 4 | 4 |
| Data pattern | All 0, all 1, PRBS, pattern (-79 bits), file | All 0, all 1, PRBS, pattern (-79 bits), file |
| Data rate | All in standard | All in standard |

1) With AMIQ04
2) Frames with 80 ms, 1x DS mode
3) Oversampling 2 is sufficient for SMIQ-B60 due to the hardware filter, AMIQ requires >4 oversampling

## Signal Analysis

There is a choice of several devices for signal analysis:

When modulation analysis is not required, the FSP spectrum analyzer is an ideal choice. Its many features including **fast ACP measurement** and **CCDF measurement** enable the FSP to cover a wide range of RF measurements, particularly for mobile stations.

The **FSIQ** signal analyzer offers similar functionality (without CCDF measurement) plus **modulation analysis** and **Code Domain Power (CDP)** measurement. Its excellent dynamic range and comprehensive modulation-analysis capability make it particularly suitable for measurements of either the forward or reverse link.

Its measurement rate is high (approximately 2 measurements per second) and the traffic-to-noise signal ratio is very good, so it is ideal for use in both development and production.

The various options for signal analysis are listed in the table below:

| Measurement | AN-Page | | cdmaOne | | CDMA2000 | | | | Analyzer | |
|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | Forward | | Reverse | | | |
| | FL | RL | forward | reverse | 1x DS | 3x MC+DS | 1x DS | 3x DS | FSIQ | FSP |
| Channel power | 8 | 15 | • | • | • | • | • | • | ✔ | ✔ |
| ACP | 8 | 15 | • | • | • | • | • | • | ✔ | ✔ 3) |
| Occupied BW | 4) | 4) | • | • | • | • | • | • | ✔ | ✔ |
| Spurious | 10 | 15 | • | • | • | • | • | • | ✔ | ✔ 3) |
| CCDF | 12 | 15 | • | • | • | • | • | • | | ✔ |
| EVM | 12 | 16 | • | • | • | | • | | ✔ 1) | |
| Rho | 12 | 16 | • | • | • | | • | | ✔ 1) | |
| I/Q offset | 12 | 16 | • | • | • | | • | | ✔ 1) | |
| CDP | 14 | -- | • | • | • | | | | ✔ 2) | |
| Phase error | 14 | -- | • | • | • | | | | ✔ 2) | |
| Timing error | 14 | -- | • | • | • | | | | ✔ 2) | |
| Frequency error | 14 | -- | • | • | • | | | | ✔ 2) | |

• / ✔ Possible

1) Only with signals of known constellation (QPSK, 8-PSK, 16QAM)

2) With FSIQK71 only RC 1-2, max. 9 active channels, forward channel

3) Dynamic rage of the FSP is sufficient for reverse link measurements and many forward link measurements. FSIQ may be required for the more demanding BTS measurements.

4) Measurement independent of the standard, see Operation Manual of the Instrument

# 4 Requirements for the Hardware

## Signal Generators

The hardware needed to generate cdma2000 signals:

**Baseband Signals (1 of this 2 instruments required)**

- **AMIQ** with cdma2000-option AMIQ-K12.
  Memory depth up to 16 Msamples.
- **SMIQ-B60** option for the SMIQ with cdma2000-option SMIQ-K12.
  Memory depth up to 512 ksamples.
  (If the SMIQ-B60 option is used, the analog baseband IQ data are available at the IQ outputs of the SMIQ.)

**RF Signals**

- **SMIQ** receiving the baseband data either from of the IQ inputs or the internal SMIQ-B60 option.

## Signal Analyzers

The hardware needed to measure cdma2000 signals is either:

- **FSP**
- or an **FSIQ**. With options FSIQ-B70 (DSP and IQ memory extension) and FSIQ-K71 (cdmaOne BTS analysis firmware), limited cdma2000 code domain power measurements are possible.

# 5 Forward Channel Measurements

## ACP, Channel Power

The cdma2000 standard uses measurement techniques and limits similar to those of cdmaOne. The stipulations for the cdmaOne standard and the spurious measurements for cdma2000 signals, can be used to obtain settings suitable for measurement, especially near the carrier. The procedure is as follows:

- **FSIQ:**
  Select **[*MARKER* – NORMAL] [<]** to access the submenu for extended measurement. Select [CHANNEL POWER] to measure channel power and [ADJACENT CHANNEL POWER] to measure ACP.
- **FSP:**
  Select **[MEAS]** [CHAN PWR ACP] to access the submenu for ACP measurement. Select [CP / ACP ON] to measure channel power and ACP.

**SR3 (RC6-RC9) and DS (Direct Sequence)**

From the list, select

- **FSIQ:**
  "CDMA2000 DS" in menu
  [POWER MEAS SETTINGS] [ACP STANDARD]
- **FSP:**
  "CDMA2000 DS" in menu
  [CP / ACP STANDARD]

and press Enter to confirm your choice.
ACP offset, BW and limit are then set as follows:

| Channel | Offset | BW | Limit |
|---|---|---|---|
| Main | 0 | 3.75 MHz | --- |
| ACP | 2.65 MHz | 30 kHz | -45 dB |
| ALT 1 | 3.75 MHz | 12.5 kHz | -80 dB |
| ALT 2 | 5.94 MHz | 1 MHz | -80 dB |

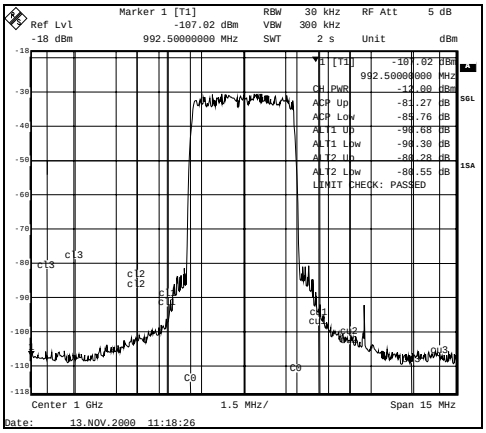



Fig. 5-1 ACP measurement for SR3 and DS

**SR3 (RC6-RC9) and MC (Multi Carrier)**

From the list, select

- **FSIQ:**
  "CDMA2000 MC" in menu
  [POWER MEAS SETTINGS] [ACP STANDARD]
- **FSP:**
  "CDMA2000 MC3" in menu
  [CP / ACP STANDARD]

and press Enter to confirm your choice.
ACP offset, BW and limit are then set as follows:

| Channel | Offset | BW | Limit |
|---|---|---|---|
| Main | 0 | 3.75 MHz | --- |
| ACP | 2.13 MHz | 30 kHz | -42 dB |
| ALT 1 | 2.50 MHz | 12.5 kHz | -80 dB |
| ALT 2 | 3.23 MHz | 1 MHz | -54 dB |

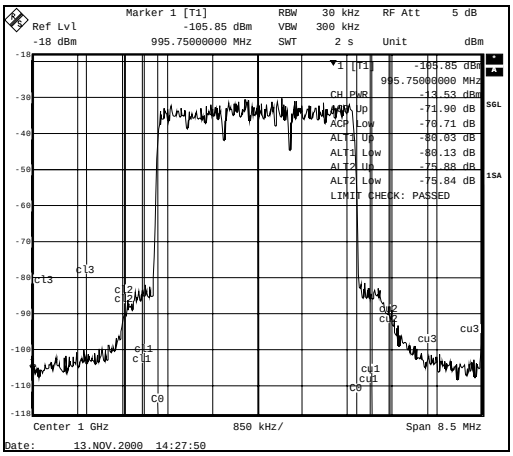



Fig. 5-2 ACP measurement for SR3 and MC

**SR1 (RC1-RC5) and DS (Direct Sequence):**

From the list, select

- **FSP:**
  "CDMA2000 MC1" in menu
  [CP / ACP STANDARD]
- for **FSIQ**, this function is not available as predefined standard. You have to set up the measurement parameters yourselve according to the table shown below.

and press Enter to confirm your choice.
ACP offset, BW and limit are then set as follows:

| Channel | Offset | BW | Limit |
|---|---|---|---|
| Main | 0 | 1.2288 MHz | --- |
| ACP | 750 kHz | 30 kHz | -45 dB |
| ALT 1 | 1.98 MHz | 30 kHz | -60 dB |
| ALT 2 | 2.65 MHz | 30 kHz | -54 dBm |

Custom ACPR measurement can easily be defined for the FSP and FSIQ by manually setting channel BW, Adjacent Channel offsets and Adjacent Channel BWs. Data entry for channel BWs and offsets are found in the channel power setup menus.

## Spurious

Standard 4.5.1 specifies compliance with the spurious mask for Band Class 0 and Band Class 1 for the base station transmitters.

The limit lines are defined in relative and absolute terms and differ depending on output power, and this means that several limit lines are required.

The procedure for loading the limit lines and using them in the device is described on page 25.

### Band Class 0 Transmitter (TIA/EIA-97-C, 4.5.1.3.1)

The limits defined for the various output power ratings are as follows:

| **Upper [MHz]** | -oo | -3.125 | -1.98 | +0,75 | +1.98 | +3.125 | Limit |
|---|---|---|---|---|---|---|---|
| **Lower [MHz]** | -3.125 | -1.98 | 0.75 | +1.98 | +3.125 | + oo | |
| **< 28 dBm** | -13 dBm | -55 dBc | -45 dBc | -45 dBc | -55 dBc | -13 dBm | R+A+L |
| **28 ... 33 dBm** | -13 dBm | -27 dBm | -45 dBc | -45 dBc | -27 dBm | -13 dBm | R+A+M |
| **> 33 dBm** | -13 dBm | -60 dBc | -45 dBc | -45 dBc | -60 dBc | -13 dBm | R+A+H |
| **Meas. BW** | 100 kHz | 30 kHz | 30 kHz | 30 kHz | 30 kHz | 100 kHz | |

The column headed “Limit” contains the limit lines. “R+A+M”, for example, means:
Switch on CD451B0R, CD451B0A and CD451B0M.

### Band Class 1 Transmitter (TIA/EIA-97-C, 4.5.1.3.2)

The limits defined for the various output power ratings are as follows:

| **Upper [MHz]** | -oo | -2.25 | -1.98 | +0,885 | +1.98 | +2.25 | Limit |
|---|---|---|---|---|---|---|---|
| **Lower [MHz]** | –2.25 | -1.98 | 0.885 | +1.98 | +2.25 | + oo | |
| **< 28 dBm** | -13 dBm | -50 dBc | -45 dBc | -45 dBc | -50 dBc | -13 dBm | R+A+L |
| **28 .. 33 dBm** | -13 dBm | -22 dBm | -45 dBc | -45 dBc | -22 dBm | -13 dBm | R+A+M |
| **> 33 dBm** | -13 dBm | -55 dBc | -45 dBc | -45 dBc | -55 dBc | -13 dBm | R+A+H |
| **Meas. BW** | 1 MHz | 30 kHz | 30 kHz | 30 kHz | 30 kHz | 1 MHz | |

The column headed “Limit” contains the limit lines. “R+A+M”, for example, means:
Switch on CD451B1R, CD451B1A and CD451B1M.

## CCDF

Complementary Cumulative Distribution Function measurement (CCDF) indicates which amplitude values are present in the signal, and how often they occur.

- **FSP:**
  **[MEAS]** [SIGNAL STATISTIC] [CCDF ON].

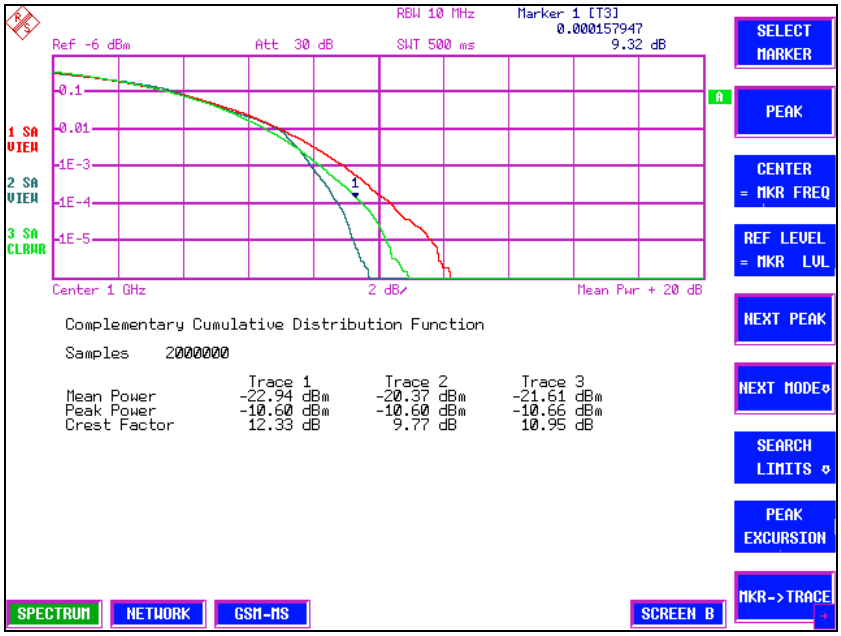



Fig. 5-3 CCDF measurement with the FSP

## Modulation Quality

Use modulation quality measurement to determine important parameters of IQ modulators, such as I/Q imbalance, rho, phase & frequency error and EVM.

Modulation quality can only be measured for signals corresponding to a constellation that can be demodulated by the FSIQ (in this case QPSK or 16QAM). cdma2000 constellations compliant with this requirement are described below:

### Pilot only (F-PICH)

*Device settings:*

| Device | Parameter | Value |
|---|---|---|
| AMIQ | File | *ForMod01.iqs* |
| FSIQ | Digital Standards | *CDMA2000 SR1/DS FWD* |

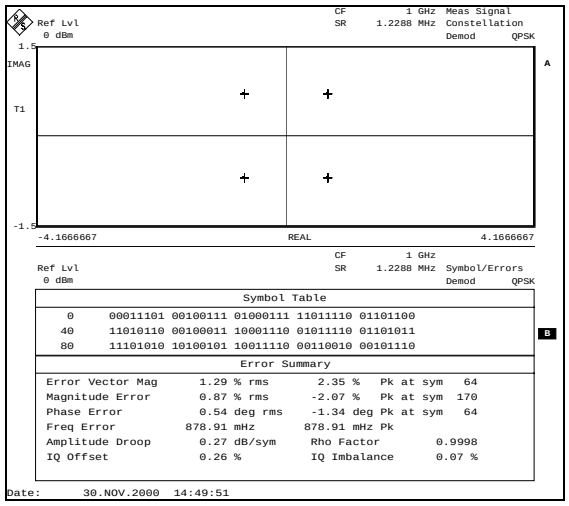



Fig. 5-4 Modulation Quality – F-PICH

### Rho Measurement: Pilot only

Rho is defined for pilot-only signals in both cdmaOne and cdma2000. The F-PICH signal maps to a QPSK signal as shown in Figure 4. Rho measurements can be made for RC1 - RC5 forward link signals. RC6-RC9 rho measurements on multi-carrier signals cannot be made with the FSIQ.

### Pilot (F-PICH) and Synch (F-SYNC)

Same power for both channels

*Device settings:*

| Device | Parameter | Value |
|---|---|---|
| **AMIQ** | File | *ForMod02.iqs* |
| **FSIQ** | Digital Standards | *CDMA2000 SR1/DS FWD* |
| | Digital Demodulation | *16QAM* |

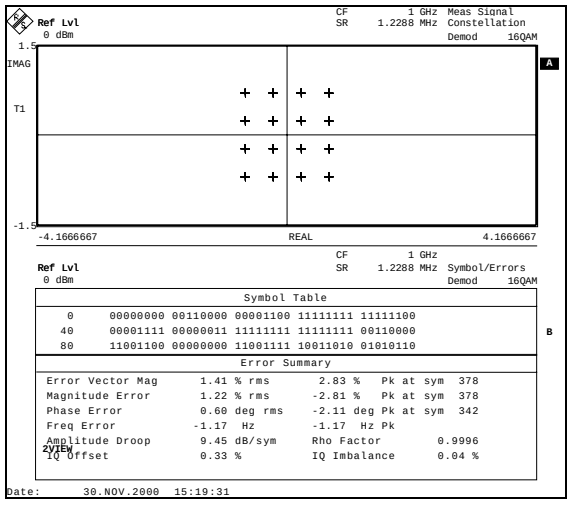



Fig. 5-5 Modulation Quality – F-PICH + F-SYNC

With this setting only the points in the diagonals of the diagrams are mapped.

## Code Domain Power (CDP), RC1-RC2

To measure Code Domain Power (CDP):

- Pilot (F-PICH) must be activated
- No more than 9 channels activated
- The DCCH channels must be switched off

cdma2000 signals are measured using the measuring functions for the IS-95 standard (= cdmaOne) of the FSIQ (FSIQ-K71).

Start Code Domain Power measurement by selecting **[MODE]** [CDMA ONE BTS] [CDP MEAS].

You can view the results in a number of modes selectable in the [DISPLAY MODE CDP] submenu:

- **CDP:** Code Domain Power, absolute
- **CDP RATIO:** Code Domain Power relative to total power
- **TIME ERROR:** Timing error per channel
- **PHASE ERROR:** Phase error per channel
- **ERROR SUMMARY:** All results in tabular form

In addition to whichever graphical display is selected, you can use the marker for a channel to view all the information (CDP, CDPR, Timing, Phase).

The WinIQSIM file BSModel.iqs contains the standard test model described here. The diagram below shows the corresponding FSIQ analysis:


Fig. 5-6 CDP and error summary standard test model

# 6 Reverse Channel Measurements

## ACP, Channel Power

The requirements are the same as for forward link, see page 8.

## Spurious

Standard 4.5.1 specifies compliance with the spurious mask for Band Class 0 and Band Class 1 for mobile station transmitters.

The limit lines are defined in relative and absolute terms, so several limit lines are required.

The procedure for loading the limit lines and using them in the device is described on page 25.

### Band Class 0 Transmitter (TIA/EIA-98-C, 4.5.1.3-1

The limits are defined as follows:

| Upper [MHz] | -oo | -3.125 | -1.98 | +0,85 | +1.98 | +3.125 |
|---|---|---|---|---|---|---|
| Lower [MHz] | –3.125 | -1.98 | 0.85 | +1.98 | +3.125 | + oo |
| Limit | -13 dBm | -54 dBc | -42 dBc | -42 dBc | -54 dBc | -13 dBm |
| Meas. BW | 100 kHz | 30 kHz | 30 kHz | 30 kHz | 30 kHz | 100 kHz |
| **OR** | | | | | | |
| Limit | -13 dBm | -54 dBm | -54 dBm | -54 dBm | -54 dBm | -13 dBm |
| Meas. BW | 100 kHz | 1.23 MHz | 1.23 MHz | 1.23 MHz | 1.23 MHz | 100 kHz |

The following limit lines are required:
CD451M01, CD451M02 and CD451M03

### Band Class 1 Transmitter (TIA/EIA-98-C, 4.5.1.3-2)

The limits are defined as follows:

| Upper [MHz] | -oo | -2.25 | -1.98 | +1,25 | +1.98 | +2.25 |
|---|---|---|---|---|---|---|
| Lower [MHz] | –2.25 | -1.98 | -1.25 | +1.98 | +2.25 | + oo |
| Limit | -13 dBm | -50 dBc | -42 dBc | -42 dBc | -50 dBc | -13 dBm |
| Meas. BW | 1 MHz | 30 kHz | 30 kHz | 30 kHz | 30 kHz | 1 MHz |
| **OR** | | | | | | |
| Limit | -13 dBm | -54 dBm | -54 dBm | -54 dBm | -54 dBm | -13 dBm |
| Meas. BW | 1 MHz | 1.23 MHz | 1.23 MHz | 1.23 MHz | 1.23 MHz | 1 MHz |

The following limit lines are required:
CD451M01, CD451M02 and CD451M03.

## CCDF

Measurement is the same as for forward channel (see page 12).

## Modulation Quality

Use modulation quality measurement to determine important parameters of IQ modulators, such as I/Q imbalance, rho, phase & frequency error and EVM.

Modulation quality can be measured only for signals corresponding to a constellation that can be demodulated by the FSIQ (in this case QPSK, 8-PSK or 16QAM). Constellations compliant with this requirement are described below:

### Pilot only (R-PICH)

*Device settings:*

| Device | Parameter | Value |
|---|---|---|
| **AMIQ** | File | *RevMod01.iqs* |
| **FSIQ** | Digital Standards | *CDMA2000 SR1/DS REV* |

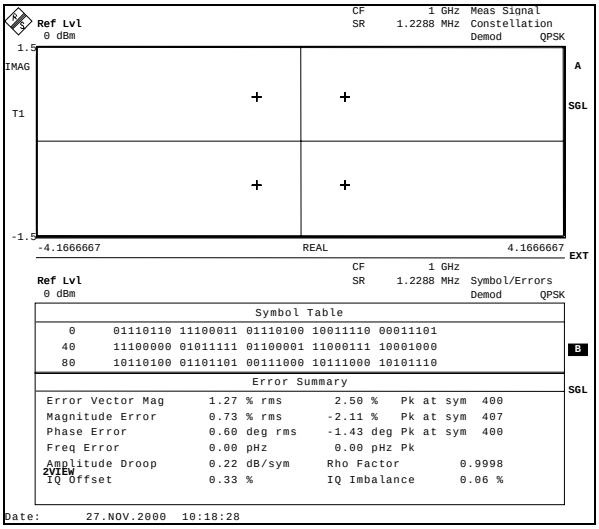



Fig. 6-1 Modulation Quality – R-PICH

**Pilot (R-PICH) and Fundamental Channel (R-FCH)**

Same power for both channels

*Device settings:*

| Device | Parameter | Value |
|---|---|---|
| **AMIQ** | File | *RevMod02.iqs* |
| **FSIQ** | Digital Standards | *CDMA2000 SR1/DS REV* |

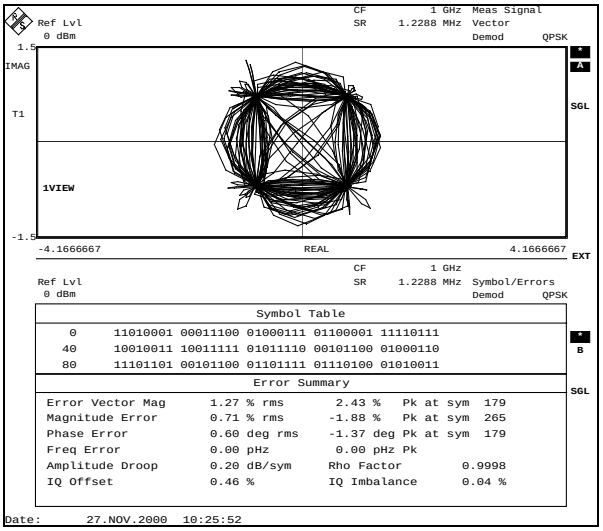



Fig. 6-2 Modulation Quality – R-PICH + R-FCH (1)

**Pilot (R-PICH) and Fundamental Channel (R-FCH)**

R-FCH lower than R-PICH by 7.5 dB

*Device settings:*

| Device | Parameter | Value |
|---|---|---|
| **AMIQ** | File | *RevMod03.iqs* |
| **FSIQ** | Digital Standards | *CDMA2000 SR1/DS REV* |
| | Digital Demodulation | *8-PSK* |

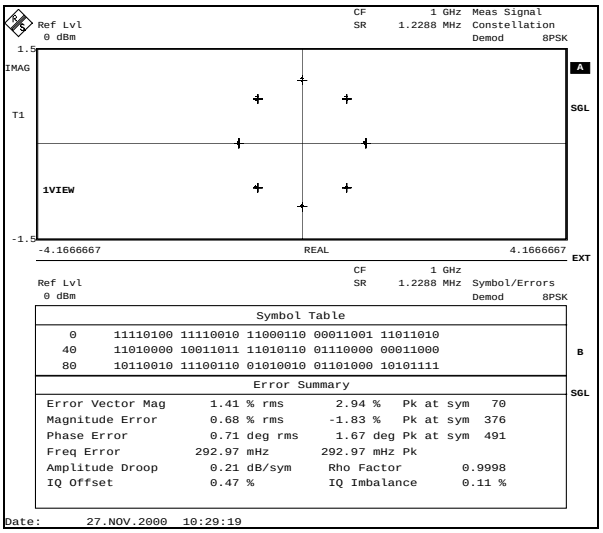



Fig. 6-3 Modulation Quality – R-PICH + R-FCH (2)

**Pilot (R-PICH), Fundamental Channel (R-FCH) and 1st Supplemental Channel (R-SCH 1)**

Same power for all channels

*Device settings:*

| Device | Parameter | Value |
|---|---|---|
| **AMIQ** | File | *RevMod04.iqs* |
| **FSIQ** | Digital Standards | *CDMA2000 SR1/DS REV* |
| | Digital Demodulation | *16QAM* |

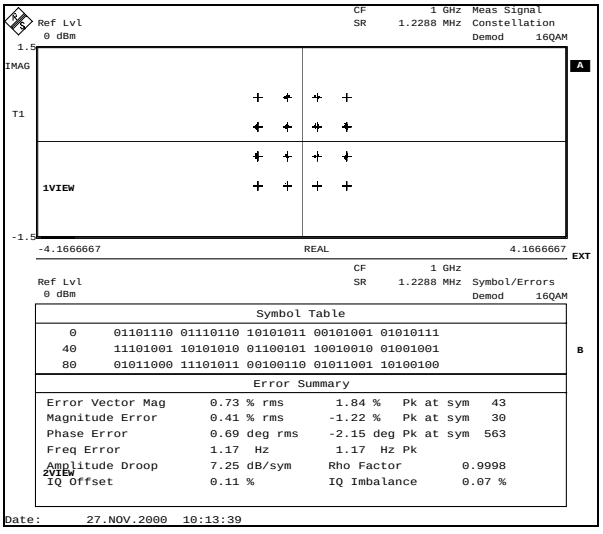



Fig. 6-4 Modulation Quality – R-PICH + R-FCH + R-SCH 1

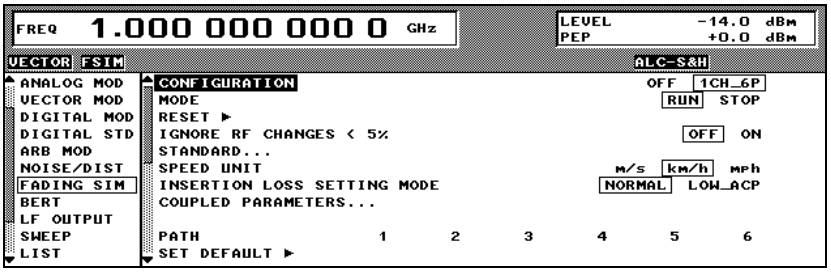
# 7 Measurements under Fading Conditions using SMIQ-B14

Measurements under fading conditions are specified as part of the receiver tests of both mobile and base stations. The specified profiles are easily implemented with the SMIQ fading simulator SMIQ-B14.

The profiles used for mobile and base stations are the same, even though the designations differ. The individual profiles are listed in the table below:

| **Configuration** | **I** | **II** | **III** | **IV** | **V** | **VI** |
|---|---|---|---|---|---|---|
| **Base station fading configuration according to TIA/EIA-97-C, 6.4.1** | **1** | **2** | **3** | **---** | **---** | **---** |
| **Mobile station fading configuration according to TIA/EIA-98-C, 6.4.1.1** | **1** | **3** | **4** | **5** | **2A** | **2B** |
| Speed [km/h] | 8 | 30 | 100 | 0 | 30 | 14 |
| No. of paths | 2 | 1 | 3 | 2 | 2 | 2 |
| Power, path 2 [dB] | 0 | --- | 0 | 0 | 0 | 0 |
| Power, path 3 [dB] | --- | --- | -3 | --- | --- | --- |
| Delay, path 1 [us] | 0 | 0 | 0 | 0 | 0 | 0 |
| Delay, path 2 [us] | 2 | --- | 2 | 2 | 2 | 2 |
| Delay, path 3 [us] | --- | --- | 14.5 | --- | --- | --- |

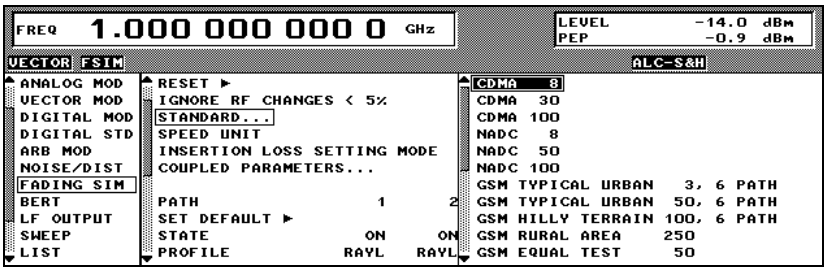
## General Settings




## Configurations

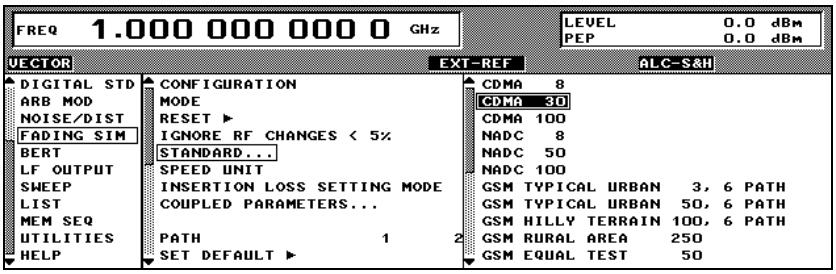
### Configuration I

This configuration corresponds to the predefined standard “CDMA 8”:



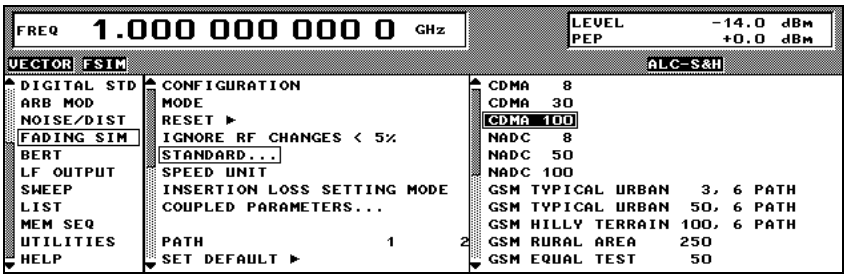
### Configuration II

This configuration corresponds to the predefined standard “CDMA 30”:



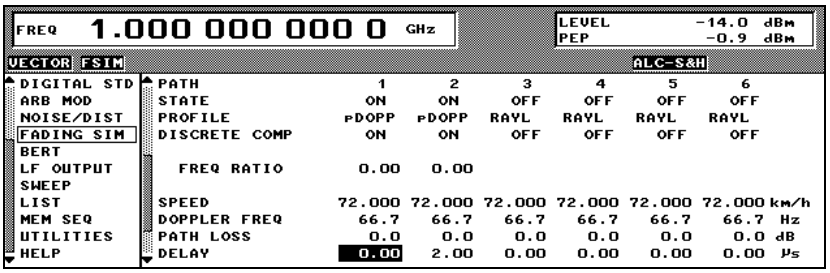

### Configuration III

This configuration corresponds to the predefined standard “CDMA 100”:




### Configuration IV

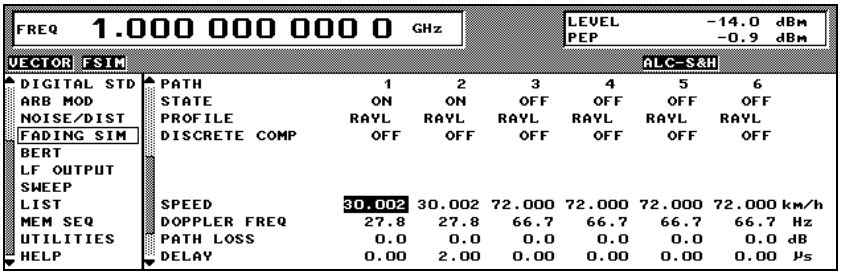
This configuration has to be set manually:




The profile (PROFILE) has to be set to pDOPP and FREQ RATIO set to 0 so that the speed can be set to 0. The speed setting is of no significance.

### Configuration V

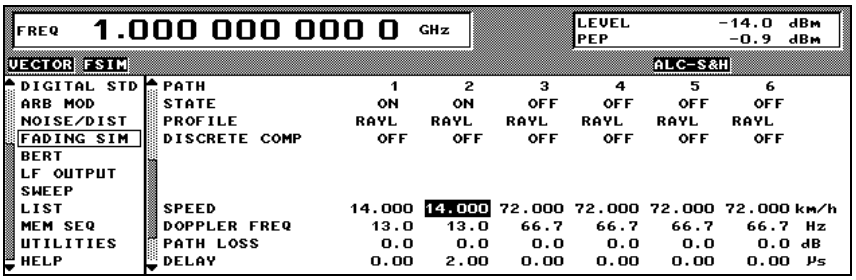
This configuration has to be set manually:




The speed steps in which the fading simulator can be set depend on the RF frequency, so in some instances the specified speed cannot be set accurately. In these cases the fading processor selects the value closest to the specified speed.

### Configuration VI

This configuration has to be set manually:




# 8 Notes

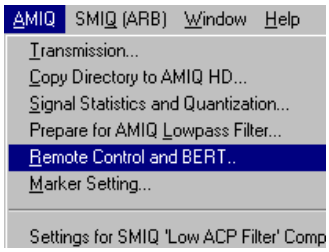
## Enabling the WinIQSIM Option for cdma2000

The AMIQ-K12 or the SMIQ-K12 option as applicable must be enabled before you can generate cdma2000 signals with the AMIQ or the SMIQ-B60.

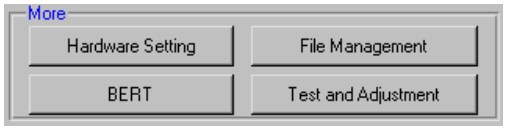
### Enabling the AMIQ-K12 Option

Connect the AMIQ to the computer using the IEC bus, start WinIQSIM and proceed as follows:

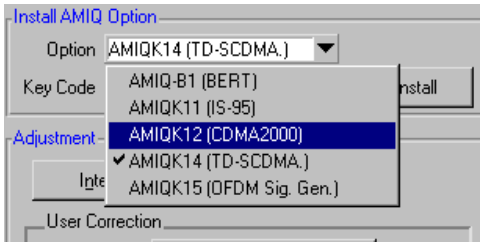
1. Open the dialog box for remote control of the AMIQ:




2. Select “Test and Adjustment”:



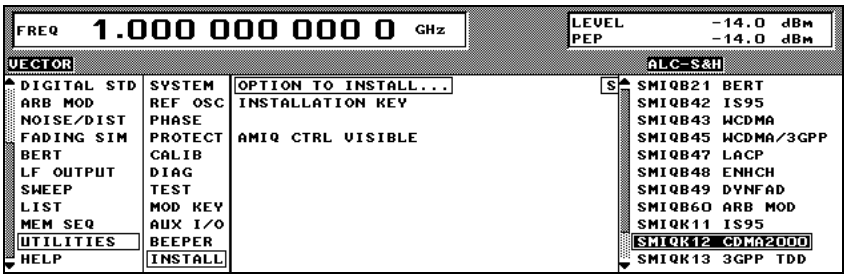

3. Select the cdma2000 option “AMIQ-K12”:




4. Enter the enabling code and click on “Install”. The option is installed and is immediately usable.

### Enabling the SMIQ-K12 Option

In order to install the option in the SMIQ, select the following submenu:

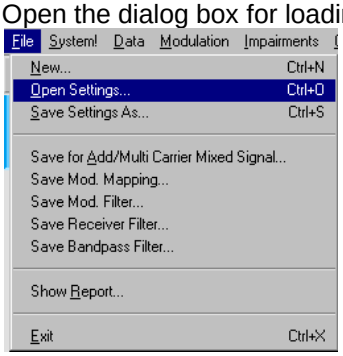



Enter the installation key.

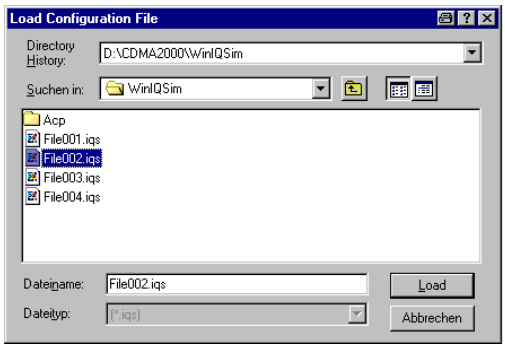
## Loading WinIQSIM Files onto the AMIQ

This Application Note includes a number of demo files with predefined cdma2000 signals. To load these signals onto the AMIQ, start WinIQSIM and proceed as follows:

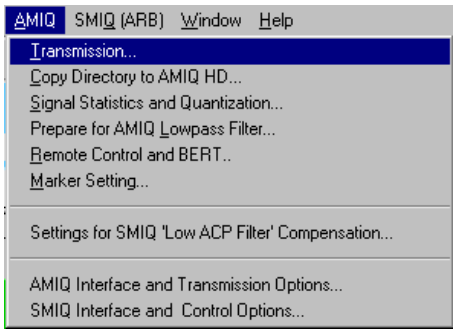
1. Open the dialog box for loading settings:



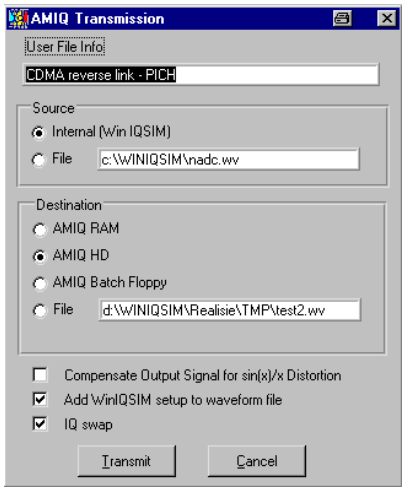

2. Select the appropriate file:



3. Select the option for transmission to the AMIQ:




4. Select the destination for the waveform:



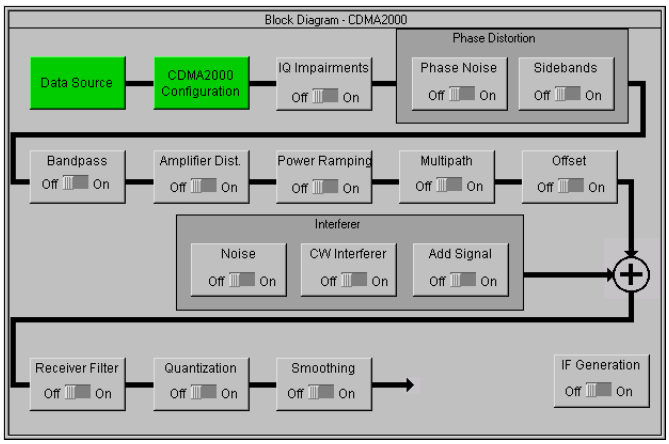

- “Destination – AMIQ RAM”: The waveform is loaded directly into the AMIQ’s main memory.
- “Destination – AMIQ HD”: The waveform is copied onto the hard disk.

***Note:*** *You cannot generate cdma2000 signals unless the AMIQ’s cdma2000 option is enabled.*

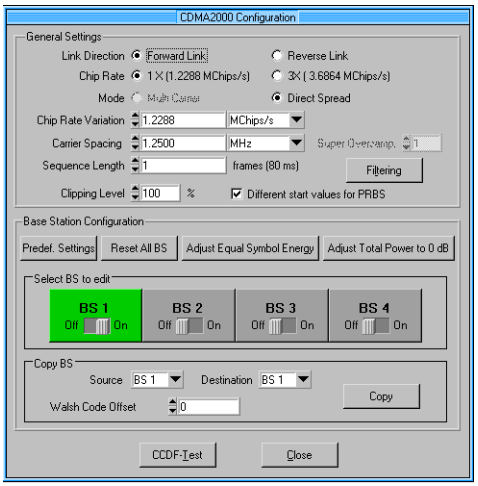
## Straightforward Setups in WinIQSIM

WinIQSIM has an easy-to-use interface for conveniently configuring cdma2000 setups.

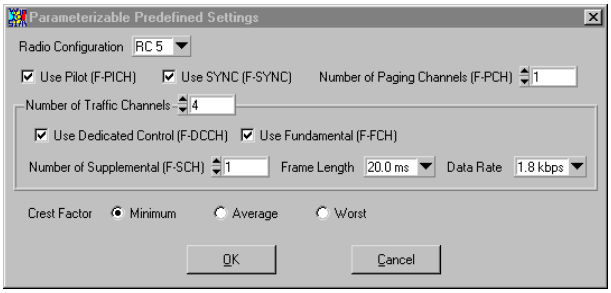
1. Select “CDMA2000 Configuration” from the Block Diagram window:




2. Select “Predef. Settings”:




3. The combo box shown here appears on the screen:




Simply check the boxes to set Link Direction, Chip Rate and Mode in order to generate a suitable signal.
This feature is available for forward link only.

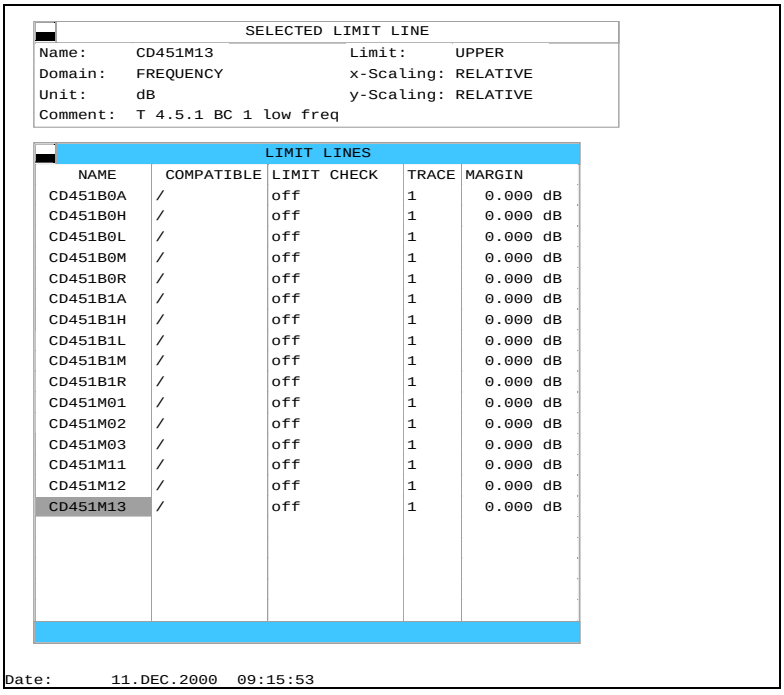
See Section 12.2.2.4 of the WinIQSIM User Guide for a detailed description of the various parameters.

## Loading and Using the Spurious Limits

The procedure for uploading the limit lines to the FSIQ is as follows:

1. Copy the file called “CDMA2000.LIA” enclosed with this Application Note onto a diskette.
2. Insert the diskette into the FSIQ’s drive.
3. Use **[MEMORY – RECALL]** to start input of the loading parameters.
4. Select [SELECT ITEMS TO RECALL] – [DISABLE ALL ITEMS].
5. Move the cursor to “LINES”, click on a units button (e.g. **[Hz]**) to confirm and use **[CLR]** to exit the submenu.
6. Use **[^]** to return to the next highest level.
7. Click on [EDIT PATH] and type “A:\”, then click on **[Hz]** to confirm.
8. Click on [EDIT NAME] and type in “CDMA2000”.
9. Click on **[Hz]** to load the limit lines.

After loading the limit lines, use **[LINES – LIMITS]** to open the table of limit lines. The list shown here will appear on the screen:




- You can activate or deactivate lines by moving the cursor to the entry of your choice in the left column and clicking on a units button (e.g. **[Hz]**).
- You can switch the limit check on or off by moving the cursor to the appropriate entry in the “LIMIT CHECK” column and clicking on a units button (e.g. **[Hz]**).

# 9 Frequently Asked Questions

Some frequently asked questions relating to the generation and measurement of cdma2000 signals are answered below:

- **Why is it that I cannot run CDP measurement? *PN Correlation Error* appears on the screen, and all channels show the same power.**
  - Is RF power applied?
  - Is there a cdma2000 signal?
  - Are I and Q swapped? (Make sure that “IQ SWAP” is activated on the SMIQ and in WinIQSim – this parameter is under “VECTOR MOD” on the SMIQ).
- **Why does measurement stop sporadically with a *PN Correlation Error* message, and the timing error is much too high?**

  Connect a frame trigger to the trigger input of the FSIQ and switch to the external trigger setting. The frame trigger can be provided externally (by the base station for example), or it can be generated by the AMIQ via one of the 4 marker outputs. You must open the “AMIQ – Marker Setting” menu in WinIQSIM and select “Frame Clock” for the channel in question.
- **Why is it that code power of the unused channels is too high, and Bad S/N Warning is issued?**
  - The send signal is being filtered by a reverse filter. In WinIQSIM, switch to the filter for cdma2000 1x Forward Link.
- **Why is it that I cannot find a cdma2000 reverse filter in WinIQSIM: I can find only “CDMA2000 1x” and “CDMA2000 1x + Equalizer (LEVM)”**

  The standard is open to interpretation in this respect, and for this reason there is no reverse filter as such, only a forward filter and an equalizer filter that is used in conjunction with the forward filter in the reverse link. Consequently, you should use the following
  – “CDMA2000 1x + Equalizer (LEVM)” for the forward link
  – “CDMA2000 1x” for the reverse link.
- **Why is it that when I set a fading speed of 30 km/h, the SMIQ switches to 30.002 km/h?**

  The speed is set in steps and the width of the steps in which the fading simulator can be set depends on the RF frequency, so in some instances the specified speed cannot be set exactly. When this happens the fading processor selects the value closest to the specified speed.
- **Why are there so many filter selections in WinIQSIM for cdmaOne and cdma2000?**

  The cdmaOne and cdma2000 standards recommend forward and reverse link filters. However, many manufacturers have elected to use custom filters to optimize adjacent channel performance. These filters can cause degradation of IQ waveform quality, resulting in higher Error Vector Magnitude. Rohde-Schwarz has created filters for WinIQSIM that are optimized for best ACPR performance when used for ACPR measurements, and also includes the standards-defined EVM optimized filters. It is recommended that EVM optimized filters be used when creating signals for vector signal evaluation. WinIQSIM can also be used to create manufacturer-specific filters for proprietary applications.

# 10 Appendix

## Abbreviations

| Abbreviation | Meaning |
|---|---|
| **DS** | Direct Sequence – mode of accessing the air interface |
| **MC** | Multi Carrier – mode of accessing the air interface |
| **RC** | Radio Configuration – assignment of codes to classes |
| **FL** | Forward Link – base station -> mobile terminal |
| **RL** | Reverse Link – mobile terminal -> base station |
| **CDMA** | Code Division Multiple Access |
| **BC** | Band Class – classification by frequency ranges |
| **CCDF** | Complementary Cumulative Distribution Function |
| **ACP** | Adjacent Channel Power |

## Enclosed WinIQSIM Files

| File name | File description |
|---|---|
| ForMod01.iqs | Forward Channel 1x DS, F-PICH |
| ForMod02.iqs | Forward Channel 1x DS, F-PICH + F-SYNC (0 dBr) |
| ForACP.iqs | Forward Channel 3x MC, 6 channels on |
| RevMod01.iqs | Reverse Channel 1x DS, R-PICH |
| RevMod02.iqs | Reverse Channel 1x DS, R-PICH + R-FCH (0 dBr) |
| RevMod03.iqs | Reverse Channel 1x DS, R-PICH + R-FCH (-7,5 dBr) |
| RevMod04.iqs | Reverse Channel 1x DS, R-PICH + R-FCH + R-SCH1 (same power for all) |
| RevACP.iqs | Reverse Channel 3x DS, 6 channels on |
| BSModel.iqs | Base Station Test Model according to standard (TIA/EIA-97-C, Section 6.5.2) |

In order to generate a correct cdma2000-signal, please make sure that IQSWAP is selected in both WinIQSim and the SMIQ (in the sub-menu **[VECTOR MOD]**).

# 11 Literature

- *Digital standards IS-95 and CDMA2000 – Supplement to SMIQ, AMIQ and WinIQSIM,* **PD 757.5908.21**
- *cdmaOne Base Station Tests – Application Firmware Module FSIQK71,* Operation Manual, **1126.4498.02**
- *Recommended Minimum Performance Standard for Base Stations Supporting Dual-Mode Spread Spectrum Cellular Mobile Stations,* **ANSI/TIA/EIA-97-C**
- *Recommended Minimum Performance Standards for Dual-Mode Spread Spectrum Mobile Stations,* **TIA/EIA-98-C**
- *Physical Layer Standard for cdma2000 Spread Spectrum Systems,* **IS-2000-2**

# 12 Ordering Information

| | | |
|---|---|---|
| **Modulation generator** | | |
| AMIQ **and** | Max. 16 Msamples I and Q | 1110.2003.04 |
| AMIQ-K12 | cdma2000 option | 1122.2503.02 |
| **Or** | | |
| SMIQ-B60 **and** | Max. 512 Ksamples I and Q | 1136.4390.02 |
| SMIQ-K12 | cdma2000 option | 1105.0435.02 |
| WinIQSIM (Version 3.50 or later) | IQ simulation software | 1110.3600.02 |
| **Vector signal generator** | | |
| SMIQ02B | 0.3...2.2 GHz | 1125.5555.02 |
| SMIQ03B | 0.3...3.3 GHz | 1125.5555.03 |
| SMIQ04B | 0.3...4.4 GHz | 1125.5555.04 |
| SMIQ06B | 0.3...6.4 GHz | 1125.5555.06 |
| SMIQ-B14 | Fading Simulator | 1085.4002.02 |
| **Signal analyzer and options** | | |
| FSIQ3 | 20 Hz... 3.5 GHz | 1119.5005.13 |
| FSIQ7 | 20 Hz... 7 GHz | 1119.5005.17 |
| FSIQ26 | 20 Hz... 26.5 GHz | 1119.6001.27 |
| FSIQ40 | 20 Hz... 40 GHz | 1119.6001.40 |
| FSIQK71 | cdmaOne BTS test | 1126.4498.02 |
| **or / and** | | |
| FSP3 | 9 kHz... 3 GHz | 1093.4495.03 |
| FSP7 | 9 kHz... 7 GHz | 1093.4495.07 |
| FSP13 | 9 kHz... 13 GHz | 1093.4495.13 |
| FSP30 | 9 kHz... 30 GHz | 1093.4495.30 |

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