

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.



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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	1x	1x	1x	1x	1x	3x	3x	3x	3x	
R	FL	1x	1x	1x	1x	1x	3x	3x	----	----	----
	RL	1x	1x	1x	1x	1x	3x	3x	----	----	----
Mod.	FL	1/2	1/2	1/4	1/2	1/4	1/6	1/8	1/4 / 1/8	1/2 / 1/8	
	RL	1/3	1/2	1/4	1/4	1/4	1/4	1/4	----	----	----
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 = 1/2 2) with R = 1/3 3) with R = 1/2

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 <i>ksamples</i>	16 <i>Msamples</i>
Memory depth [frames] ²⁾	1 ... 2	1 ... 40
Chip rate ³⁾	1 <i>kcps</i> ... 40 <i>Mcps</i>	10 <i>cps</i> ... 100 <i>Mcps</i>
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	
	FL	RL	forward	reverse	Forward		Reverse		FSIQ	FSP
					1x DS	3x MC+DS	1x DS	3x DS		
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 range 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

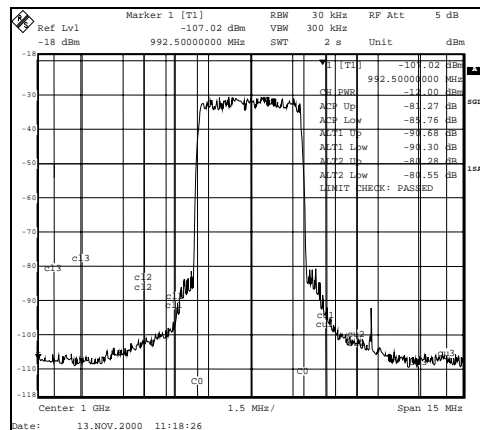


Fig. 5-1 ACP measurement for SR3 and DS

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

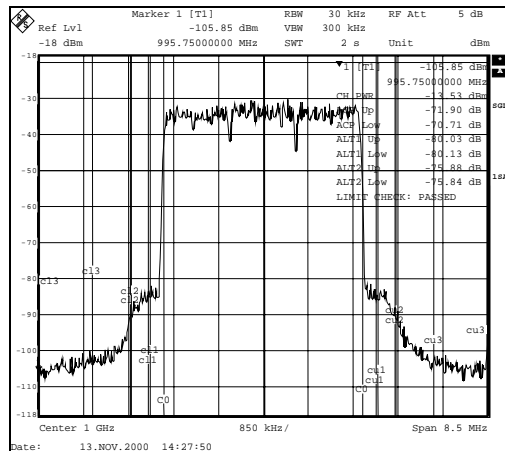


Fig. 5-2 ACP measurement for SR3 and MC

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 yourself 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]	-∞	-3.125	-1.98	+0,75	+1.98	+3.125	Limit
Lower [MHz]	-3.125	-1.98	0.75	+1.98	+3.125	+ ∞	
< 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]	-∞	-2.25	-1.98	+0,885	+1.98	+2.25	Limit
Lower [MHz]	-2.25	-1.98	0.885	+1.98	+2.25	+ ∞	
< 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].

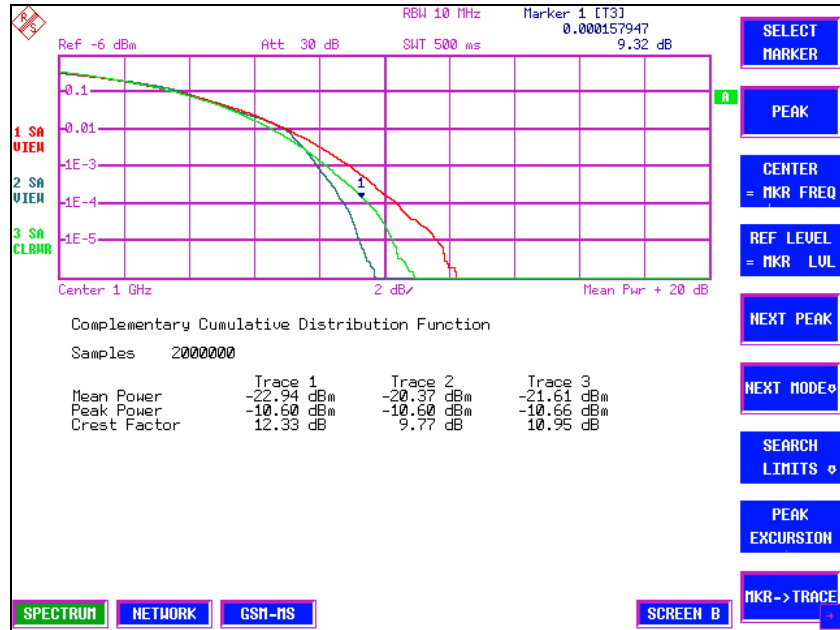


Fig. 5-3 CCDF measurement with the FSP

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

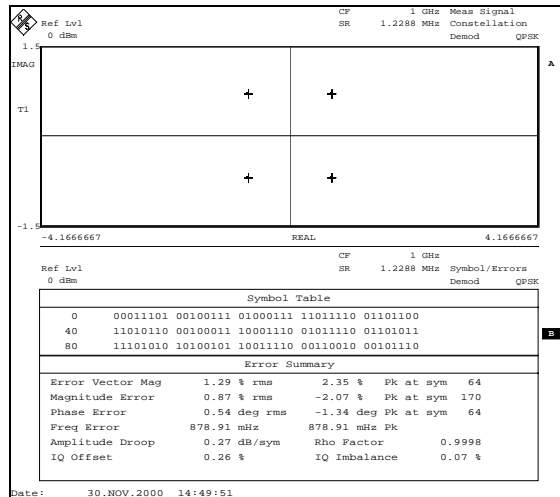


Fig. 5-4 Modulation Quality – F-PICH

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

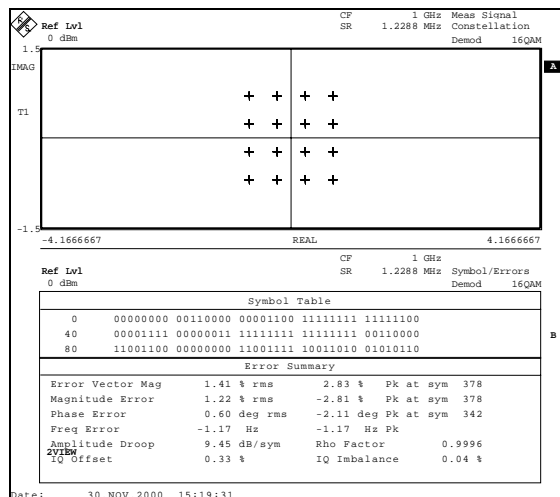


Fig. 5-5 Modulation Quality – F-PICH + F-SYNC

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

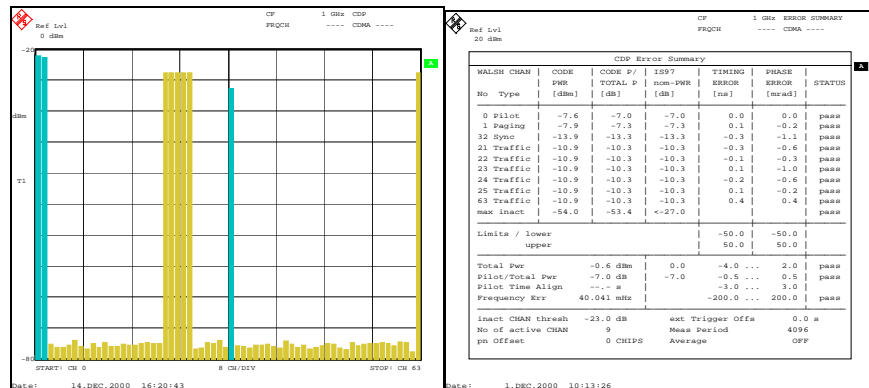


Fig. 5-6 CDP and error summary standard test model

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]	-∞	-3.125	-1.98	+0,85	+1.98	+3.125
Lower [MHz]	-3.125	-1.98	0.85	+1.98	+3.125	+ ∞
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]	-∞	-2.25	-1.98	+1,25	+1.98	+2.25
Lower [MHz]	-2.25	-1.98	-1.25	+1.98	+2.25	+ ∞
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

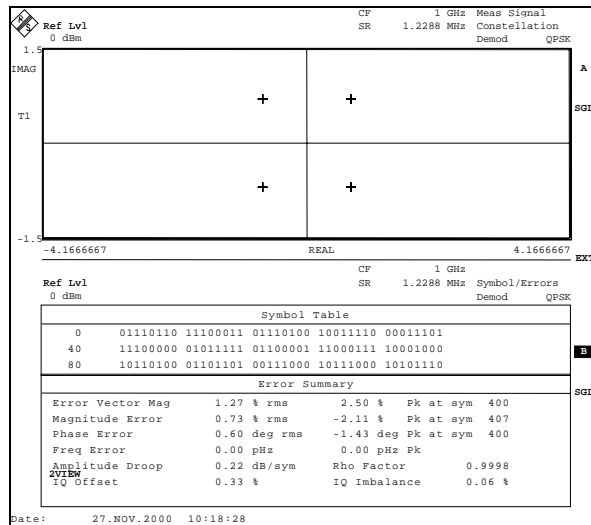


Fig. 6-1 Modulation Quality – R-PICH

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

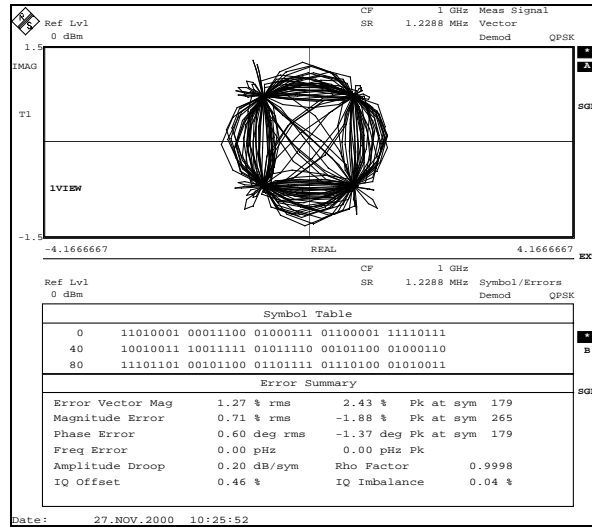


Fig. 6-2 Modulation Quality – R-PICH + R-FCH (1)

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

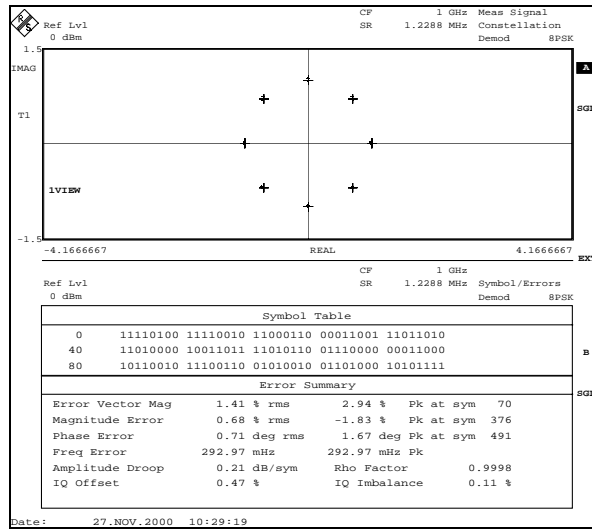


Fig. 6-3 Modulation Quality – R-PICH + R-FCH (2)

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

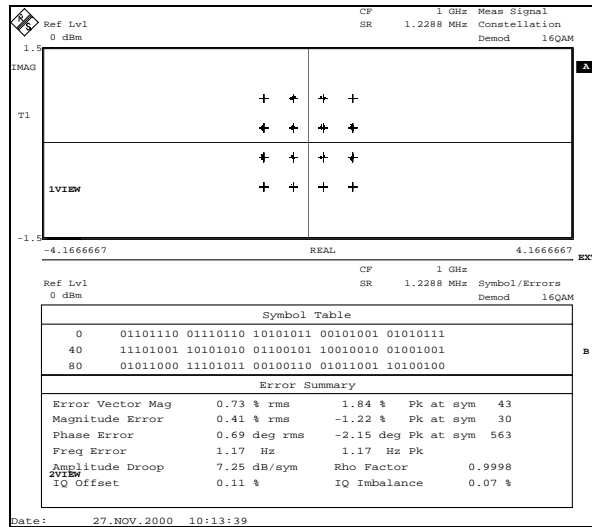


Fig. 6-4 Modulation Quality – R-PICH + R-FCH + R-SCH 1

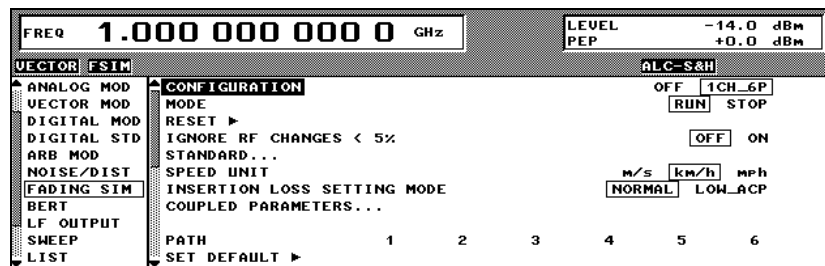
7 Measurements under Fading Conditions using SMIQ-B14

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	---	---	---

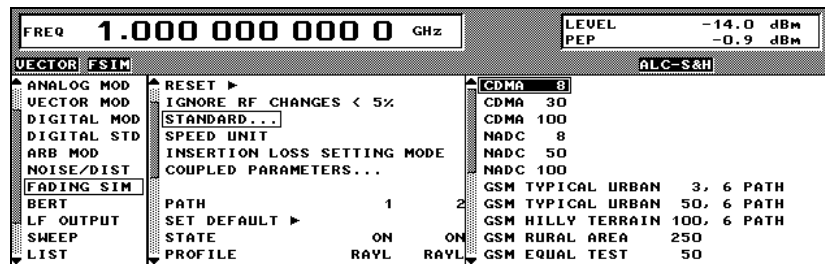
General Settings



Configurations

Configuration I

This configuration corresponds to the predefined standard "CDMA 8":



Configuration II

This configuration corresponds to the predefined standard "CDMA 30":

FREQ 1.000 000 000 0 GHz		LEVEL 0.0 dBm	PEP 0.0 dBm
UECTOR	EXT-REF	ALC-S&H	
DIGITAL STD	CONFIGURATION	CDMA 8	
ARB MOD	MODE	CDMA 30	
NOISE/DIST	RESET ▶	CDMA 100	
FADING SIM	IGNORE RF CHANGES < 5%	NADC 8	
BERT	STANDARD...	NADC 50	
LF OUTPUT	SPEED UNIT	NADC 100	
SWEEP	INSERTION LOSS SETTING MODE	GSM TYPICAL URBAN 3, 6 PATH	
LIST	COUPLED PARAMETERS...	GSM TYPICAL URBAN 50, 6 PATH	
MEM SEQ	PATH 1 2	GSM HILLY TERRAIN 100, 6 PATH	
UTILITIES	SET DEFAULT ▶	GSM RURAL AREA 250	
HELP		GSM EQUAL TEST 50	

Configuration III

This configuration corresponds to the predefined standard "CDMA 100":

FREQ 1.000 000 000 0 GHz		LEVEL -14.0 dBm	PEP +0.0 dBm
UECTOR FSIM	ALC-S&H		
DIGITAL STD	CONFIGURATION	CDMA 8	
ARB MOD	MODE	CDMA 30	
NOISE/DIST	RESET ▶	CDMA 100	
FADING SIM	IGNORE RF CHANGES < 5%	NADC 8	
BERT	STANDARD...	NADC 50	
LF OUTPUT	SPEED UNIT	NADC 100	
SWEEP	INSERTION LOSS SETTING MODE	GSM TYPICAL URBAN 3, 6 PATH	
LIST	COUPLED PARAMETERS...	GSM TYPICAL URBAN 50, 6 PATH	
MEM SEQ	PATH 1 2	GSM HILLY TERRAIN 100, 6 PATH	
UTILITIES	SET DEFAULT ▶	GSM RURAL AREA 250	
HELP		GSM EQUAL TEST 50	

Configuration IV

This configuration has to be set manually:

FREQ 1.000 000 000 0 GHz		LEVEL -14.0 dBm	PEP -0.9 dBm
UECTOR FSIM	ALC-S&H		
DIGITAL STD	PATH 1 2 3 4 5 6		
ARB MOD	STATE ON ON OFF OFF OFF OFF		
NOISE/DIST	PROFILE pDOPP pDOPP RAYL RAYL RAYL RAYL		
FADING SIM	DISCRETE COMP ON ON OFF OFF OFF OFF		
BERT	FREQ RATIO 0.00 0.00		
LF OUTPUT	SPEED 72.000 72.000 72.000 72.000 72.000 72.000 km/h		
SWEEP	DOPPLER FREQ 66.7 66.7 66.7 66.7 66.7 66.7 Hz		
LIST	PATH LOSS 0.0 0.0 0.0 0.0 0.0 0.0 dB		
MEM SEQ	DELAY 0.00 2.00 0.00 0.00 0.00 0.00 μs		
UTILITIES			
HELP			

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:

FREQ 1.000 000 000 0 GHz		LEVEL -14.0 dBm	PEP -0.9 dBm
UECTOR FSIM	ALC-S&H		
DIGITAL STD	PATH 1 2 3 4 5 6		
ARB MOD	STATE ON ON OFF OFF OFF OFF		
NOISE/DIST	PROFILE RAYL RAYL RAYL RAYL RAYL RAYL		
FADING SIM	DISCRETE COMP OFF OFF OFF OFF OFF OFF		
BERT	SPEED 30.002 30.002 72.000 72.000 72.000 72.000 km/h		
LF OUTPUT	DOPPLER FREQ 27.8 27.8 66.7 66.7 66.7 66.7 Hz		
SWEEP	PATH LOSS 0.0 0.0 0.0 0.0 0.0 0.0 dB		
LIST	DELAY 0.00 2.00 0.00 0.00 0.00 0.00 μs		
MEM SEQ			
UTILITIES			
HELP			

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:

FREQ		1.000 000 000 0 GHz						LEVEL	-14.0 dBm
								PEP	-0.9 dBm
VECTOR	FSIM	ALC-S&H							
DIGITAL STD	PATH	1	2	3	4	5	6		
ARB MOD	STATE	ON	ON	OFF	OFF	OFF	OFF		
NOISE/DIST	PROFILE	RAYL	RAYL	RAYL	RAYL	RAYL	RAYL		
FADING SIM	DISCRETE COMP	OFF	OFF	OFF	OFF	OFF	OFF		
BERT									
LF OUTPUT									
SWEEP									
LIST	SPEED	14.000	14.000	72.000	72.000	72.000	72.000	km/h	
MEM SEQ	DOPPLER FREQ	13.0	13.0	66.7	66.7	66.7	66.7	Hz	
UTILITIES	PATH LOSS	0.0	0.0	0.0	0.0	0.0	0.0	dB	
HELP	DELAY	0.00	2.00	0.00	0.00	0.00	0.00	µs	

8 Notes

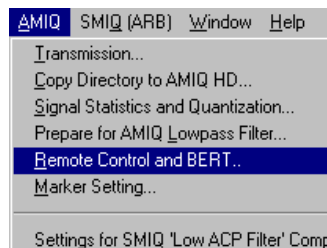
Enabling the WinIQSIM Option for cdma2000

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:

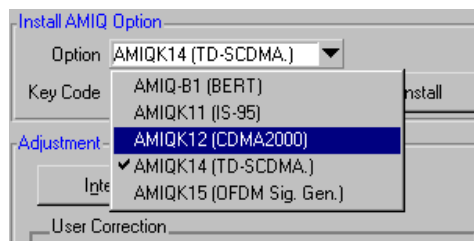
1. Open the dialog box for remote control of the AMIQ:



2. Select "Test and Adjustment":



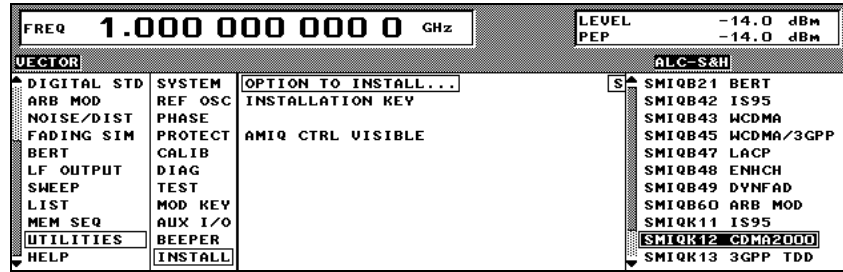
3. Select the cdma2000 option "AMIQ-K12":



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:

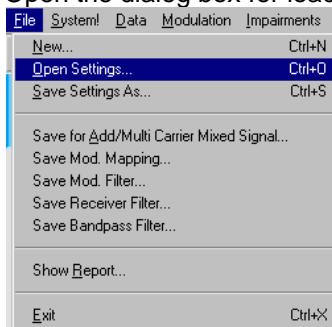


Enter the installation key.

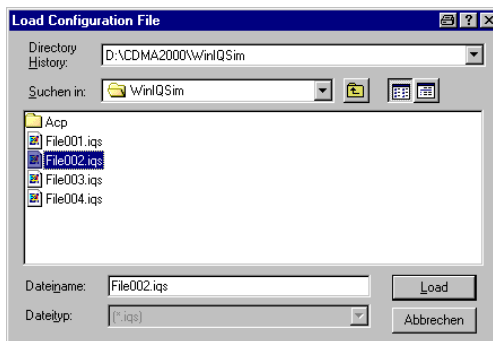
Loading WinIQSIM Files onto the AMIQ

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:

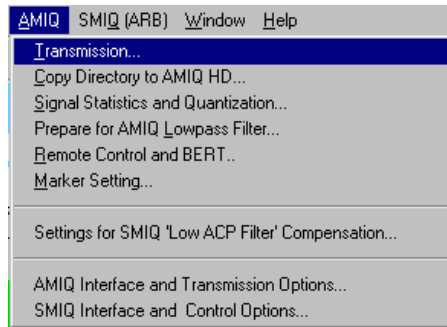
1. Open the dialog box for loading settings:



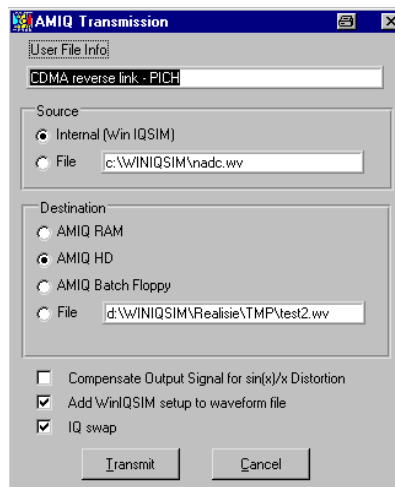
2. Select the appropriate file:



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.

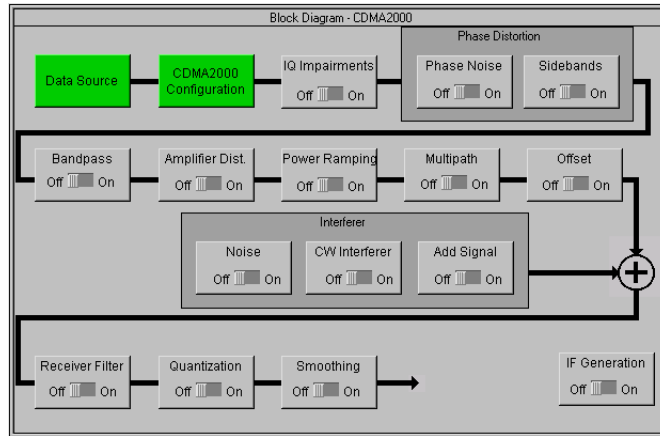
- "Destination – AMIQ HD": The waveform is copied onto the hard disk.

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

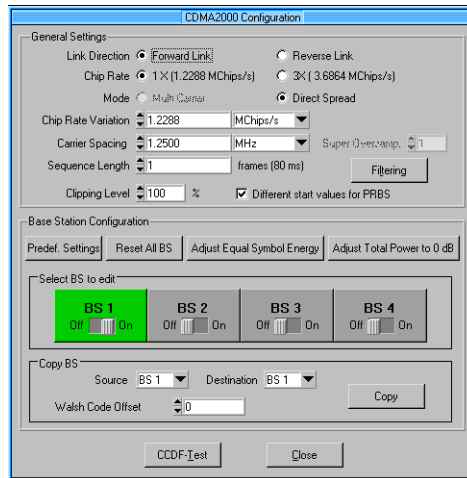
Straightforward Setups in WinIQSIM

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

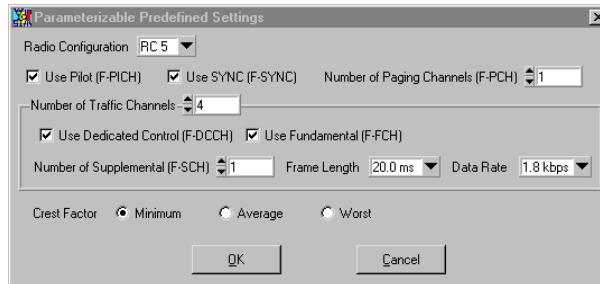
1. Select “CDMA2000 Configuration” from the Block Diagram window:



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:

SELECTED LIMIT LINE					
Name:	CD451M13	Limit:	UPPER		
Domain:	FREQUENCY	x-Scaling:	RELATIVE		
Unit:	dB	y-Scaling:	RELATIVE		
Comment:	T 4.5.1 BC 1 low freq				

LIMIT LINES					
NAME	COMPATIBLE	LIMIT CHECK	TRACE	MARGIN	
CD451B0A	/	off	1	0.000 dB	
CD451B0H	/	off	1	0.000 dB	
CD451B0L	/	off	1	0.000 dB	
CD451B0M	/	off	1	0.000 dB	
CD451B0R	/	off	1	0.000 dB	
CD451B1A	/	off	1	0.000 dB	
CD451B1H	/	off	1	0.000 dB	
CD451B1L	/	off	1	0.000 dB	
CD451B1M	/	off	1	0.000 dB	
CD451B1R	/	off	1	0.000 dB	
CD451M01	/	off	1	0.000 dB	
CD451M02	/	off	1	0.000 dB	
CD451M03	/	off	1	0.000 dB	
CD451M11	/	off	1	0.000 dB	
CD451M12	/	off	1	0.000 dB	
CD451M13	/	off	1	0.000 dB	

Date: 11.DEC.2000 09:15:53

- 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 AMIQ-K12	Max. 16 Msamples I and Q cdma2000 option	1110.2003.04 1122.2503.02
Or		
SMIQ-B60 and SMIQ-K12	Max. 512 Ksamples I and Q cdma2000 option	1136.4390.02 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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