

Rohde & Schwarz® Products: AMIQ, SMIQ, FSP, FSU, FSQ  
SMIQ-B14, SMIQ-B17, SMIQ-B60, SMIQ-K12, AMIQ-K12, FS-K82

# cdma2000® Base Station Test with R&S® Equipment

## Application Note

This Application Note describes measurements compliant with the cdma2000 base station standard described in 3GPP2 C.S0010 / TIA/EIA-97 / ARIB STD-T64-C.S0010.

The primary focus is on solutions for generating and analyzing cdma2000 signals. The special characteristics that make the selected signal generators and signal analyzers eminently suitable for this purpose are detailed, and remote control programming is demonstrated by a free of charge program.

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## **1. Overview, cdma2000 lower layer test basics**

cdma2000 as described by Third Generation Partnership 2 (3GPP2) is an access method 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 provides a brief introduction to the cdma2000 standard. However its main focus is on solutions for generating and analyzing cdma2000 signals using equipment from Rohde & Schwarz. The features that make R&S SMIQ Vector Signal Generator and R&S AMIQ I/Q Modulation Generator and the R&S FSP and R&S FSU Spectrum Analyzers and R&S FSQ Signal Analyzer eminently suitable for this purpose are detailed.

Each measurement as described in the standard 3GPP2 C.S0010-A is shown, special implementation hints are given, and typical measurement results are presented as instrument screenshots.

The application note covers receiver and transmitter tests according to

- 3GPP2 C.S0010
- TIA/EIA-97 and
- ARIB STD-T64-C.S0010.

Additionally, a small free of charge test sequencer software (called "GDE") is included to show the necessary IEEE bus commands, and to run all cdma2000 tests for demonstration and evaluation.

The following abbreviations are used in this application note for R&S test equipment:

- The R&S SMIQ Vector Signal Generator is referred to as SMIQ.
- The R&S SMIQ-B60 Arbitrary Waveform Generator option is referred to as SMIQ-B60.
- The R&S AMIQ I/Q Modulation Generator is referred to as AMIQ.
- The R&S ABFS Baseband Fading Simulator is referred to as ABFS.
- The R&S FSP and FSU Spectrum Analyzer are referred to as FSP and FSU.
- The R&S FSQ Signal Analyzer is referred to as FSQ.
- FSP, FSU and FSQ in general is referred to as FSx.
- The R&S NRP Power Meter is referred to as NRP.

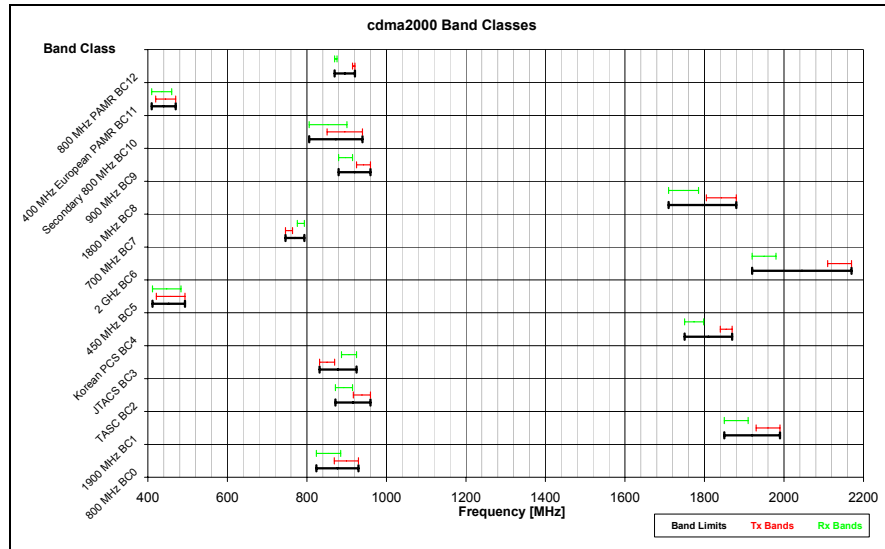
### **Frequency Allocation**

Due to local regulations, there are 13 different band classes defined in the cdma2000 standard.

The frequency ranges and parameters are listed in the table below:

## cdma2000 BS Measurement According to C.S0010-A

Band Class	Tx-Rx Spacing	Channel Spacing	Transm Test for BS	CDMA Channel Number	CDMA Frequency [MHz]
0 (800 MHz Band)	+45 MHz	30 kHz	MS Receiver	1 .. N .. 799	825,0300 ... 884,9700
				991 .. N .. 1023	824,0400 ... 825,0000
			BS Transm	1 .. N .. 799	870,0300 ... 929,9700
1 (1900 MHz Band)	+80 MHz	50 kHz	MS Receiver	0 .. N .. 1199	1850,0000 ... 1909,9500
				0 .. N .. 1199	1930,0000 ... 1989,9500
			BS Transm	0 .. N .. 1000	889,9875 ... 914,9875
2 (TACS Band)	+45 MHz	25 kHz	MS Receiver	1329 .. N .. 2047	872,0125 ... 889,9625
				0 .. N .. 1000	934,9875 ... 959,9875
			BS Transm	1329 .. N .. 2047	916,9625 ... 934,9625
3 (JTACS Band)	-55 MHz (only even N allowed)	25 kHz	MS Receiver	1 .. N .. 799	915,0125 ... 924,9875
				801 .. N .. 1039	898,0125 ... 900,9875
				1041 .. N .. 1199	887,0125 ... 888,9875
			BS Transm	1201 .. N .. 1600	893,0125 ... 898,0000
				1 .. N .. 799	860,0125 ... 869,9875
				801 .. N .. 1039	842,0125 ... 845,9875
4 (Korean PCS Band)	+90 MHz	50 kHz	MS Receiver	0 .. N .. 599	1750,0000 ... 1797,9500
				0 .. N .. 599	1840,0000 ... 1869,9500
			BS Transm	1 .. N .. 300	450,0250 ... 457,4750
5 (450 MHz Band)	+10 MHz	25 kHz	MS Receiver	539 .. N .. 871	411,6750 ... 419,9750
				1039 .. N .. 1473	451,3100 ... 459,9900
		1792 .. N .. 2016		479,0000 ... 483,4800	
		BS Transm	1 .. N .. 300	460,0250 ... 467,4750	
			539 .. N .. 871	421,6750 ... 429,9750	
			1039 .. N .. 1473	461,3100 ... 469,9900	
1792 .. N .. 2016	489,0000 ... 493,4800				
6 (2 GHz Band)	+190 MHz	50 kHz	MS Receiver	0 .. N .. 1199	1920,0000 ... 1979,9500
			BS Transm	0 .. N .. 1199	2110,0000 ... 2169,9500
7 (700 MHz Band)	-30 MHz	50 kHz	MS Receiver	0 .. N .. 359	776,0000 ... 793,9500
			BS Transm	0 .. N .. 359	746,0000 ... 763,9500
8 (1800 MHz Band)	+95 MHz	50 kHz	MS Receiver	0 .. N .. 1499	1710,0000 ... 1784,9500
			BS Transm	0 .. N .. 1499	1805,0000 ... 1879,9500
9 (900 MHz Band)	+45 MHz	50 kHz	MS Receiver	0 .. N .. 699	880,0000 ... 914,9500
			BS Transm	0 .. N .. 699	925,0000 ... 959,9500
10 (Secondary 800 MHz Band)	+45 MHz +39 MHz	25 kHz	MS Receiver	0 .. N .. 719	806,0000 ... 823,9750
				720 .. N .. 919	896,0000 ... 900,9750
			BS Transm	0 .. N .. 719	851,0000 ... 868,9750
				720 .. N .. 919	935,0000 ... 939,9750
11 (400 MHz European PAMR Band)	+10 MHz	25 kHz	MS Receiver	1 .. N .. 400	450,0000 ... 459,9750
				1001 .. N .. 1400	410,0000 ... 419,9750
			BS Transm	1 .. N .. 400	460,0000 ... 469,9750
				1001 .. N .. 1400	420,0000 ... 429,9750
12 (800 MHz PAMR Band)	+45 MHz	25 kHz	MS Receiver	0 .. N .. 239	870,0125 ... 875,9875
			BS Transm	0 .. N .. 239	915,0125 ... 920,9875



For each band class, different subclasses and blocks are defined.

Not every frequency channel is used. For detailed information, please refer to the standard ([5], Chapter 3.1).

## **Channel guide**

cdma2000 defines several channels, new compared to IS-95, for accessing the Physical Layer via the MAC Layer. The following list summarises then channels and their function. For detailed informations, please refer to standard C.S0003-C: "Medium Access Control (MAC) Standard for cdma2000 Spread Spectrum Systems".

- **Pilot and Sync Channels**  
Pilot channels are used to synchronize between mobile and base station (F/R-PICH), implementation of transmit diversity (F-TDPICH, F-ATDPICH), and improved mobil synchronization (F-APICH). Additional information like system time and PN Codes are transmitted using the Sync Channel (F-SYNCH).
- **Common Control Channels**  
Transport forward and reverse informations (F/R-CCCH) that are not assigned to a dedicated traffic channel.
- **Traffic Channels**  
The primary traffic takes place on the Fundamental Channels (F/R-FCH) and the Supplemental Code Channels (F/R-SCCH). For high Radio Configurations, the Supplemental Channels (F/R-SCH) can also be used.  
Special messages during a call are transmitted using a Dedicated Control Channel (F/R-DCCH).
- **Paging and Broadcast Channels**  
Paging Channel (F-PCH) for standard demands and additionally Quick Paging Channel (F-QPCH) to indicate configuration changes quickly are used by cdma2000.  
For broadcast purpose (e.g. SMS), a Broadcast Control Channel (F-BCCH) is provided.
- **Access Channels**  
Used to initiate a call and get a base station slot. Channels used are Access Channel (R-ACH) and Enhanced Access Channel (R-EACH).

## **Data Rate and Chip Rate, Radio Configuration**

cdma2000 is based on Code Domain Multiple Access (CDMA) on the air interface. This means that 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.

cdma2000-1 is compatible with cdmaOne and supports only Direct Sequence (DS) access at 1.2288 Mchips/s.

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:

## cdma2000 BS Measurement According to C.S0010-A

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	1/2	1/2	1/4	1/2	1/4	1/6	1/8	1/4 or 1/8	1/2 or 1/8
	RL	1/3	1/2	1/4	1/4	1/4	1/4	---	---	---
Mod	FL	BPSK	BPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK	QPSK
	RL	64-array	64-array	BPSK	BPSK	BPSK	BPSK	---	---	---
1200	FL+RL			RL		RL				
1350				RL		RL				
1500				FL+RL	FL	RL	FL	FL		
1800			FL+RL		RL	FL	RL		FL	FL
2400	FL+RL			RL		RL				
2700				FL+RL	FL	RL	FL	FL		
3600			FL+RL		RL	FL	RL		FL	FL
4800	FL+RL			FL+RL	FL	RL	FL	FL		
7200				FL+RL	RL	FL	RL		FL	FL
9600	FL+RL W64			FL+RL W64	FL W128	RL	FL W128	FL W256		
14400				FL+RL W64	RL	FL W64	RL		FL W128	FL W256
19200				FL+RL W32	FL W64	RL	FL W64	FL W128		
28800					RL	FL W32	RL		FL W64	FL W128
38400				FL+RL W16	FL W32	RL	FL W32	FL W64		
57600					RL	FL W16	RL		FL W32	FL W64
76800				FL+RL W8	FL W16	RL	FL W16	FL W32		
115200					RL	FL W8	RL		FL W16	FL W32
153600				FL+RL W4	FL W8	RL	FL W8	FL W16		
230400					RL	FL W4	RL		FL W8	FL W16
307200				RL 1)	FL W4	RL 2)	FL W4	FL W8		
460800							RL		FL W4	FL W8
614400						RL 2)		FL W4		
1036800							RL 1)			FL W4

FL: Forward Link, RL: Reverse Link  
SR: Symbol Rate, R: Rate of the code  
Mod: Modulation, W: Walsh code, x: Chips/Sample

1) R=1/2  
2) R=1/3  
3) R=1/2

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](http://www.rohde-schwarz.com)).

## Test Models and Test Signals

cdma2000 describes some basic test signal configurations like a nominal base station model, pilot or access channel only, ....

Typical test files are provided as WinIQSIM setting files (\*.iqs) and waveform files (\*.vv) which can be uploaded via the demo software direct into an AMIQ modulation generator (using software option AMIQ-K12) or SMIQ signal generator (using software option SMIQ-K21). The SMIQ must include the optional Arbitrary Waveform Generator (SMIQ-B60).

### BS Test Model

The nominal test model is defined for testing the Tx part of the Base Station (BS). The model 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 %	-13.3 dB	$W_1^{64}$
Sync (F-SYNC)	1	18.82 %	-7.3 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.

This signal is normally generated by the base station, so the BS Test Model file is only used if the capabilities of the signal analyser need to be demonstrated using SMIQ and a cdma2000 signal.

The signal must be generated by the base station for tests 4.2.1.2, 4.2.1.3, 4.3.1, 4.3.2, 4.4.1, 4.4.3 and 4.4.4.

#### Provided test signal (1xBsMod.iqs / 1xBsMod.vv)

The test file provided has F-PICH, F-PCH, F-SYNC, F-FCH and 5 F-SCH as active channels, 1 frame, oversampling 2.

### F-PICH only

The F-PICH configuration is used for basic BS transmitter test (test 4.1.2 and 4.2.2).

The signal constellation is equal to a simple QPSK because only 1 channel is active.

This signal is normally generated by the base station, so the BS Test Model file is only used if the capabilities of the signal analyser need to be demonstrated using SMIQ and a cdma2000 signal.

The signal must be generated by the base station for tests 4.1.2 and 4.2.2.



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### **Provided test signal (1xPilot.iqs / 1xPilot.wv)**

The test signal provided has F-PICH as active channel, 1 frame, oversampling 2.

### **R-ACH only**

The R-ACH configuration is used to test the Access Probe Acquisition capability of the BS (test 3.2).

### **Provided test signal (1xRACH.isq / 1xRACH.wv)**

The test file provided has the R-ACH as active channel, 1 frame, oversampling 2.

### **R-CCCH only**

R-CCCH only is used to test the demodulation performance of the BS in the presence of noise and fading (test 3.3.1 and 3.3.2).

### **Provided test file (1xRCCCH.iqs / 1xRCCCH.wv)**

The test file provided has 1 R-CCCH as active channel, configured with 20 ms frame length and 19.2 kbps data rate.

## **FCH / Fundamental Channel Test Modes**

The Fundamental Channel Test Modes are used to generate traffic on the channel and measure BER under various conditions like fading or noise.

The standard defines 9 different test modes with additional options for each test mode.

The 9 different test modes describe different configurations of the different so called "Service Options" of cdma2000 (Loopback, Test Data and Markov).

There are different multiplex options, transmission rates and traffic types for each model and each service option.

Please refer to standards C.S0013, C.S0025 and C.S0026 ([7]..[9]) for the different service option configurations.

The Forward Channel Test Mode signal must be generated by the Base Station for tests 4.2.3 and 4.3.3.

The Reverse Channel Test Mode signal must be generated by the Mobile Station Simulator for tests 3.4.x, 3.5.x and 3.7.

### **Provided test file (1xFFCH1.iqs / 1xFFCH1.wv)**

The test file provided is equal to Forward Fundamental Channel Test Mode 1, LSO, Service Option 2, and has F-PICH and 1 F-FCH as active channel, configured with 20 ms frame length and 9.6 kbps data rate.

### **Provided test file (1xRFCH1.iqs / 1xRFCH1.wv)**

The test file provided is equal to Reverse Fundamental Channel Test Mode 1, LSO, Service Option 2, and has 1 R-FCH as active channel, configured with 20 ms frame length and 9.6 kbps data rate.

## **cdma2000 BS Measurement According to C.S0010-A**

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### **Test Modes**

For receiver test purpose, a number of test modes are defined in the standard. The tables below summarise the different settings.

Test Mode	Forward Traffic Channel Radio Configuration			Reverse Traffic Channel Radio Configuration		
	Fundamental	Supplemental	Dedicated Control	Fundamental	Supplemental	Dedicated Control
1	SO 2 / 54 / 55	SO 30		SO 2 / 54 / 55	SO 30	
		RC1			RC1	
2	SO 9 / 54 / 55	SO 31		SO 9 / 54 / 55	SO 31	
		RC2			RC2	
3	SO 32 / 54 / 55	SO32	SO32	SO 32 / 54 / 55	SO32	SO32
		RC3			RC3	
4	SO 32 / 54 / 55	SO32	SO32	SO 32 / 54 / 55	SO32	SO32
		RC4			RC3	
5	SO 32 / 54 / 55	SO32	SO32	SO 32 / 54 / 55	SO32	SO32
		RC5			RC4	
6	SO 32 / 54 / 55	SO32	SO32	SO 32 / 54 / 55	SO32	SO32
		RC6			RC5	
7	SO 32 / 54 / 55	SO32	SO32	SO 32 / 54 / 55	SO32	SO32
		RC7			RC5	
8	SO 32 / 54 / 55	SO32	SO32	SO 32 / 54 / 55	SO32	SO32
		RC8			RC6	
9	SO 32 / 54 / 55	SO32	SO32	SO 32 / 54 / 55	SO32	SO32
		RC9			RC6	

Table 1 – Test Modes and Service Options / Radio Configurations

Service Option	Type	Forward Channel				Reverse Channel			
		Multiplex Option	RC	Transmission Rate	Traffic Type	Multiplex Option	RC	Transmission Rate	Traffic Type
SO2	Loopback	0x01	1	1, 1/2, 1/4 or 1/8	Primary Traffic on F-FCH	0x01	1	1, 1/2, 1/4 or 1/8	Primary Traffic on R-FCH
SO9	Loopback	0x02	2	1, 1/2, 1/4 or 1/8	Primary Traffic on F-FCH	0x02	2	1, 1/2, 1/4 or 1/8	Primary Traffic on R-FCH
SO30	Loopback	0x03	1	1, 1/2, 1/4 or 1/8	Primary Traffic on F-SCCH	0x01	1	1, 1/2, 1/4 or 1/8	Primary Traffic on R-FCH
SO31	Loopback	0x04	2	1, 1/2, 1/4 or 1/8	Primary Traffic on F-SCCH	0x02	2	1, 1/2, 1/4 or 1/8	Primary Traffic on R-FCH
SO32	Test Data	0x01 0x02	various	channel dependant	various	0x01 0x02	various	channel dependant	various
SO54	Markov	0x01 0x02	1,3,4,6,7 2,5,8,9	1, 1/2, 1/4 or 1/8	Primary Traffic on F-FCH	0x01 0x02	1,3,5 2,4,6	1, 1/2, 1/4 or 1/8	Primary Traffic on R-FCH
SO55	Loopback	0x01 0x02	1,3,4,6,7 2,5,8,9	1, 1/2, 1/4 or 1/8	Primary Traffic on F-FCH	0x01 0x02	1,3,5 2,4,6	1, 1/2, 1/4 or 1/8	Primary Traffic on R-FCH

Table 2 – Details for Service Options

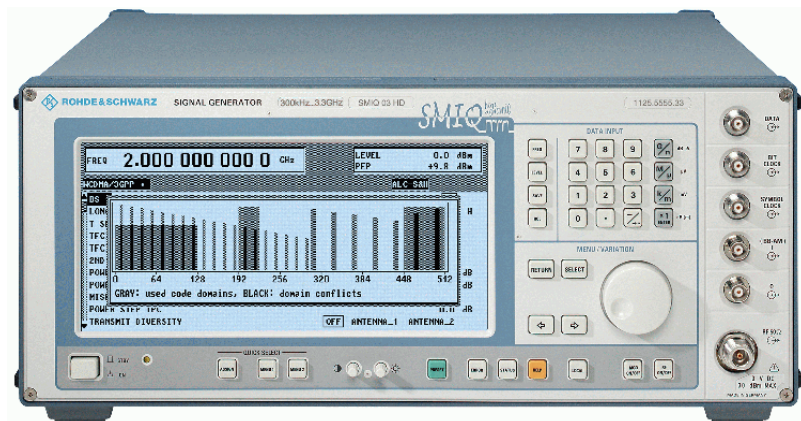
For more details, please refer to the related standard documents as mentioned in the reference list at the end of this application note.

## 2. Rohde & Schwarz Solutions for cdma2000 BS tests

The following chapter gives an overview of the available R&S instruments for cdma2000 testing and the necessary instruments as required in the standard.

### Signal Generators

**SMIQ** vector signal generators are particularly suitable for generating cdma2000 signals. As an SMIQ is equipped with high-performance modulators, the baseband signal input to an SMIQ is modulated with minimal distortion into the RF band.



SMIQ can also be used for channel simulation, as a result of the wide range of options such as a fading simulator and an 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 Error Vector Magnitude (EVM) and Adjacent Channel Power (ACP) are characteristic of this solution.

The **AMIQ** I/Q 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.



## cdma2000 BS Measurement According to C.S0010-A

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

Parameter	SMIQ + SMIQ-B60	SMIQ + AMIQ <sup>1)</sup>
Frequency range	300 kHz ... 6.4 GHz	300 kHz ... 6.4 GHz
Level range	-140 ... +13 dBm PEP	-140 ... +13 dBm PEP
Max. waveform length [frames] <sup>2)</sup>	512 <i>ksamples</i> 1 ... 2	16 <i>Msamples</i> 1 ... 40
Nonvolatile memory	1.441.594	approx. 8.000.000.000
Chip rate <sup>3)</sup>	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

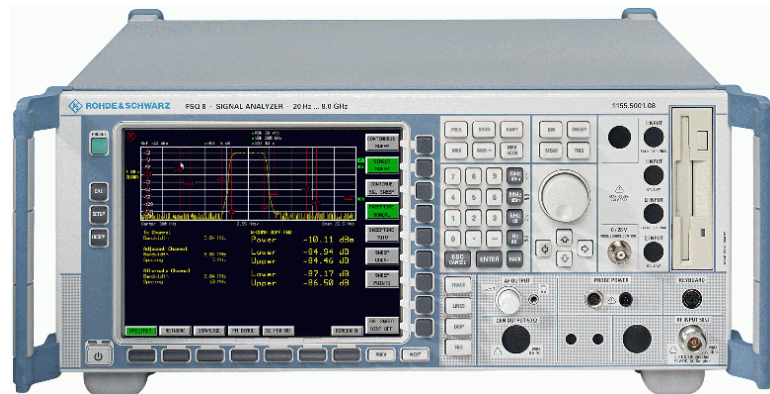
2) Frames with 80 ms, 1x DS mode

3) Oversampling 2 is sufficient for SMIQ-B60 due to the hardware filter, AMIQ requires >4 oversampling

## Signal Analyzers

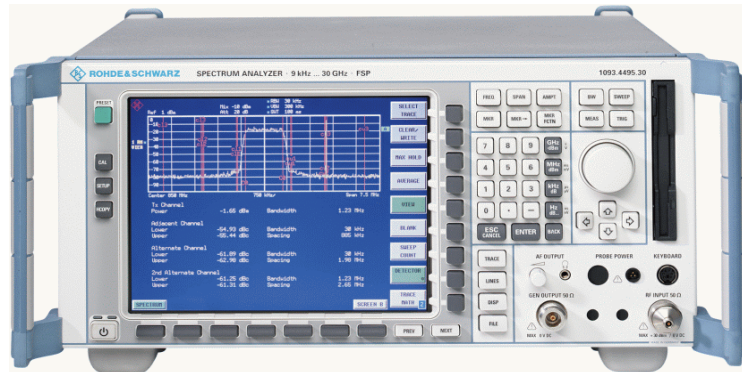
There is a choice of 3 devices for signal analysis:

- For a high-performance cdma2000 code domain analysis, either the **FSQ** signal analyzer or the FSU spectrum analyzer is an ideal choice. It offers both excellent dynamic range and comprehensive modulation-analysis capability including **Code Domain Power (CDP)** using option FS-K82 and **CCDF measurement** capability.



- When highest performance 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. With option FS-K82, the FSP also provides Code Domain Power analysis and has nearly the same software capabilities as an FSU or FSQ (number of slots and EVM performance is slightly different).

## cdma2000 BS Measurement According to C.S0010-A



- The **FSIQ** signal analyzer can complete all the spectrum measurements plus **modulation analysis** and **Code Domain Power (CDP)** measurement for IS95 signals which are a subset of cdma2000. cdmaOne measurements with FSIQ are not discussed in this Application Note. Please refer to 1MA34 ([1]) for a detailed description on cdma2000 measurements with FSIQ.

## Other Instruments

- To set up the exact power at the BS Rx port, Power Meter **NRP** in combination with Power Sensor **NRP-Z11** is ideal for this purpose.



- For measurements on the cdma2000 Mobile Stations (MS), you can use **CMU200** Universal Radio Communication Tester in combination with **CMU-B83** (cdma2000 signaling unit) and **CMU-K83 .. 87** (software personalities for different cdma2000 band classes).

## **Instruments as required in the standard**

The following paragraph describes the necessary instruments according to the Standard ([5], Chapter 6.4 - Standard Test Equipment) and the corresponding Rohde & Schwarz instruments:

### **Channel Simulation (Chapter 6.4.1)**

The channel simulator applies different fading profiles to the signal in order to test the receiver part of the base station.

The hardware option **SMIQ-B14** (fading simulator) for **SMIQ** can generate all the required fading profiles quickly and easily.

If only baseband fading is required, an **ABFS** Baseband Fading Simulator can be used to generate fading in the IQ domain.

### **Waveform Quality Measurement (Chapter 6.4.2)**

This calculates the difference between the ideal and the measured signal in a vector oriented way (I and Q components) and calculates parameters like the rho factor or the phase error. The calculation is done in IQ or code domain.

The software option **FS-K82** (cdma2000 personality) for **FSQ / FSU / FSP** is the ideal instrument for this kind of measurement task. It provides automatic channel detection, fast measurement in the code domain and many different functions to evaluate cdma2000 signals.

### **Mobile Station Simulator (Chapter 6.4.3)**

The simulator provides a signal to the Rx port of the base station under test for FER measurement or power measurement tests.

An **SMIQ** Signal Generator, incorporating with the hardware option **SMIQ-B60** (arbitrary waveform generator) and the software option **SMIQ-K12** (cdma2000 signal generation) or the **AMIQ** I/Q modulation generator and the software option **AMIQ-K12** (cdma2000 signal generation), can generate all types of cdma2000 signal for 1x or 3x mode. It provides flexible signal setup for all parameters.

Please note that an SMIQ is NOT capable to perform an FER (Frame Error Rate) or BER (Bit Error Rate) measurement of a cdma2000 signal. For FER and BER measurement, the base station must provide a "service mode" to make the FER and BER measurement in the base station.

### **AWGN Generator (Chapter 6.4.4)**

The AWGN generator simulates additive noise which is generated in reality by different sources like other base stations or poor amplifiers.

The hardware option **SMIQ-B17** (noise and distortion simulator) for SMIQ can generate all the required types of noise with fast setup time and very good settability and gain flatness.

If only baseband noise generation is required, an ABFS Baseband Fading Simulator with the **ABFS-B1** Noise Generator option can be used in conjunction to generate noise in the IQ domain.

### **CW Generator (Chapter 6.4.5)**

The CW generator is used to generate a CW signal which may perhaps mix with local base station oscillator frequencies and fall into the receiver band of the base station. This may cause interference that leads to decreased BER or FER performance.

You may use a high performance CW generator from R&S like **SMIQ** or **SMV** to generate the CW signal.

### **Spectrum Analyzer (Chapter 6.4.6)**

The spectrum analyzer is used to make power and spurious signal measurements.

You may use any R&S spectrum analyzer like the **FSP**, **FSU** or **FSQ**. In combination with the cdma2000 personality **FS-K82**, this is the ideal choice to make cdma2000 transmitter measurements and evaluate receiver spurious signals.

### **Average Power Meter (Chapter 6.4.7)**

The average power meter is used to measure the exact input power at the BS Rx port. This is important because minute discrepancies in the level can result in high BER and FER changes.

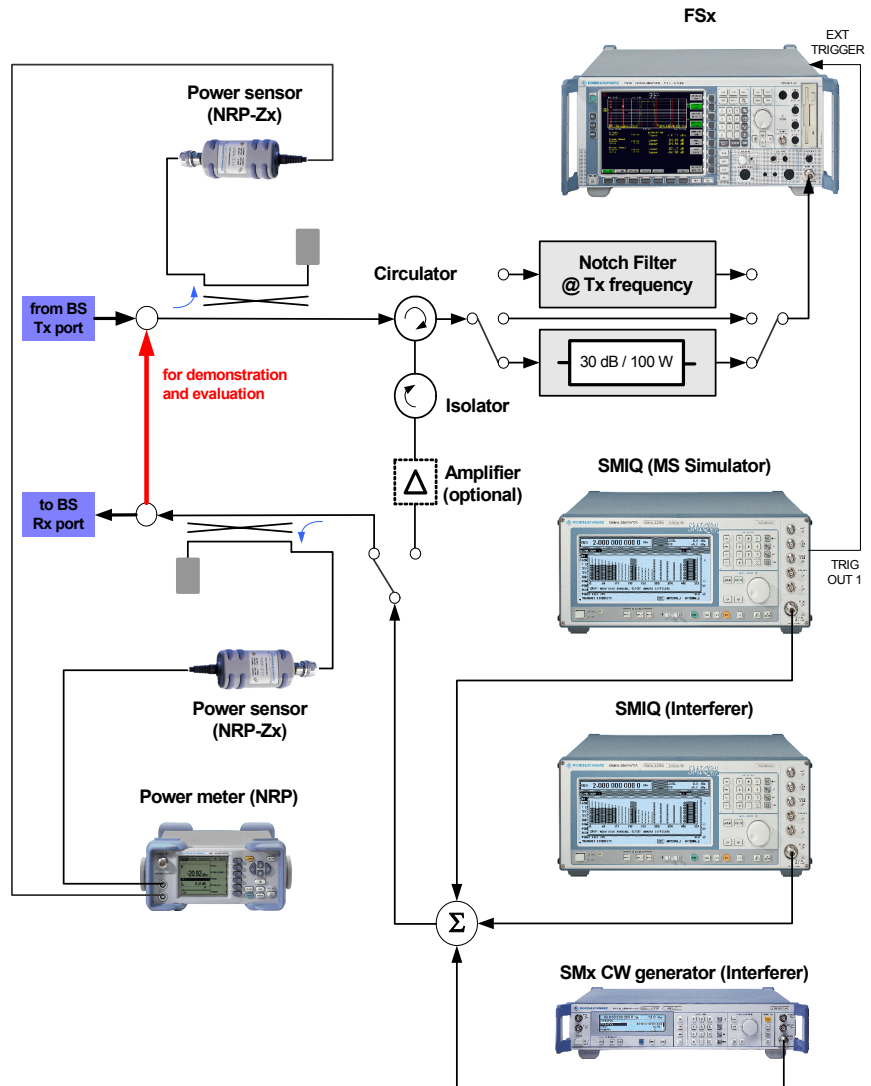
The Power Meter **NRP** used in conjunction with the Power Sensor **NRP-Z11** is ideal for this purpose. It offers a innovative multipath sensor technology, 90 dB dynamic range, high measurement speed and accurate measurement results regardless of bandwidth and modulation.

You can use the NRP-Z11 in combination with the basic instrument NRP or connect it to your PC direct via USB bus (using option **NRP-Z3** or **NRP-Z4**).

## Complete test setup

The following overview shows a recommended complete test setup for cdma2000 BS tests.

For each individual test, only a part of the components is used. Please refer to the corresponding chapter in order to check which instruments are necessary.





## **Test and demo software**

This application note comes with a small demo program called "GDE" (=Generic Demonstration Engine) which is free of charge.

Each test described in this application note can be executed fast and easy using the demo program. Results and test times can be evaluated with a single mouse click.

The program offers an easy-to-use User Interface, benchmarking and IEEE command sequence export functions to integrate the programming code in any user-specific test environment.

### **NOTE - Demonstration:**

To demonstrate or evaluate the functions of the instruments, please connect the SMIQ Vector Signal Generator direct to the FSx Signal Analyzer via the RF port.  
Please connect also option SMIQ-Z5 (BNC Adapter for rear panel) to the SMIQ and connect TRIG OUT 1 to EXT TRIGGER of FSx in order to demonstrate e.g. trigger to sync measurement.

## **PC Requirements**

**Minimum** requirements to run GDE on your PC:

- **Operating system:**  
Windows 95 / 98 / NT 4.0 / 2000 / Me / XP
- **Generic PC requirements:**
  - Pentium 133 MHz
  - 32 MByte
  - 10 MByte free harddisc space
  - VGA monitor
- **IEC/IEEE bus interface:**  
Rohde & Schwarz IEEE-488.2 bus interface PS-B4, 1006.6207.04, or National Instruments GPIB card

**Recommended** system configuration:

- **Operating system:**  
Windows 98 / 2000 / Me / XP  
Microsoft Internet Explorer 5.0 or higher
- **Generic PC requirements:**
  - Pentium II 450 MHz or higher
  - 128 MByte
  - 50 MByte free harddisc space (to store WV files and test cases)
  - XGA monitor (1024x768)
- **IEC/IEEE bus interface:**  
National Instruments GPIB card, driver software version 1.7 or higher

## **Installation**

The file 1MA61\_<Version Number>.EXE is required to install the sequencer GDE and the cdma2000 test cases on the controlling PC.

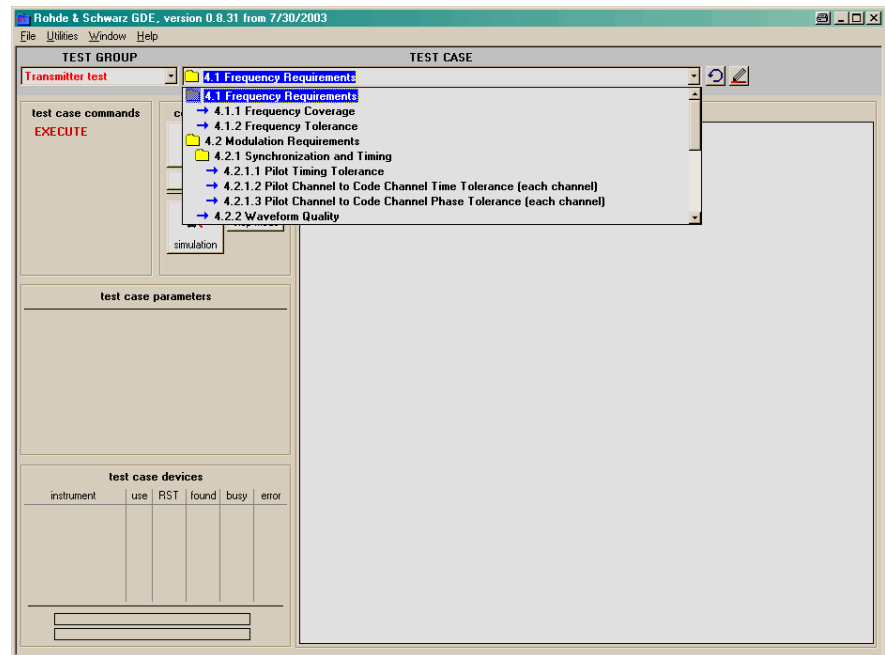
Execute the installation program and select the installation directory. During installation, program files are copied to a directory of your choice. A new menu item "R&S cdma2000 Tests" is created in the START menu of your windows system.

### Getting started

When started the first time, you are requested to register.

We kindly ask you to register GDE. Registration is free of charge and does not obligate you or your company. The unregistered version has full functionality and no expiration date.

Please follow the instructions on the screen in order to register GDE. After clicking "Continue" or entering Name and Key, the user interface will come up:



- You can select between Transmitter and Receiver Tests or load all required test files for transmitter or receiver tests to SMIQ-B60 Arbitrary Waveform Generator. Select the feature you want to use with the "TEST GROUP" list box.
- Each test described in this application note is listed in the list box "TEST CASE".
- When selected, you can set up all required parameters ("TEST CASE PARAMETERS")
- Tests are always divided into Configuration and Measurement. Use the buttons in the TEST CASE COMMANDS frame to start the individual test steps.
- Results and messages are displayed in the RESULT SUMMARY frame.

For details about information and installation please refer to the manual of GDE or use the online manual by pressing the <F1>-key in GDE.

### 3. cdma2000 Receiver Minimum Requirements

#### General aspects

- **Waveform files**  
Because the waveform files which must be loaded to the AMIQ / SMIQ-B60 are quite large and need about 40 seconds to transfer, please run the loading routine in the GDE first and start the required test afterwards.  
All IEEE example files use SMIQ-B60 because this is a one-box solution and sufficient for all tests.
- **Frequencies**  
The supplied IEEE example sequences are independent from the band class. Select any frequency for both signal generator and spectrum analyser. Please select the proper frequencies for the band class to test.  
If test setups are different to for different band classes, band classBC 0 is used.
- **Test signals**  
If a test requires more than one test model or signal configuration to be set up and measured, the test sequences are only built up for one test model (usually the first mentioned in the standard). Additional test models can be added very easily by using another test signal file.
- **Levels**  
Levels for generator and analyzer are set for demonstration purpose. You can connect them via a normal RF cable and get the best performance values.  
If other requirements need to be met, please set the levels in the demonstration program according to your needs.
- **Demonstration / Evaluation**  
To evaluate the capabilities of the instruments without a BS under test, please connect a signal analyzer or a spectrum analyzer (R&S FSx) instead of the BS to show the generated receiver test signals.  
Detailed information can be found in the table at the beginning of each test.

## Using the power meter in the Rx tests

All Rx measurements (except tests 3.1 and 3.6.x) require a power meter to measure the power at the Rx port of the BS.

Because of the high accuracy of the SMIQ signal generator and the built-in attenuator, it is not necessary to use a power meter for setting up the output power of the mobile station simulator.

The following instructions outline the use of the power meter for special lab applications where a real mobile station simulator should be used.

The standard requires a dynamic range of 117 dB (-70 .. +47 dBm) for the power sensor. This can not be measured with any existing power sensor.

But it is very easy to extend the dynamic range by simply adding additional attenuators to the setup:

The basic setup direct at the Rx port of the base station is shown in this picture:

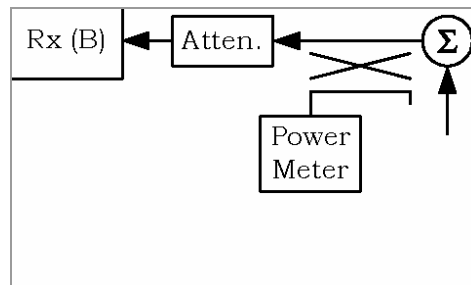


Figure – Power Meter setup

The dynamic range of the NRP-Z11 Power Meter is -67..+23 dBm = 90 dB.

- In order to extend the dynamic range to measure the HIGHEST specified power (+47 dBm), insert a 30 dB attenuator direct before the power meter. This will lead to a dynamic range of -36 .. +53 dBm and meet the specifications of +47 dBm as highest power. (You could also use a 20 dB attenuator in combination with a 3 dB attenuator (to meet the requirements more exactly) resulting in a dynamic range of -44 .. +46 dBm)
- In order to extend the dynamic range to measure the LOWEST specified power (-70 dBm), insert a additional 6 dB attenuator between the BS Rx port and the already inserted attenuator. This will lead to a dynamic range of -73 .. +17 dBm and meet the specifications of -70 dBm as lowest power.

The basic value of the attenuation between the mobile station simulator and the Rx port of the BS is not defined in the standard.

The use of the power meter is the same for all Rx test (measure the power and adjust the MS simulator), so the example sequences do not use the NRP power sensor.

## Instruments and Signal list

The lists below show all the measurements for receiver tests and the required instruments and signals (for the purpose of measurement and evaluation):

## cdma2000 BS Measurement According to C.S0010-A

Class	Number	Measurement	Conf	Instruments needed														
				RF generator			cdma2000 SW		CW source		Spectrum analyzer					cdma2000 SW		
				SMIQ	SMIQ-B17 (noise)	SMIQ-B14 (fading)	SMQB60 SMIQ-K12	AMIQ AMIQ-K12	R&S CW generator	R&S CW generator	FSQ	FSU	FSP	FSIQ	R&S SA	FS K82	FSIQ K71	
Receiver test	3.1	Frequency Coverage Requirements	---	---			---		---		---					---		
	3.2	Access Probe Acquisition	1	☑	☑		☑		---		---					---		
	3.3	<i>R-CCCH Demodulation Performance</i>																
	3.3.1	Performance in Additive White Gaussian Noise	1	☑	☑		☑		---		☞	☞	☞	☞	☞			
	3.3.2	Performance in Multipath Fading with Closed Loop Power Control	2	☑	☑	☑	☑		---		☞	☞	☞	☞	☞			
	3.4	<i>R-Traffic Channel Demodulation Performance</i>																
	3.4.1	Performance in Additive White Gaussian Noise	1	☑	☑		☑		---		☞	☞	☞	☞	☞			
	3.4.2	Performance in Multipath Fading without Closed Loop Power Control	2	☑	☑	☑	☑		---		☞	☞	☞	☞	☞			
	3.4.3	Performance in Multipath Fading with Closed Loop Power Control	2	☑	☑	☑	☑		---		☞	☞	☞	☞	☞			
	3.5	<i>Receiver Performance</i>																
	3.5.1	Receiver Sensitivity	1	☑			☑		---		☞	☞	☞	☞	☞			
	3.5.2	Receiver Dynamic Range	1	☑			☑		---		☞	☞	☞	☞	☞			
	3.5.3	Single Tone Desensitization	3	☑			☑	☑		---		☞	☞	☞	☞	☞		
	3.5.4	Intermodulation Spurious Response Attenuation	4	☑			☑	☑	☑	---		☞	☞	☞	☞	☞		
	3.5.5	Adjacent Channel Selectivity <sup>1)</sup>	8	☑			☑		---		☞	☞	☞	☞	☞			
	3.6	<i>Limitations on Emissions</i>																
	3.6.1	Conducted Spurious Emissions	any	---			---		---		☺	☺	☺	☺	☺	---		
	3.6.2	Radiated Spurious Emissions	any	---			---		---		☺	☺	☺	☺	☺	---		
	3.7	Receiver Signal Quality Indicator (RSQI)	1	☑	☑		☑		---									

- ☑ needed for the measurement (exact this one)
- ☺ can do the measurement (one of them)
- ☞ needed for demonstration
- not used

1) 2 x cdma2000 generators needed

Conf Functional Setup according to Standard Chapter 6.5.1

Table 3 – Required Instruments for cdma2000 receiver tests

**cdma2000 BS Measurement According to C.S0010-A**

Class	Number	Measurement	Measurement																			
			R-ACH	SR1 R-EACH	SR3 R-EACH	SR1 R-CCCH	SR3 R-CCCH	all Fundamental CTM	all Dedicated Control CTM	all Supplemental CTM	all Supplemental Code CTM	Fundamental Traffic CTM 1	Fundamental Traffic CTM 2	Fundamental Traffic CTM 3	Fundamental Traffic CTM 5	Fundamental Traffic CTM 7	Fundamental Traffic CTM 9	Dedicated Control CTM 3	Dedicated Control CTM 5	Dedicated Control CTM 7	Dedicated Control CTM 9	
Receiver test	3.1	Frequency Coverage Requirements	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	3.2	Access Probe Acquisition	X	X	X																	
	3.3	<i>R-CCCH Demodulation Performance</i>																				
	3.3.1	in Additive White Gaussian Noise				X	X															
	3.3.2	in Multipath Fading with Closed Loop Power Control				X	X															
	3.4	<i>R-Traffic Channel Demodulation Performance</i>																				
	3.4.1	in Additive White Gaussian Noise						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	3.4.2	in Multipath Fading without Closed Loop Power Control						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	3.4.3	in Multipath Fading with Closed Loop Power Control						X	X	X	X	X	X	X	X	X	X	X	X	X	X	X
	3.5	<i>Receiver Performance</i>																				
	3.5.1	Receiver Sensitivity										X	X	X	X	X	X	X	X	X	X	X
	3.5.2	Receiver Dynamic Range										X	X	X	X	X	X	X	X	X	X	X
	3.5.3	Single Tone Desensitization										X	X	X	X	X	X	X	X	X	X	X
	3.5.4	Intermodulation Spurious Response Attenuation										X	X	X	X	X	X	X	X	X	X	X
	3.5.5	Adjacent Channel Selectivity										X	X	X	X	X	X	X	X	X	X	X
	3.6	<i>Limitations on Emissions</i>																				
	3.6.1	Conducted Spurious Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	3.6.2	Radiated Spurious Emissions	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--	--
	3.7	Receiver Signal Quality Indicator (RSQI)										X	X	X	X	X	X	X	X	X	X	X

CTM    Channel Test Mode  
X       Used  
x       Used (all CTM's)

Table 4 – Required Test Signals for cdma2000 receiver tests

(refer to "Test Models and Test Signals" for a more detailed description of the test signals)

### **3.1 Frequency Coverage Requirements**

<b>Purpose</b>	<b>Basic instrument</b>	<b>Options</b>	<b>Used to</b>
<i>measurement</i>	---	---	BS software setup only
<i>+ demonstration</i>	---	---	---

#### **Test purpose**

The cdma2000 BS must cover the assigned frequency range and be able to receiver the dedicated cdma2000 channels.

#### **Test method**

There are no measurements necessary here because this is a software setup in the BS.

#### **Test implementation hints**

---

#### **Remote Control Programming Example**

Because this is only a software test for the BS, there is no IEEE example provided for this test.

#### **Typical Measurement Result**

This is only a software setup of the BS, so no special measurements need to be made here.



### 3.2 Access Probe Acquisition

Purpose	Basic instrument	Options	Used to
measurement	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate required cdma2000 signal (MS simulator) <b>signal type: access channel</b>
		SMIQ-B17	add AWGN signal <b>signal type: noise</b>
	NRP + NRP-Z11	---	measure BS Rx port input power
+ demonstration	FSP, FSU or FSQ	optional FS-K82	show spectrum overview

#### Test purpose

The Access test computes the probability for the MS to access the BS with a paging action in the presence of noise.

#### Test method

The function setup for this test is shown below:

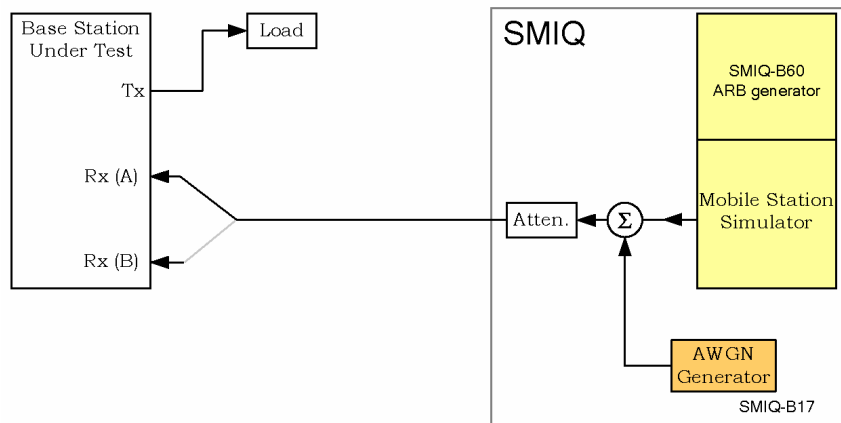


Fig. 3.2.1 - Access Probe Acquisition Test Setup

The test must be performed for all supported band classes and for Access Channel (R-ACH) and Enhanced Access Channel (R-EACH) in both 1x and 3x mode.

### Test implementation hints

- **Signal power:**  
The MS simulator signal power is defined as a minimum noise power value and a specific  $E_b / N_0$  value. So, the total input power as the BS Rx input can be selected freely.
- **Notation of noise level:**  
In other standards, AWGN scenarios are described by the total output power of the signal source and the  $E_b / N_0$  value.  
The cdma2000 standard specifies the spectral density of the AWGN generator and the  $E_b / N_0$  value for each test. The signal power for the cdma2000 signal source must be calculated from these two values.

### Remote Control Programming Example

The Remote Control Programming Example will:

- generate the R-ACH signal using SMIQ and SMIQ-B60
- adjust the noise level to the value as required in the standard
- show both the noise-free and noise-added signal using 2 traces on the spectrum analyzer in frequency domain mode.  
(for demonstration purposes only)

### Typical measurement result

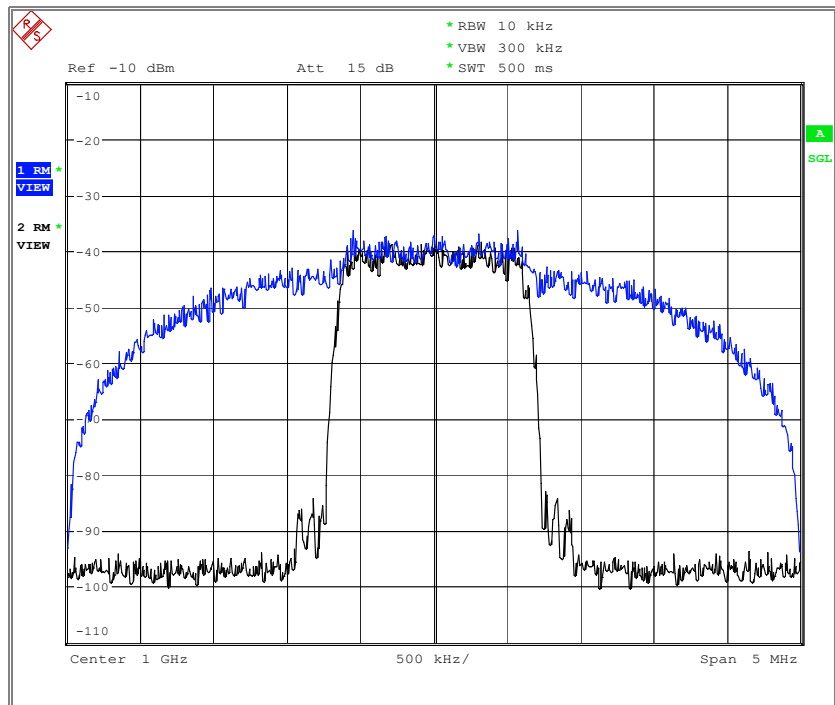


Fig. 3.2 – Access Probe Acquisition measurement result

### 3.3 R-CCCH Demodulation Performance

#### 3.3.1 Performance in AWGN

Purpose	Basic instrument	Options	Used to
measurement	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate required cdma2000 signal (MS simulator) <b>signal type: R-CCCH</b>
		SMIQ-B17	add AWGN signal <b>signal type: noise</b>
	NRP + NRP-Z11	---	measure BS Rx port input power
+ demonstration	FSP, FSU or FSQ	optional FS-K82	show spectrum overview

#### Test purpose

The tests verify that the BS has proper demodulation performance for the Reverse Common Control Channel (R-CCCH) in an AWGN (no fading or multipath) environment by calculating the Frame Error Rate (FER).

#### Test method

The function setup for this test is shown below:

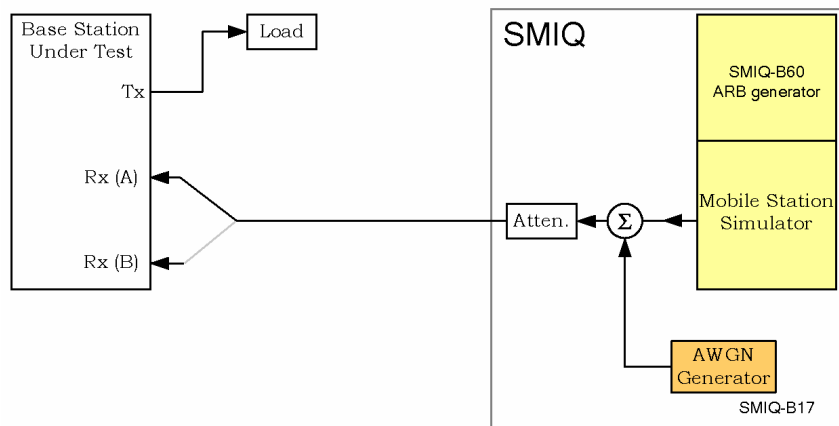


Fig. 3.3.1.1 - R-CCCH Demodulation Performance - AWGN Test Setup

The test describes 6 different test scenarios with different data rates and frame lengths, and specifies a lower and upper FER level for a certain  $E_b / N_0$  for each scenario. The corresponding  $E_b / N_0$  values are in the range between 3.1 and 4.6 dB.

Each test scenario must be run for each supported spreading rate (1 and/or 3).

### **Test implementation hints**

- **Signal power:**  
The MS simulator signal power is defined as a noise power value and a specific  $E_b / N_0$  value. So, the total input power as the BS Rx must be calculated from these two values.
- **FER calculation**  
The frame error rate (FER) must be calculated by the BS using its own test capabilities.
- **Call setup**  
Because SMIQ can't set up a call using the e.g. Enhanced Access channel, the BS must be set in a proper mode by specific service options.
- **Notation of noise level:**  
Other standards AWGN scenarios are described by the total output power of the signal source and the  $E_b / N_0$  value.  
The cdma2000 standard specifies the spectral density of the AWGN generator and the  $E_b / N_0$  value for each test. The signal power for the cdma2000 signal source must be calculated from these two values.

### **Remote Control Programming Example**

The Remote Control Programming Example will:

- generate an R-CCCH signal using SMIQ and SMIQ-B60 (19.2 kbps, 20 ms frame)
- adjust the noise level to the maximum and minimum value as required in the standard  
(values are taken from standard table A.2.1-1.)
- show the 3 traces (noise-free, upper and lower noise level signal) using 3 traces on the spectrum analyzer in frequency domain mode.  
(for demonstration purposes only)

Typical measurement result

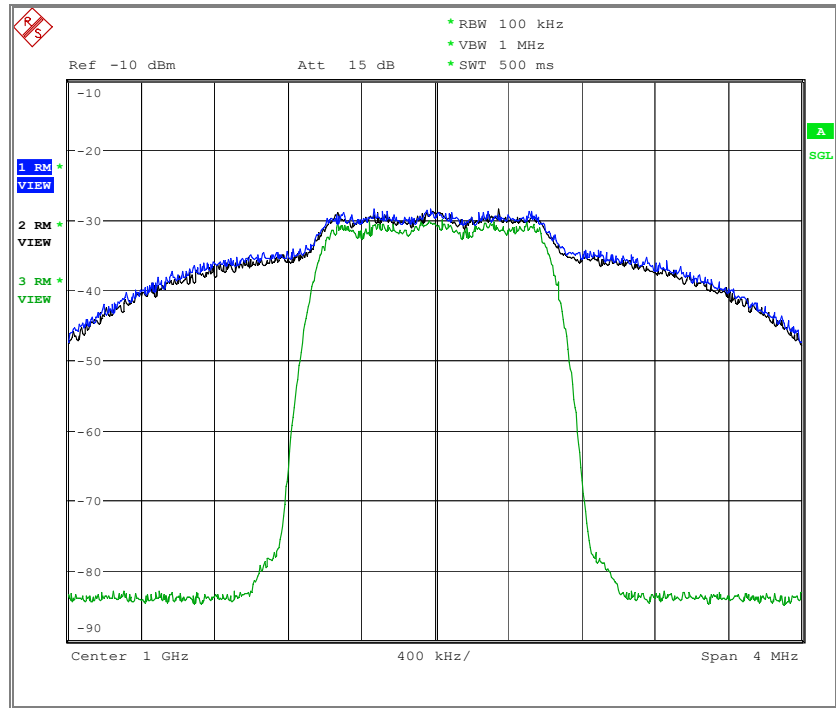


Fig. 3.3.1.2 – R-CCCH Demodulation Performance: AWGN measurement result

### 3.3.2 Performance in Multipath Fading - Closed Loop

Purpose	Basic instrument	Options	Used to
measurement	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate required cdma2000 signal (MS simulator) <b>signal type: R-CCCH</b>
		SMIQ-B17	add AWGN signal <b>signal type: noise</b>
		SMIQ-B14	channel simulation (fading) <b>signal type: rayleigh fading</b>
	NRP + NRP-Z11	---	measure BS Rx port input power
+ demonstration	FSP, FSU or FSQ	optional FS-K82	show spectrum overview

#### Test purpose

The tests verify that the BS has proper demodulation performance of the Reverse Common Control Channel (R-CCCH) in a Multipath Fading **and** AWGN environment.

#### Test method

The function setup for this test is shown below:

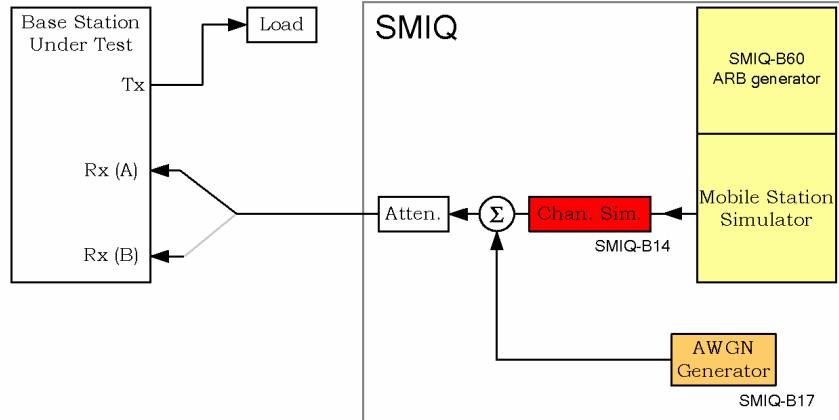


Fig. 3.3.2.1 - R-CCCH Demodulation Performance: Fading + AWGN (closed loop) Test Setup

The test describes 6 different test scenarios - as already used in test 3.3.1, with different data rates and different frame lengths, and specifies a certain  $E_b / N_0$  ratio to be met.

The 10 different band classes are grouped in 3 different band class groups. For this test scenario, both AWGN and channel simulation (fading) are applied. There are 4 different fading profiles to apply to the test scenario, and an upper and lower  $E_b / N_0$  ratio for the AWGN generator is specified.

### **Test implementation hints**

- **Signal power:**  
The MS simulator signal power is defined as a noise power value and a specific  $E_b / N_0$  value. So, the total input power as the BS Rx must be calculated from these two values.
- **FER calculation**  
The FER must be calculated by the BS using its own test capabilities.
- **Call setup**  
Because SMIQ can't set up a call (e.g. by using the Enhanced Access Channel), the BS must be set in a proper mode by specific service options.

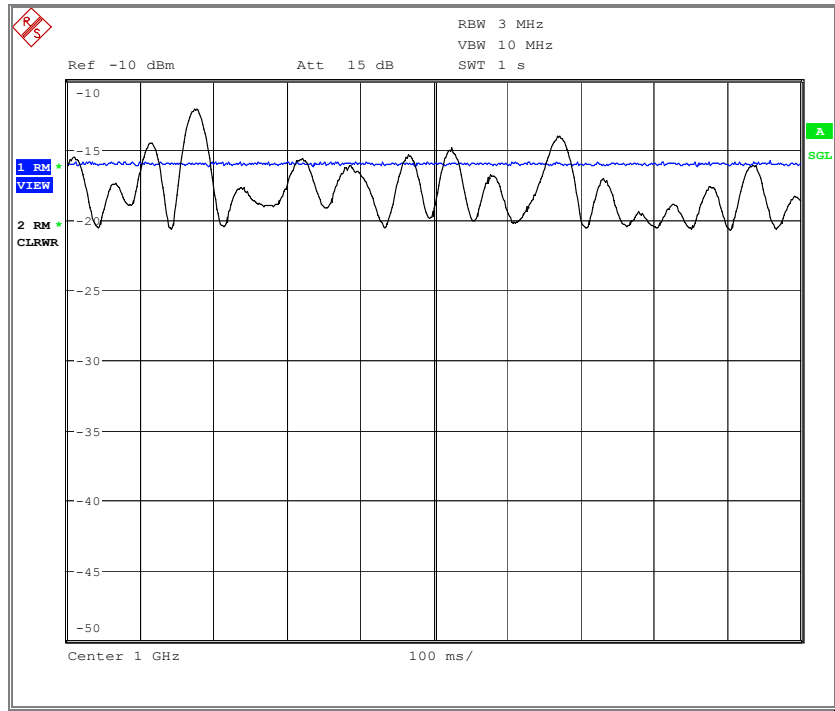
### **Remote Control Programming Example**

The Remote Control Programming Example will:

- generate a R-CCCH signal using SMIQ and SMIQ-B60 (19.2 kbps, 20 ms frame)
- switch between all 4 defined fading profiles, then adjust the noise level to the maximum and minimum value as required in the standard (values is taken from standard table A.2.1-1, BC0, Case A-D.)
- show the noise-free signal using trace 1 and the 8 different test cases subsequent in time domain.  
*(for demonstration purposes only)*

The values are used as specified for band class 0.

**Typical measurement result**



**Fig. 3.3.2.2 - R-CCCH Demodulation Performance: Fading + AWGN (closed loop) measurement result – Fading Profil A**



## cdma2000 BS Measurement According to C.S0010-A

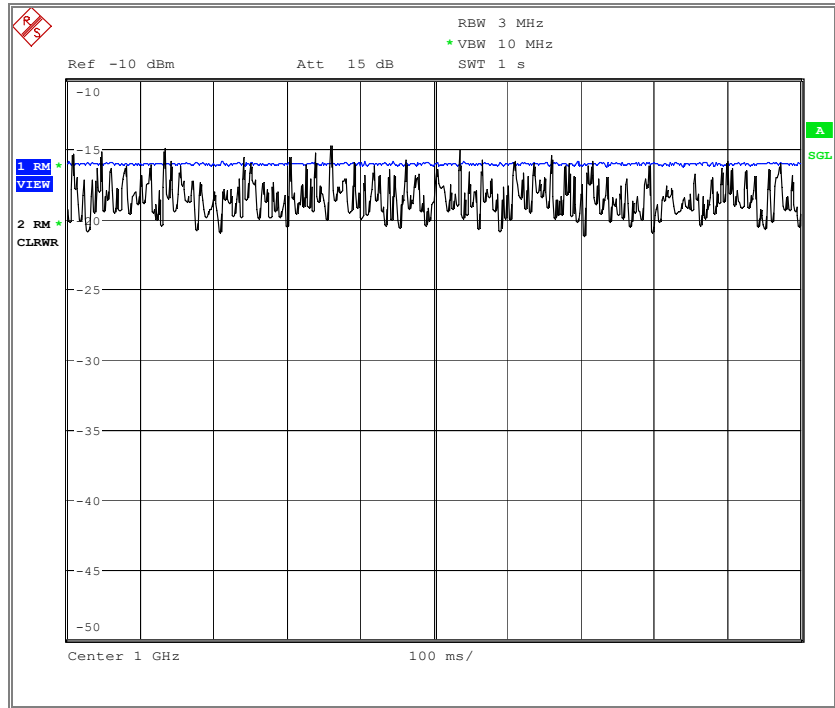


Fig. 3.3.2.3 - R-CCCH Demodulation Performance: Fading + AWGN (closed loop) measurement result – Fading Profil D

### 3.4 R-TCH Demodulation Performance

#### 3.4.1 Performance in AWGN

Purpose	Basic instrument	Options	Used to
measurement	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate required cdma2000 signal (MS simulator) <b>signal type: Fund. Test Modes</b>
		SMIQ-B17	add AWGN signal <b>signal type: noise</b>
	NRP + NRP-Z11	---	measure BS Rx port input power
+ demonstration	FSP, FSU or FSQ	optional FS-K82	show spectrum overview

#### Test purpose

The tests verify that the BS has proper demodulation performance of the Reverse Traffic Channel (R-TCH) in an AWGN (no fading or multipath) environment by calculating the Frame Error Rate (FER).

#### Test method

The function setup for this test is shown below:

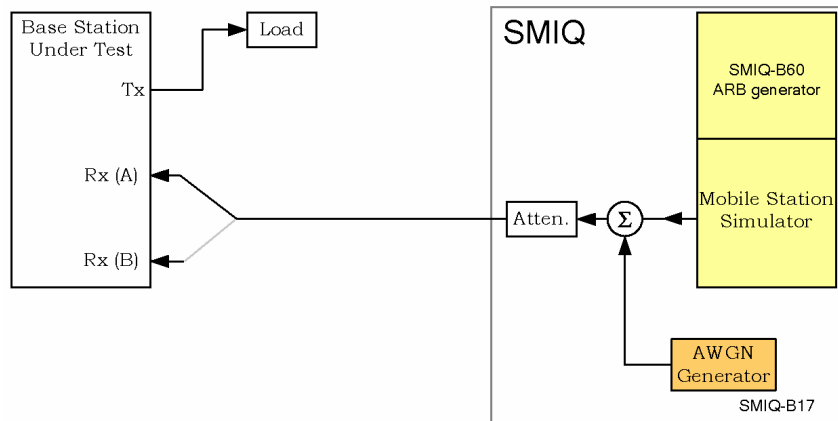


Fig. 3.4.1.1 - R-TCH Demodulation Performance: AWGN Test Setup

The test must be performed for each band class and each radio configuration (on R-FCH, R-DCCH, R-SCCH and R-SCH) the base station can demodulate, and must be done for convolutional and / or turbo coding if the feature is supported by the BS.

A upper and lower  $E_b / N_0$  ratio for the AWGN generator is specified.

### Test implementation hints

- **Signal power:**  
The MS simulator signal power is defined as a noise power value and a specific  $E_b / N_0$  value. So, the total input power as the BS Rx must be calculated from these two values.
- **FER calculation**  
The FER must be calculated by the BS using its own test capabilities.
- **Call setup**  
Because SMIQ can't set up a call (e.g. by using the Enhanced Access Channel), the BS must be set in a proper mode by specific service options.

### Remote Control Programming Example

The Remote Control Programming Example will:

- generate a Reverse Fundamental Channel test mode 1 signal using the SMIQ and SMIQ-B60 (9.6 kbps, 20 ms frame)
- adjust the noise level to the maximum and minimum value as required in the standard (values are taken from standard table A.3.1-1)
- show the 3 traces (noise-free, upper and lower noise level signal) using 3 traces on the spectrum analyzer in frequency domain mode.  
(for demonstration purposes only)

### Typical measurement result

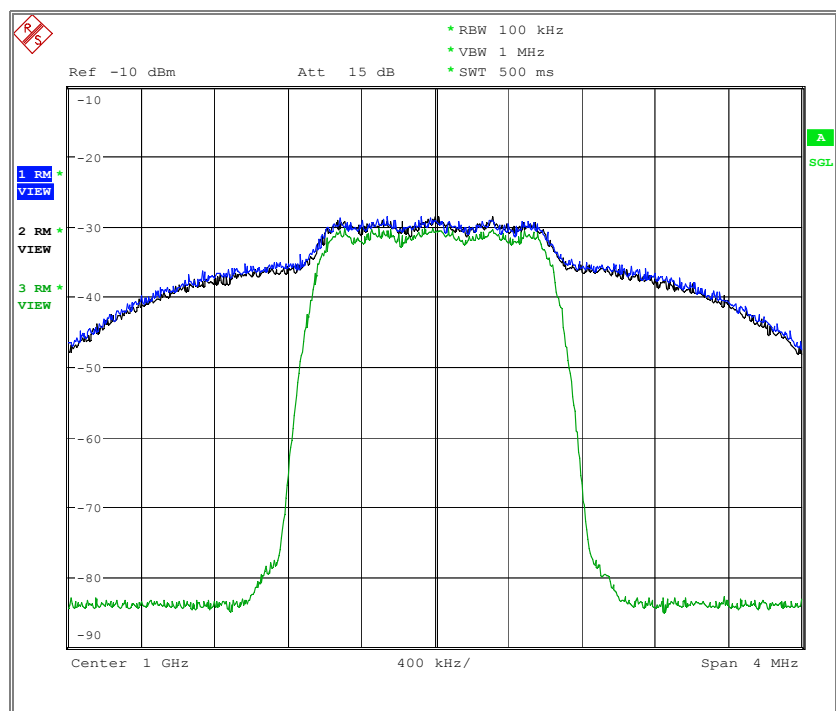


Fig. 3.4.1.2 - R-TCH Demodulation Performance: AWGN measurement result

### 3.4.2 Performance in Multipath Fading - Open Loop

Purpose	Basic instrument	Options	Used to
measurement	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate required cdma2000 signal (MS simulator) <b>signal type: Fund. Test Modes</b>
		SMIQ-B17	add AWGN signal <b>signal type: noise</b>
		SMIQ-B14	channel simulation (fading) <b>signal type: rayleigh fading</b>
	NRP + NRP-Z11	---	measure BS Rx port input power
+ demonstration	FSP, FSU or FSQ	optional FS-K82	show spectrum overview

#### Test purpose

The tests verify that the BS has proper demodulation performance of the Reverse Common Control Channel in a Multipath Fading and AWGN environment with open loop power control.

#### Test method

The function setup for this test is shown below:

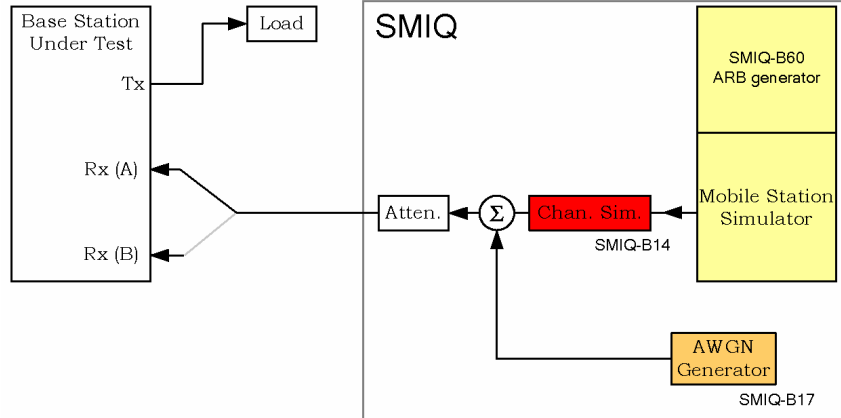


Fig. 3.4.2.1 - R-CCCH Demodulation Performance: Fading + AWGN (open loop) Test Setup

The test must be performed for each band class and each radio configuration (on R-FCH, R-DCCH, R-SCCH and R-SCH) the base station can demodulate.

The channels simulator uses 3 of the 4 channel simulator configurations defined in the standard, and a upper and lower  $E_b / N_0$  ratio for the AWGN generator is specified.

### **Test implementation hints**

- **Signal power:**  
The MS simulator signal power is defined as a noise power value and a specific  $E_b / N_0$  value. So, the total input power as the BS Rx must be calculated from these two values.
- **FER calculation**  
The FER must be calculated by the BS using its own test capabilities.
- **Call setup**  
Because SMIQ can't set up a call (e.g. by using the Enhanced Access Channel), the BS must be set in a proper mode by specific service options.
- **Fading profiles**  
The fading profiles used in this test can be found in the appendix – Manual fading simulator configuration.  
Case C is equal to Configuration 2, C to 3 and D and D2 as equal to Configuration 4.

### **Remote Control Programming Example**

The Remote Control Programming Example will:

- generate a Reverse Fundamental Channel test mode 1 signal using SMIQ and SMIQ-B60 (9.6 kbps, 20 ms frame)
- switch between all 3 defined fading profiles, then adjust the noise level to the maximum and minimum value as required in the standard (values are taken from standard table A.3.2-1, RC1, BC0, Case B-D2)
- show the 3 traces (noise-free, upper and lower noise level signal) using 3 traces on the spectrum analyzer in frequency domain mode subsequent for all 3 fading models.  
(for demonstration purposes only)

**Typical measurement result**

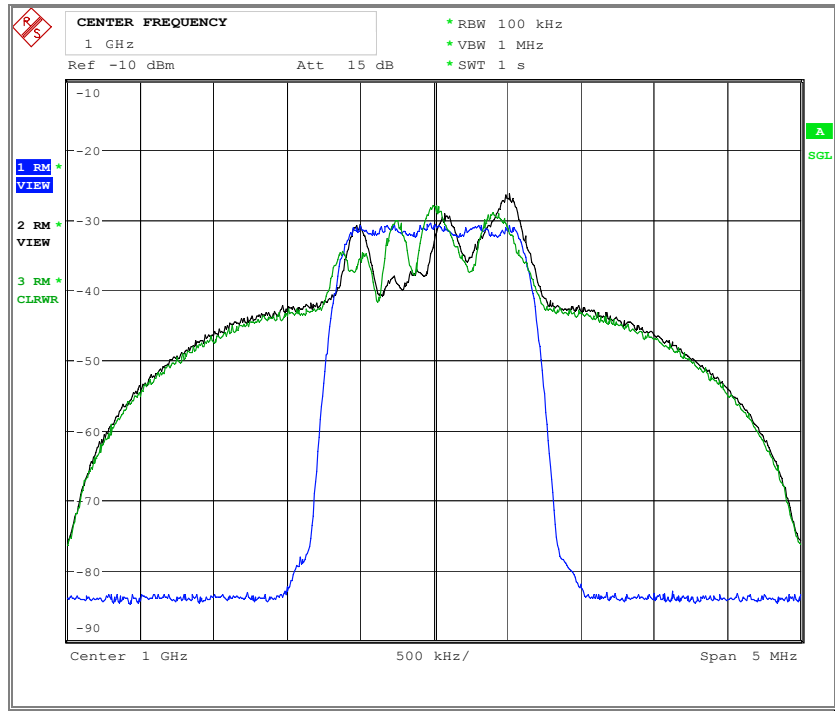


Fig. 3.4.2.2 - R-CCCH Demodulation Performance: Fading + AWGN (open loop) measurement result – Fading Profile B

## cdma2000 BS Measurement According to C.S0010-A

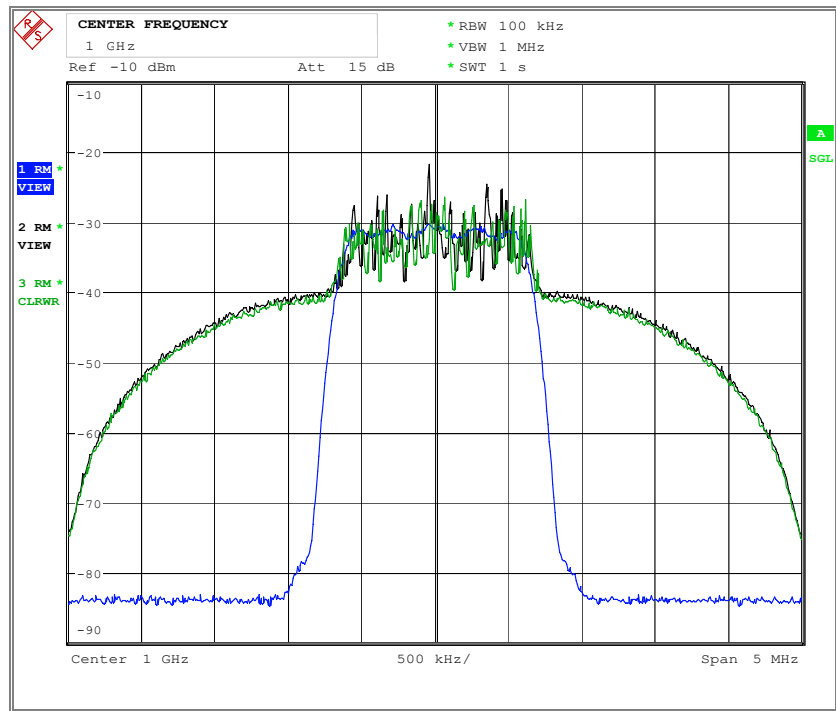


Fig. 3.4.2.3 - R-CCCH Demodulation Performance: Fading + AWGN (open loop) measurement result – Fading Profile D2

### 3.4.3 Performance in Multipath Fading - Closed Loop

Purpose	Basic instrument	Options	Used to
measurement	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate required cdma2000 signal (MS simulator) <b>signal type: Fund. Test Modes</b>
		SMIQ-B17	add AWGN signal <b>signal type: noise</b>
		SMIQ-B14	channel simulation (fading) <b>signal type: rayleigh fading</b>
	NRP + NRP-Z11	---	measure BS Rx port input power
+ demonstration	FSP, FSU or FSQ	optional FS-K82	show spectrum overview

#### Test purpose

The tests verify that the BS has proper demodulation performance of the Reverse Common Control Channel in an Multipath Fading and AWGN environment with closed loop power control.

#### Test method

The function setup for this test is shown below:

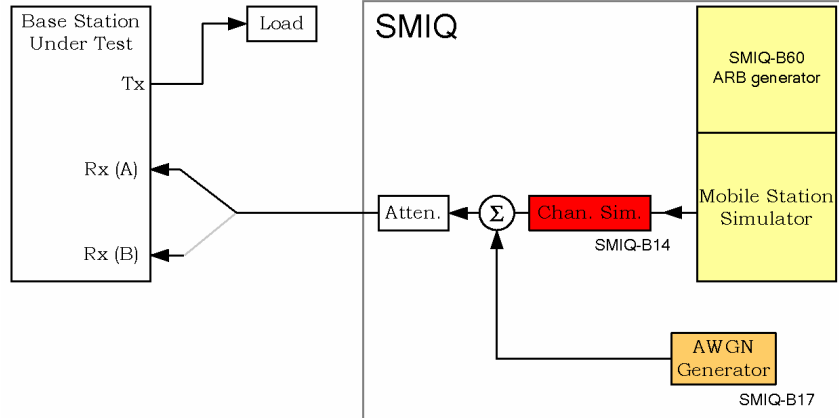


Fig. 3.4.3.1 - R-CCCH Demodulation Performance: Fading + AWGN (closed loop) Test Setup

The test must be performed for each band class and each radio configuration (on R-FCH, R-DCCH, R-SCCH and R-SCH) the base station can demodulate, and must be done for convolutional and / or turbo coding if the feature is supported by the BS.

The channels simulator uses 4 channel simulator configurations defined in the standard, and a upper and lower  $E_b / N_0$  ratio for the AWGN generator is specified. Some RC's only use 2 different fading models.



### **Test implementation hints**

- **Signal power:**  
The MS simulator signal power is defined as a noise power value and a specific  $E_b / N_0$  value. So, the total input power as the BS Rx must be calculated from these two values.
- **FER calculation**  
The FER must be calculated by the BS using its own test capabilities.
- **Call setup**  
Because SMIQ can't set up a call (e.g. by using the Enhanced Access Channel), the BS must be set in a proper mode by specific service options.
- **Fading profiles**  
The fading profiles used in this test can be found in the appendix – Manual fading simulator configuration.  
Case A is equal to Configuration 1, B to 2, C to 3 and D to 4.

### **Remote Control Programming Example**

The Remote Control Programming Example will:

- generate a Reverse Fundamental Channel test mode 1 signal using SMIQ and SMIQ-B60 (9.6 kbps, 20 ms frame)
- switch between 2 defined fading profiles (as required for RC1 Fundamental Channel Tests), then adjust the noise level to the maximum and minimum value as required in the standard (values are taken from standard table A.3.3-1, BC0)
- show the 3 signals (noise-free, upper and lower noise level signal) using 3 traces on the spectrum analyzer in frequency domain mode subsequent for the 2 fading models.  
(for demonstration purposes only)

Typical measurement result

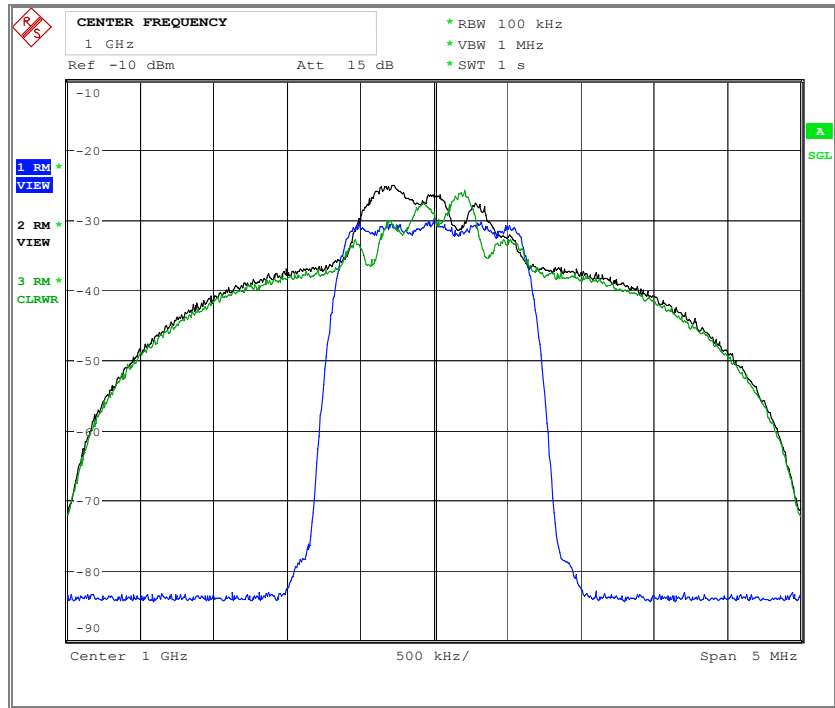


Fig. 3.4.3.2 - R-CCCH Demodulation Performance: Fading + AWGN (closed loop) measurement result – Fading Profile B

## cdma2000 BS Measurement According to C.S0010-A

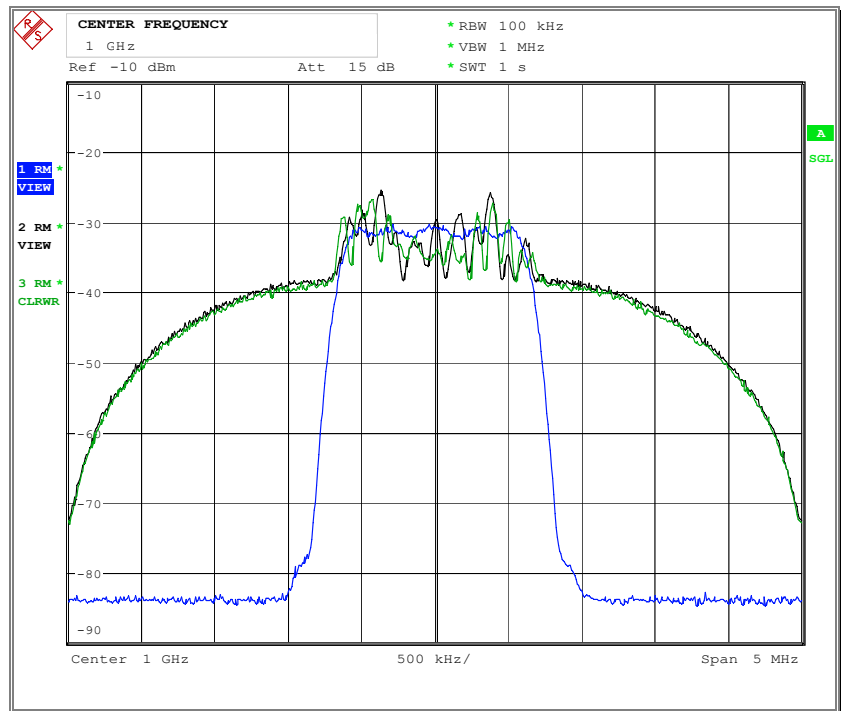


Fig. 3.4.3.3 - R-CCCH Demodulation Performance: Fading + AWGN (closed loop) measurement result – Fading Profile C

### 3.5 Receiver Performance

#### 3.5.1 Receiver Sensitivity

Purpose	Basic instrument	Options	Used to
measurement	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate required cdma2000 signal (MS simulator) <b>signal type:</b> <i>Fund. Test Modes</i> <i>Ded. Test Modes</i>
	NRP + NRP-Z11	---	measure BS Rx port input power
+ demonstration	FSP, FSU or FSQ	optional FS-K82	show spectrum overview measure channel power

#### Test purpose

The receiver sensitivity of the BS has to maintain a R-TCH FER of 1 % at a certain minimum received power, measured at the BS RF input ports.

#### Test method

The function setup for this test is shown below:

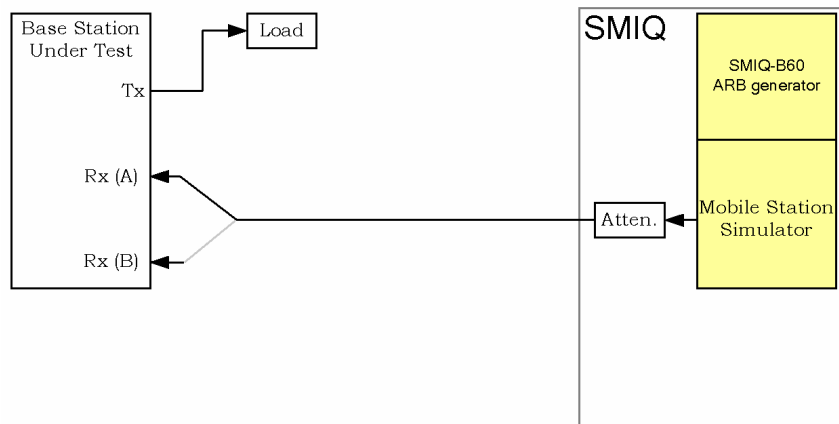


Fig. 3.5.1.1 - Receiver Performance: Sensitivity Test Setup

The test must be performed for each band class and each radio configuration the base station can demodulate.

#### Test implementation hints

- FER calculation**  
 The FER must be calculated by the BS using its own test capabilities.
- Call setup**  
 Because SMIQ can't set up a call (e.g. by using the Enhanced Access Channel), the BS must be set in a proper mode by specific service options.

### Remote Control Programming Example

The Remote Control Programming Example will:

- generate a Reverse Fundamental Channel test mode 1 signal using SMIQ and SMIQ-B60 at a user-defined level (9.6 kbps, 20 ms frame)
- reduce the MS simulator power in 2 user-defined steps
- show the 3 signals (full power, reduced power step 1 and 2) using 3 traces on the spectrum analyzer in frequency domain mode and measure the channel power.  
*(for demonstration purposes only)*

### Typical measurement result

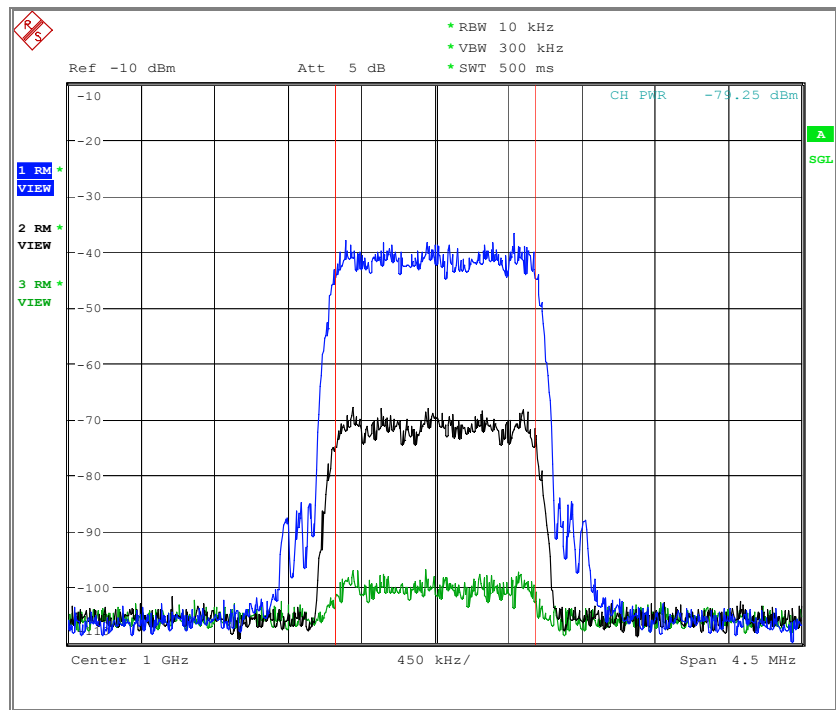


Fig. 3.5.1.2 - Receiver Performance: Sensitivity measurement result

### 3.5.2 Receiver Dynamic Range

Purpose	Basic instrument	Options	Used to
measurement	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate required cdma2000 signal (MS simulator) <b>signal type:</b> <i>Fund. Test Modes</i> <i>Ded. Test Modes</i>
	NRP + NRP-Z11	---	measure BS Rx port input power
+ demonstration	FSP, FSU or FSQ	optional FS-K82	show spectrum overview

#### Test purpose

The receiver dynamic range is the input power range at the BS RF input ports over which the FER does not exceed a specific value, calculated as the difference between the sensitivity as measured by the test in 3.5.1 and the maximum total power per RF input port at which an FER of 1% is maintained.

#### Test method

The function setup for this test is shown below:

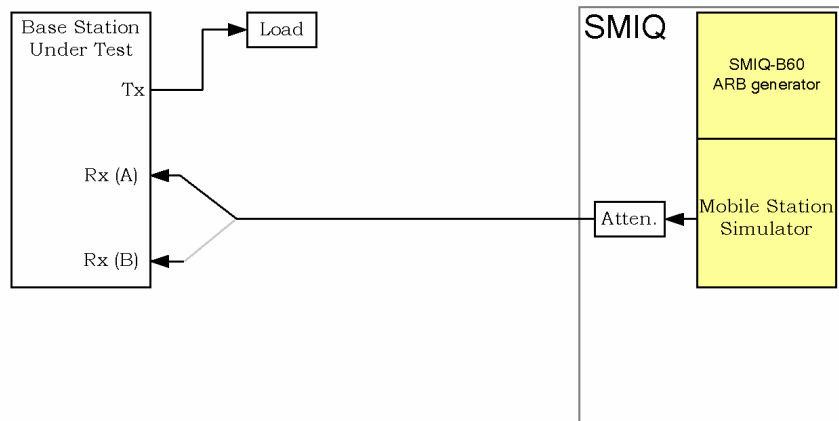


Fig. 3.5.2.1 - Receiver Performance: Dynamic Range Test Setup

The test must be performed for each band class and each radio configuration the base station can demodulate.

#### Test implementation hints

- **FER calculation**  
The FER must be calculated by the BS using its own test capabilities.
- **Call setup**  
Because SMIQ can't set up a call (e.g. by using the Enhanced Access Channel), the BS must be set in a proper mode by specific service options.

### Remote Control Programming Example

The Remote Control Programming Example will:

- generate a Reverse Fundamental Channel test mode 1 signal using SMIQ and SMIQ-B60 at a user-defined level (9.6 kbps, 20 ms frame)
- show the signal using 1 trace on the spectrum analyzer in frequency domain mode and measure the channel power.  
*(for demonstration purposes only)*

### Typical measurement result

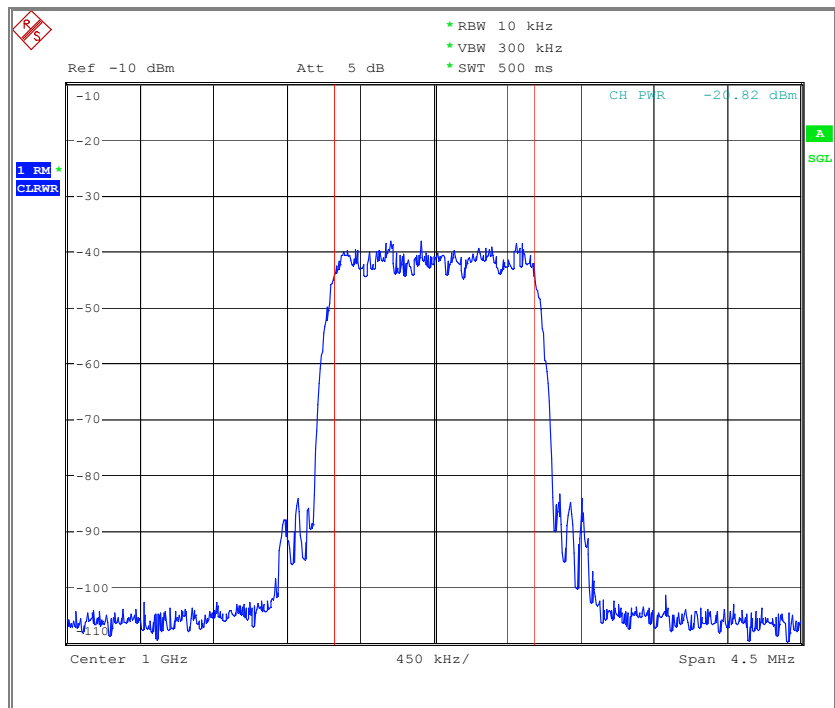


Fig. 3.5.2.2 - Receiver Performance: Dynamic Range measurement result

### 3.5.3 Single Tone Desensitization

Purpose	Basic instrument	Options	Used to
measurement	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate required cdma2000 signal (MS simulator) <b>signal type:</b> <i>Fund. Test Modes</i> <i>Ded. Test Modes</i>
	R&S CW generator (SMIQ, SML, SMR, ...)	---	generate interferer <b>signal type:</b> <i>CW signal</i>
	NRP + NRP-Z11	---	measure BS Rx port input power
+ demonstration	FSP, FSU or FSQ	FS-K82	show spectrum overview

#### Test purpose

Single tone desensitization is a measure of the ability to receive a CDMA signal on the assigned channel frequency in the presence of a single tone that is offset from the center frequency of the assigned channel.

#### Test method

The function setup for this test is shown below:

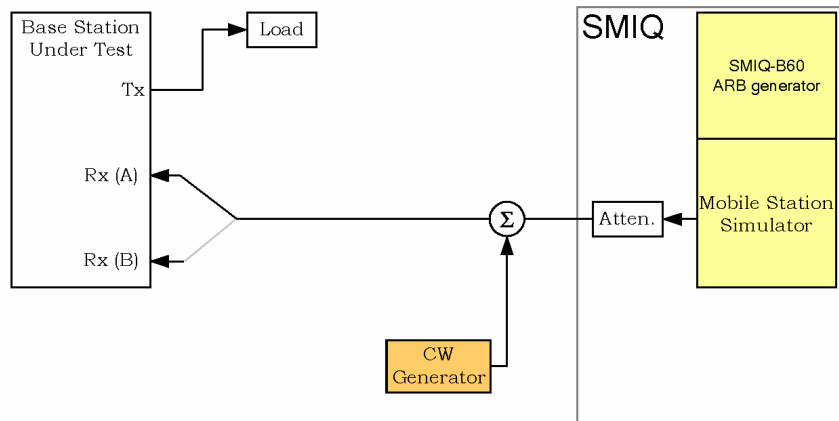


Fig. 3.5.3.1 - Receiver Performance: Single Tone Desensitization Test Setup

The test must be performed for each band class except Band Class 6 and each radio configuration the base station can demodulate.

4 different CW generator offset frequencies and levels are defined for this test according to the table below:

Rate and Band Class	Offset frequency	CW level above MS
SR1, BC 0	± 750 kHz	50 dB
SR1, BC 0,2,3,5	± 900 kHz	87 dB
SR1, BC 1,4,7	± 1,25 MHz	80 dB
SR3	± 2,50 MHz	87 dB



### **Test implementation hints**

- ***MS simulator power***  
This value is not specified in the standard. So, select a MS simulator power level to ensure that the CW generator can generate a CW signal at the specified power level.  
If, for example,  $\pm 900$  kHz offset frequency sensitization is tested and the maximum available CW generator power is +10 dBm, the MS simulator power must be below  $(+10-87=) -77$  dBm.
- ***FER calculation***  
The FER must be calculated by the BS using its own test capabilities.
- ***Call setup***  
Because SMIQ can't set up a call (e.g. by using the Enhanced Access Channel), the BS must be set in a proper mode by specific service options.
- ***CW generator performance***  
Additional filters may be necessary to suppress unwanted spurious of the CW generator at the MS simulator frequency.

### **Remote Control Programming Example**

The Remote Control Programming Example will:

- generate a Reverse Fundamental Channel test mode 1 signal using the SMIQ and SMIQ-B60 at a user-defined level (9.6 kbps, 20 ms frame)
- use the same SMIQ to generate all CW carriers for BC 0 ( $\pm 750$  and  $\pm 900$  kHz) subsequently
- show the MS simulator signal using trace 1 and the CW carriers using trace 2 and 3 (maximum hold) with a spectrum analyzer in frequency domain mode.  
*(for demonstration purposes only)*

The Channel Power to CW ratio is 50 dB as required for  $\pm 750$  kHz offset. 87 dB as required for  $\pm 900$  kHz offset can not be displayed on the analyzer, so 50 dB are set here as well for demonstration purpose.

Typical measurement result

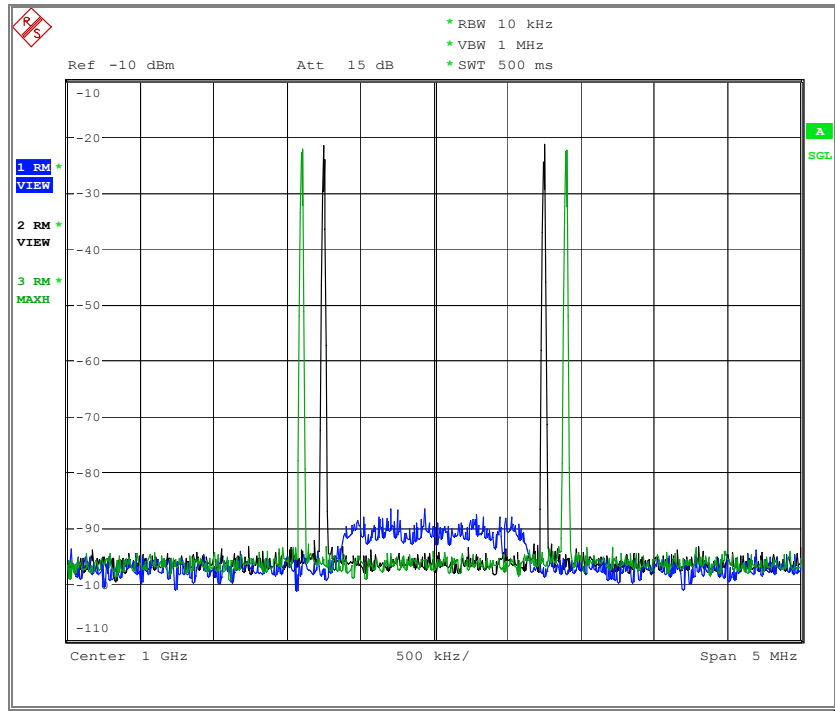


Fig. 3.5.3.2 - Receiver Performance: Single Tone Desensitization measurement result

### 3.5.4 Intermodulation Spurious Response Attenuation

Purpose	Basic instrument	Options	Used to
measurement	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate required cdma2000 signal (MS simulator) <b>signal type:</b> <i>Fund. Test Modes</i> <i>Ded. Test Modes</i>
	R&S CW generator (SMIQ, SML, SMR, ...)	---	generate 1. interferer <b>signal type:</b> <i>CW signal</i>
	R&S CW generator (SMIQ, SML, SMR, ...)	---	generate 2. interferer <b>signal type:</b> <i>CW signal</i>
	NRP + NRP-Z11	---	measure BS Rx port input power
+ demonstration	FSP, FSU or FSQ	FS-K82	show spectrum overview

#### Test purpose

This is a measure of a receiver's ability to receive a CDMA signal in the presence of two interfering CW tones which are assigned to frequencies such that the third order mixing of the interferers can occur in the non-linear elements of the receiver, producing an interfering signal in the CDMA signal band.

#### Test method

The function setup for this test is shown below:

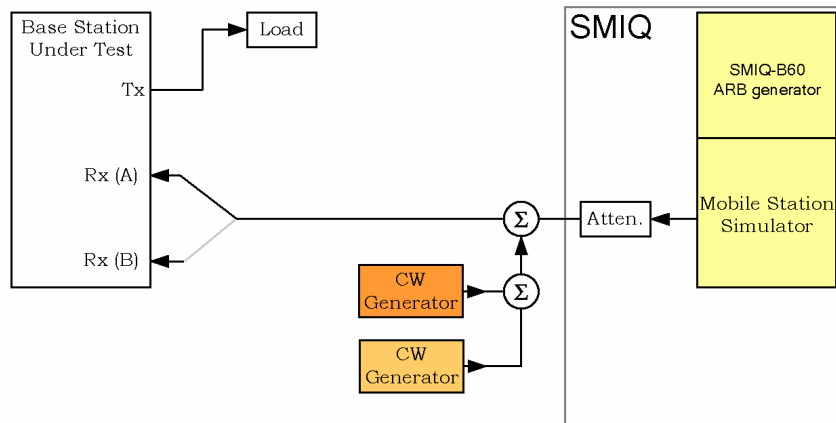


Fig. 3.5.4.1 - Receiver Performance: Intermodulation Attenuation Test Setup

The test must be performed for each band class except Band Class 6 and each radio configuration the base station can demodulate.

3 different CW generator offset frequencies are defined for this test according to the table below (the IM3 products which are generated in the used band are marked in bold).

The level for the CW carriers must be 72 dB (BC 0,2,3,5,7) or 70 dB (BC 1,4,6,8) above the MS simulator output power.

## ***cdma2000 BS Measurement According to C.S0010-A***

---

<b>Rate and Band Class</b>	<b>Offset 1</b>	<b>Offset 2</b>	<b>IM3 products</b>
SR1, BC 0,2,3,5	± 900 kHz	± 1700 kHz	<b>± 100 kHz</b> ± 2,50 MHz
SR1, BC 1,4,6,7	± 1,25 MHz	± 2,05 MHz	<b>± 450 kHz</b> ± 2,85 MHz
SR3	± 2,50 MHz	± 3,30 MHz	<b>± 1,70 MHz</b> ± 4,10 MHz

Please note that the ± indicates the signal for the whole row, so for example + 900 kHz must be combined with +1700 kHz and not –1700 kHz.

### **Test implementation hints**

- ***MS simulator power***  
This value is not specified in the standard. So, select a MS simulator power level to ensure that the CW generator can generate a CW signal at the specified power level (as already described for test 3.5.3).
- ***FER calculation***  
The FER must be calculated by the BS using it's own test capabilities.
- ***Call setup***  
Because SMIQ can't set up a call (e.g. by using the Enhanced Access Channel), the BS must be set in a proper mode by specific service options.

### **Remote Control Programming Example:**

The Remote Control Programming Example will

- generate a Reverse Fundamental Channel test mode 1 signal using SMIQ and SMIQ-B60 at a user-defined level (9.6 kbps, 20 ms frame)
- use the same SMIQ to generate the CW carrier pairs for BC 0 (± 900 kHz and ± 1700 kHz) sub-sequently
- show the MS simulator signal using trace 1 and the CW carrier pairs using trace 2 and 3 with a spectrum analyzer in frequency domain mode.  
*(for demonstration purposes only)*

Because 70 dB dynamic range can not be displayed on the analyzer, 50 dB are used for this demonstration.

Typical measurement result

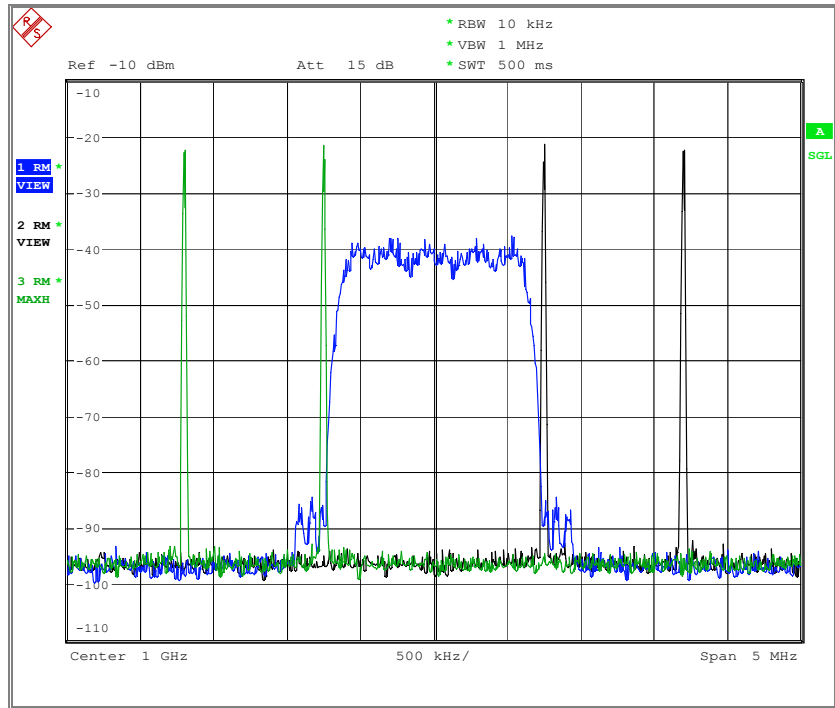


Fig. 3.5.4.2 - Receiver Performance: Intermodulation Attenuation Test Setup

### 3.5.5 Adjacent Channel Selectivity

Purpose	Basic instrument	Options	Used to
measurement	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate required cdma2000 signal (MS simulator) <b>signal type:</b> <i>Fund. Test Modes</i> <i>Ded. Test Modes</i>
	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate interfering cdma2000 signal (MS simulator) <b>signal type:</b> <i>RC5 full rate</i>
	NRP + NRP-Z11	---	measure BS Rx port input power
+ demonstration	FSP, FSU or FSQ	FS-K82	show spectrum overview

#### Test purpose

This is a measure of the ability to receive a CDMA signal on the assigned channel frequency in the presence of another strong CDMA signal that is offset from the center frequency of the assigned channel.

#### Test method

The function setup for this test is shown below:

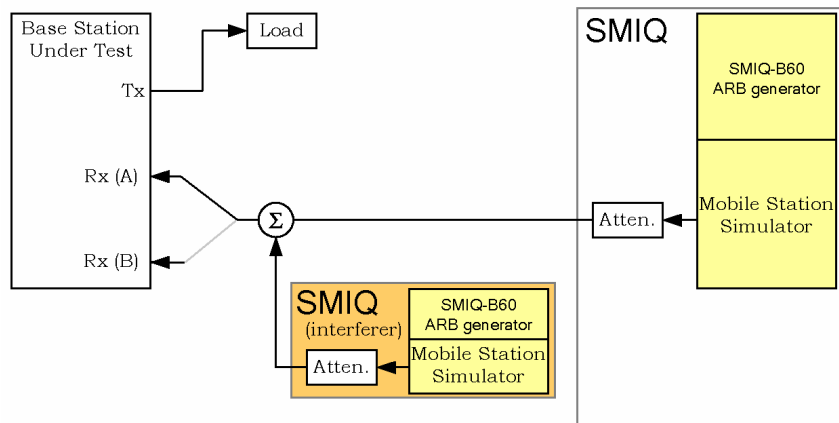


Fig. 3.5.5.1 - Receiver Performance: Adjacent Channel Selectivity Test Setup

The test must be performed for Band Class 6 and each radio configuration the base station can demodulate.

2 different scenarios are described in the standard:

Operation Mode	Frequency Offset	Interferer Power	Interferer Signal Type
SR1	± 2,50 MHz	-53 dBm	Full rate RC 3
SR3	± 5,00 MHz	-49 dBm	Full rate RC 5

### Test implementation hints

- **FER calculation**  
The FER must be calculated by the BS using its own test capabilities.
- **Call setup**  
Because SMIQ can't set up a call (e.g. by using the Enhanced Access Channel), the BS must be set in a proper mode by specific service options.

### Remote Control Programming Example

The Remote Control Programming Example will:

- generate a Reverse Fundamental Channel test mode 1 signal using SMIQ and SMIQ-B60 at a user-defined level (9.6 kbps, 20 ms frame)
- use the same SMIQ to generate the MS interferer signal at both possible offset frequencies for SR 1 ( $\pm 2.5$  MHz @ user-defined level)
- show the MS simulator signal using trace 1 and the MS interferer using trace 2 with a spectrum analyzer in frequency domain mode.  
(for demonstration purposes only)

### Typical measurement result

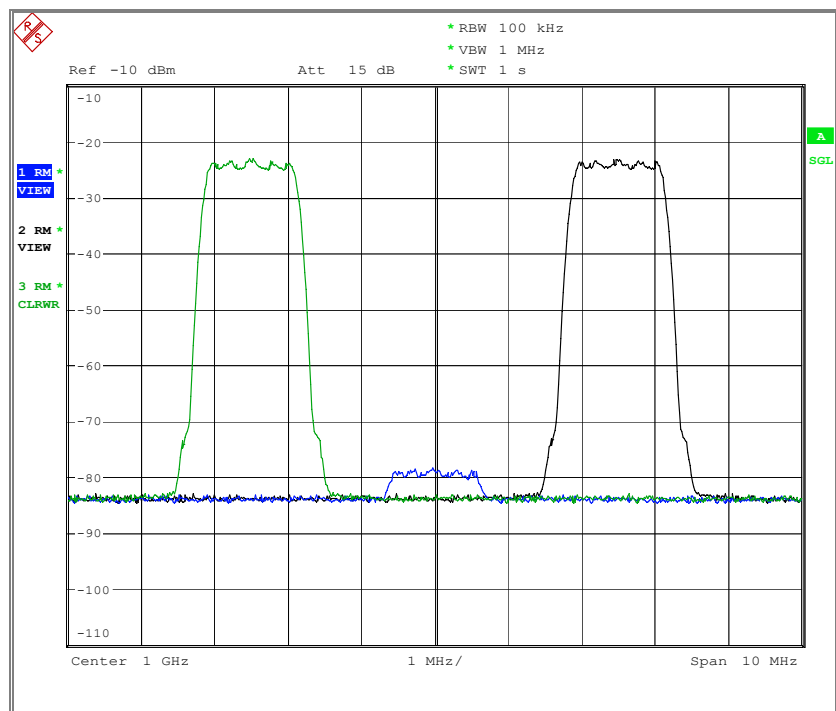


Fig. 3.5.5.2 - Receiver Performance: Adjacent Channel Selectivity measurement result

## 3.6 Limitations on Emissions

### 3.6.1 Conducted Spurious Emissions

Purpose	Basic instrument	Options	Used to
measurement	FSP, FSU or FSQ	---	measurement item: <i>spurious emission level</i>

#### Test purpose

Conducted spurious emissions are spurious emissions generated or amplified in the base station equipment and appearing at the receiver RF input ports.

This measurement verifies spurious emissions when all transmitter RF outputs are switched off.

#### Test method

The function setup for this test is shown below:

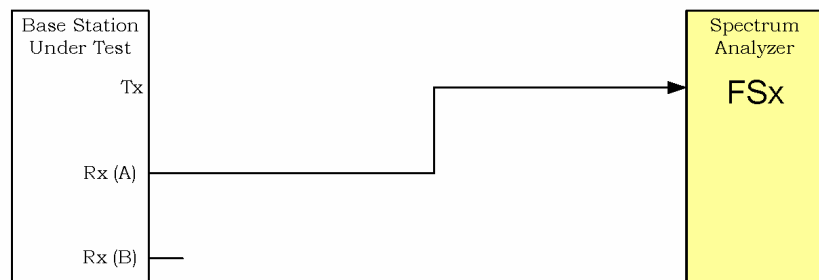


Fig. 3.6.1.1 - Emission Limits: Conducted Spurious Emissions Test Setup

There are 5 different measurement ranges specified in the standard:

1. Measurement within the BS receiver bands (Rx)
2. Measurement within the BS transmitter bands (Tx)
3. Measurement within the PHS band at the input port
4. Measurement within all other bands (not for band class 6)
5. Region specific (no values specified)

The *lower* sweep end is specified as lowest intermediate / oscillator frequency or 1 MHz. In practice, this value will be 1 MHz because no lower intermediate frequency will occur in a base station.

The *upper* sweep end is specified to:

- 2.6 GHz for Band Classes 0,2,5,7
- 3.0 GHz for Band Class 3
- 6.0 GHz for Band Classes 1,4,6,8



### Test implementation hints

- **Measurement "within all other bands":**  
For "measurement within all other bands", take the complete sweep spectrum and exclude the Rx and Tx bands covered from the base station.  
In the IEEE example, the spectrum analyzer reference level is set 10 dB higher than the emission limit in the standard, and the input attenuation is set to 0 dB. So, for example, if the standard requires -80 dBm emission limit, set the reference level to -70 dBm and the input attenuation to 0 dB for a better performance.

### Remote Control Programming Example

The Remote Control Programming Example will either:

- measure all conducted spurious emission limits using a spectrum analyzer in high resolution single sweep mode  
**OR**
- measure all conducted spurious emission limits using a spectrum analyzer in individual single sweep mode.

Measurements "within all other bands" are assumed to be for a base station supporting all band classes.

### Typical measurement result

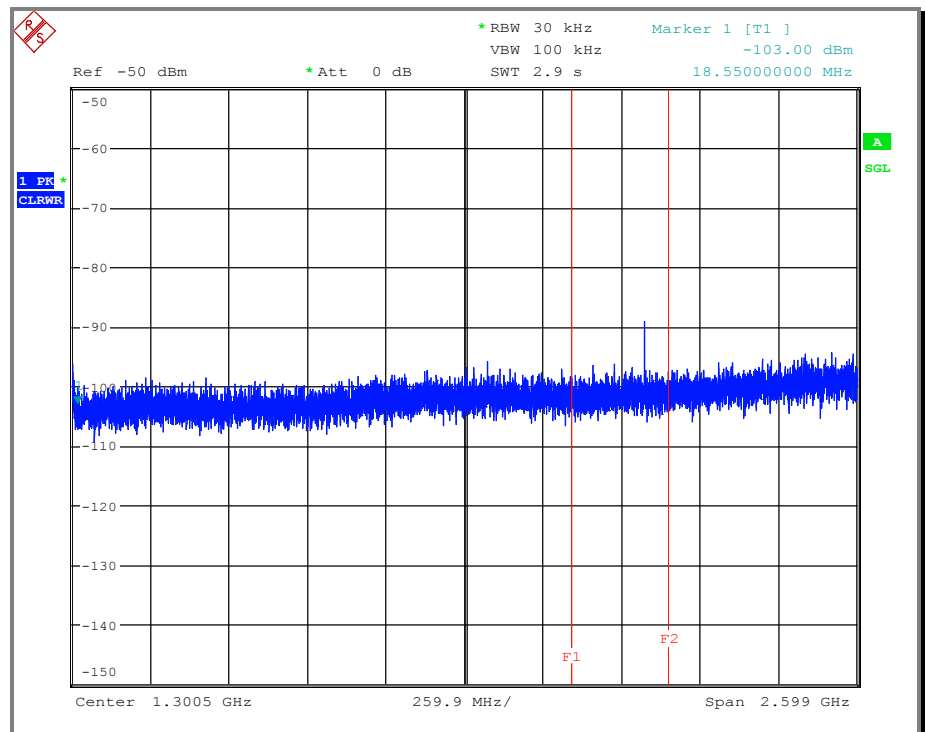


Fig. 3.6.1.2 - Emission Limits: Conducted Spurious Emissions measurement result (high resolution)

### 3.6.2 Radiated Spurious Emissions

Purpose	Basic instrument	Options	Used to
<i>measurement</i>	FSP, FSU or FSQ <sup>1)</sup>	---	measurement item: <i>spurious emission level</i>

#### Test purpose

The measurements for radiated spurious emissions are carried out within the transmitter radiated spurious emissions (Test 4.4.2).

Current region-specific radio regulation rules shall apply.

#### Test method

For testing radiated spurious emissions, an antenna must be connected to the spectrum analyzer, and the radiated power must be measured.

No receiver radiated spurious emissions are explicitly stated. Current region-specific radio regulation rules shall apply.

Please refer to the standard documents for your region in order to test radiated spurious emissions.

#### Test implementation hints

---

#### Remote Control Programming Example

Because this is a region-specific tests, there is no IEEE example provided for this test.

The structure is the same as in test 3.6.1 - Conducted Spurious Emissions.

#### Typical measurement result

---

### 3.7 Receiver Signal Quality Indicator - RSQI

Purpose	Basic instrument	Options	Used to
measurement	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate required cdma2000 signal (MS simulator) <b>signal type:</b> <i>Fund. Test Modes</i> <i>Ded. Test Modes</i>
		SMIQ-B17	add AWGN signal <b>signal type:</b> <i>noise</i>
	NRP + NRP-Z11	---	measure BS Rx port input power
+ demonstration	FSP, FSU or FSQ	optional FS-K82	show spectrum overview

#### Test purpose

Received signal quality indicator (RSQI) refers to a measurement of signal quality performed by the basestation. RSQI measurement results are used for comparisons of signal strength between different basestations.

#### Test method

The function setup for this test is shown below:

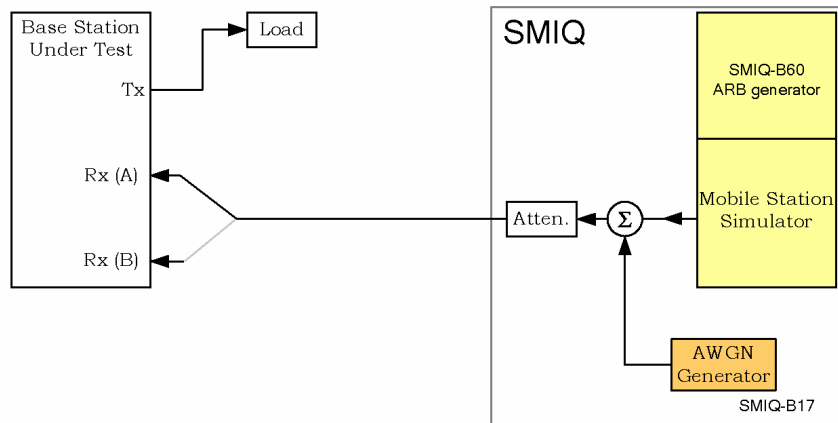


Fig. 3.7.1 - Receiver Signal Quality Indicator Test Setup

The test must be performed for each band class and each radio configuration the base station can demodulate.

The measurement starts with a certain MS simulator output power and a  $E_b / N_0$  value of 8 dB. The MS simulator power is then lowered by 6 dB in the first measurement step, and increased in 1 dB steps up to a level where a  $E_b / N_0$  of 14 dB is reached (during this process, the noise power is hold constant while the MS simulator power is changed). For each step, the RSQI reported from the base station must be recorded.

### Test implementation hints

- **Call setup**

Because SMIQ can't set up a call (e.g. by using the Enhanced Access Channel), the BS must be set in a proper mode by specific service options.

### Remote Control Programming Example

The Remote Control Programming Example will:

- generate a Reverse Fundamental Channel test mode 1 signal using SMIQ and SMIQ-B60 at a user-defined level
- run through the different level steps and  $E_b/N_0$  ratios
- show the first MS simulator signal power step using trace 1 and the different level steps using trace 2 using a spectrum analyzer in frequency domain mode, switching between carrier and noise and noise only, measure the total output power and the noise output power, calculate the S/N ratio and display it.  
*(for demonstration purposes only)*

### Typical measurement result

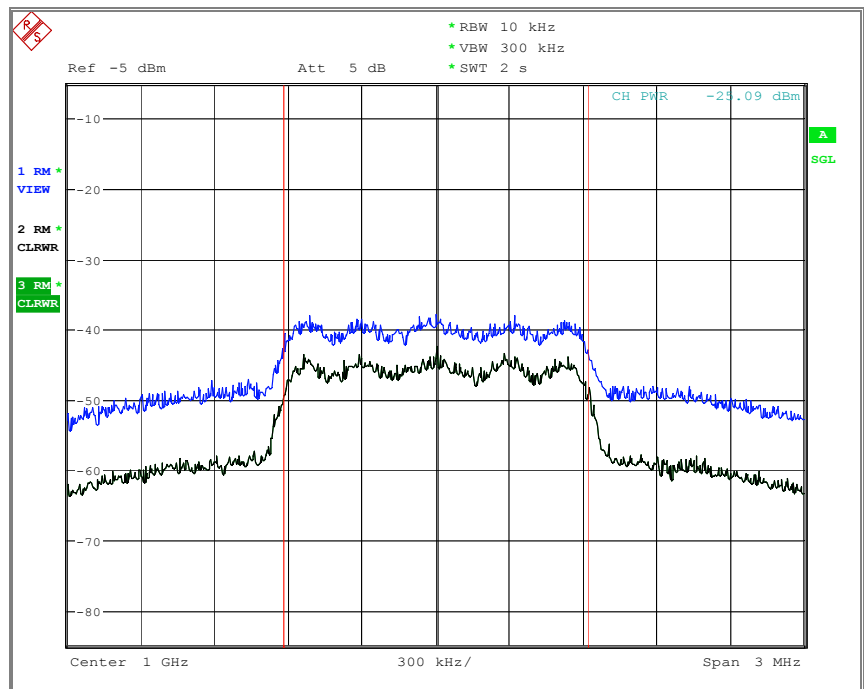


Fig. 3.7.2 - Receiver Signal Quality Indicator measurement result

## 4. cdma2000 Transmitter Minimum Standards

### General Aspects

- **Waveform files**  
Because the waveform files which must be loaded to the AMIQ / SMIQ-B60 are quite large and need about 40 seconds to transfer, please run the loading routine in the GDE first and start the required test afterwards.  
All IEEE example files use SMIQ-B60 because this is a one-box solution and sufficient for all tests.
- **Frequencies**  
The supplied IEEE example sequences are independent from the band class. Select any frequency for both signal generator and spectrum analyser. Please select the proper frequencies for the band class to test.  
If test setups are different for different band classes, BC 0 is used.
- **Test signals**  
If a test requires more than one test model or signal configuration to be set up and measured, the test sequences are only built up for one test model (usually the first mentioned in the standard). Additional test models can be added very easily by using another test signal file.
- **Levels**  
Levels for generator and analyzer are set for demonstration purpose. You can connect them via a normal RF cable and get the best performance values.  
If other requirements need to be met, please set the levels in the demonstration program according to your needs.
- **Demonstration / Evaluation**  
To evaluate the capabilities of the instruments without a BS under test, please connect a SMIQ and SMIQ-B60 instead of the BS. It will generate the required test signal to simulate the BS.  
Detailed informations can be found in the table at the beginning of each test.

## Instruments and signal list

The lists below show all measurements for transmitter tests and the required instruments and signals (for measurement and evaluation purpose):

Class	Number	Measurement	Conf	Instruments needed														
				RF generator			cdma2000 SW		CW source		Spectrum analyzer					cdma2000 SW		
				SMIQ	SMIQ B17	SMIQ B14	SMIQB60 SMIQ-K12	AMIQ AMIQ-K12	R&S CW generator	R&S CW generator	FSQ	FSU	FSP	FSIQ	R&S SA	FS K82	FSIQ K71	
Transmitter test	4.1	<i>Frequency Requirements</i>																
	4.1.1	Frequency Coverage	---	---			---		---		---					---		
	4.1.2	Frequency Tolerance	any	🌀			🌀			☑	☑	☑	☑ <sup>2)</sup>		⚙️ <sup>1)</sup>	☑		
	4.2	<i>Modulation Requirements</i>																
	4.2.1	<i>Synchronization and Timing</i>																
	4.2.1.1	Pilot Timing Tolerance	5	🌀			🌀			☑	☑	☑	☑		⚙️ <sup>1)</sup>			
	4.2.1.2	Pilot Channel to Code Channel Time Tolerance	6	🌀			🌀			☑	☑	☑	☑ <sup>1)</sup>		⚙️ <sup>1)</sup>			
	4.2.1.3	Pilot Channel to Code Channel Phase Tolerance	6	🌀			🌀			☑	☑	☑	☑ <sup>1)</sup>		⚙️ <sup>1)</sup>			
	4.2.2	Waveform Quality	5	🌀			🌀			☑	☑	☑	☑ <sup>2)</sup>		⚙️ <sup>1)</sup>	☑		
	4.2.3	Forward Power Control Subchannel	1															
	4.3	<i>RF Output Power Requirements</i>																
	4.3.1	Total Power	any	🌀			🌀			☑	☑	☑	☑	☑				
	4.3.2	Pilot Power	any	🌀			🌀			☑	☑	☑	☑ <sup>1)</sup>		⚙️ <sup>1)</sup>			
	4.3.3	Code Domain Power	6 / 7	🌀			🌀			☑	☑	☑	☑ <sup>1)</sup>		⚙️ <sup>1)</sup>			
	4.4	<i>Limitations on Emissions</i>																
	4.4.1	Conducted Spurious Emissions	any	---			---		---		☑	☑	☑	☑ <sup>3)</sup>		⚙️ <sup>1)</sup>	---	
	4.4.2	Radiated Spurious Emissions	any	---			---		---		☑	☑	☑	☑	☑		---	
	4.4.3	Inter-Base Station Transmitter Intermodulation	9															
	4.4.4	Occupied Bandwidth	any	🌀			🌀		---	☑	☑	☑	☑	☑	☑	☑		

- ⚙️ needed for the measurement
- ☑ can do the measurement
- 🌀 needed for demonstration
- 
- 1) with FSIQK71 only RC1-2, max. 9 active channels
- 2) possible with FSIQ-B7 and FSIQK71
- 3) power dependant mask adjust only with FS-K83
- Conf Functional Setup according to Standard Chapter 6.5.1

Table 5 – Required Instruments for cdma2000 transmitter tests

**cdma2000 BS Measurement According to C.S0010-A**

Class	Number	Measurement	F-PICH	F-TDPICH	F-Pilot(s)	BS Test Model	Fundamental Traffic CTM 1	Fundamental Traffic CTM 2	Fundamental Traffic CTM 3	Fundamental Traffic CTM 7	Dedicated Control CTM 3	Dedicated Control CTM 7
Transmitter test	<b>4.1</b>	<b>Frequency Requirements</b>										
	4.1.1	Frequency Coverage	--	--	--	--	--	--	--	--	--	--
	4.1.2	Frequency Tolerance	X									
	<b>4.2</b>	<b>Modulation Requirements</b>										
	<b>4.2.1</b>	<b>Synchronization and Timing</b>										
	4.2.1.1	Pilot Timing Tolerance			X							
	4.2.1.2	Pilot Channel to Code Channel Time Tolerance				X						
	4.2.1.3	Pilot Channel to Code Channel Phase Tolerance				X						
	4.2.2	Waveform Quality	X	X								
	4.2.3	Forward Power Control Subchannel					X	X	X	X	X	X
	<b>4.3</b>	<b>RF Output Power Requirements</b>										
	4.3.1	Total Power				X						
	4.3.2	Pilot Power				X						
	4.3.3	Code Domain Power					X	X	X	X	X	X
	<b>4.4</b>	<b>Limitations on Emissions</b>										
	4.4.1	Conducted Spurious Emissions				X						
	4.4.2	Radiated Spurious Emissions	--	--	--	--	--	--	--	--	--	--
	4.4.3	Inter-Base Station Transmitter Intermodulation				X						
	4.4.4	Occupied Bandwidth				X						

CTM: Channel Test Mode

Table 6 – Required Test Signals for cdma2000 transmitter tests  
(refer to "Test Models and Test Signals" for a more detailed description of the test signals)

## **4.1 Frequency Requirements**

### **4.1.1 Frequency Coverage**

<b>Purpose</b>	<b>Basic instrument</b>	<b>Options</b>	<b>Used to</b>
<i>measurement</i>	---	---	BS software setup only
<i>+ demonstration</i>	---	---	---

#### **Test purpose**

The cdma2000 BS must cover the assigned frequency range and be able to receive the dedicated cdma2000 channels.

#### **Test method**

There are no measurements necessary, as this is a software setup in the BS.

#### **Test implementation hints**

---

#### **Remote Control Programming Example**

As this is only a software test for the BS, there is no IEEE example provided for this test.

#### **Typical measurement result**

As this is only a software setup for the base station, so no special measurements need to be made here.



### 4.1.2 Frequency Tolerance

Purpose	Basic instrument	Options	Used to
<i>measurement</i>	FSP, FSU or FSQ	FS-K82	measurement <b>item:</b> <i>carrier frequency error</i>
<i>+ demonstration</i>	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate cdma2000 signal (BS simulation) <b>signal type:</b> <i>F-PCH only</i>

#### Test purpose

This measurement evaluates the difference between the actual CDMA transmit carrier frequency and the specified CDMA transmit frequency assignment.

This test shall apply to every band class that the base station supports.

#### Test method

The function setup for this test is shown below:

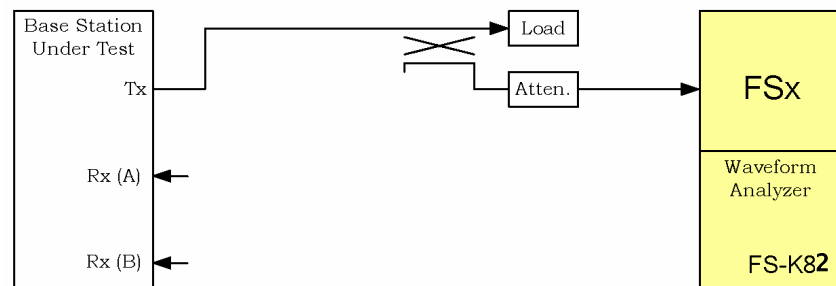


Fig. 4.1.2.1 - Frequency Tolerance Test Setup

The test must be done for all supported band classes.

Frequency tolerance must be tested with Forward Pilot Channel (F-PICH) and - if supported - Transmit Diversity Pilot Channel only setup of the BS.

The test should be done as part of the waveform quality test (Test 4.2.2).

#### Test implementation hints

- Use of external trigger**  
 The standard describes the use of an external trigger (system time reference signal) from the base station. Because the cdma2000 personality FS-K82 can synchronize to the test signal, the external trigger need not be used for this test.

**Remote Control Programming Example**

The Remote Control Programming Example will:

- generate a F-PICH signal using the SMIQ and SMIQ-B60 (for demonstration purposes only)
- setup the FS-K82 for frequency tolerance measurement
- read out the measurement value in ppm and Hz and display it.

**Typical measurement result**

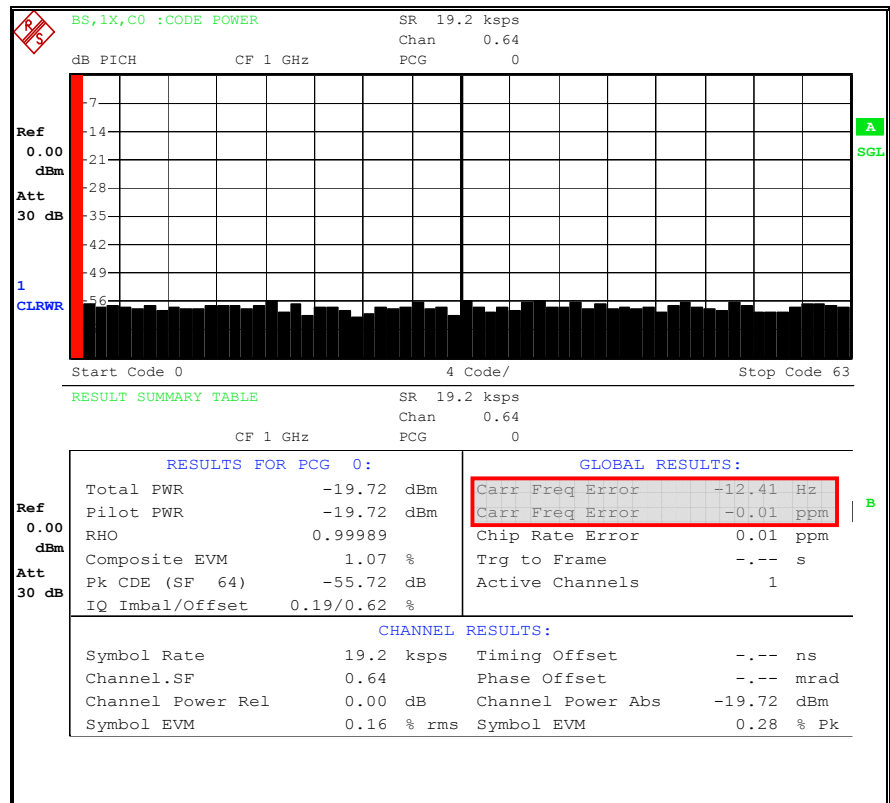


Fig. 4.1.2.2 - Frequency Tolerance measurement result

## 4.2.1 Synchronization and Timing

### 4.2.1.1 Pilot Timing Tolerance

Purpose	Basic instrument	Options	Used to
<i>measurement</i>	FSP, FSU or FSQ	FS-K82	measurement <b>item: trigger to frame</b>
<i>+ demonstration</i>	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate cdma2000 signal (BS simulation) <b>signal type: F-pilot channels only</b>

#### Test purpose

The time base reference shall be time-aligned to CDMA System Time. Reliable external means should be provided at each base station to synchronize each base station time base reference to CDMA System Time. Each base station should use a frequency reference with sufficient accuracy to maintain time alignment to CDMA System Time.

#### Test method

The function setup for this test is shown below:

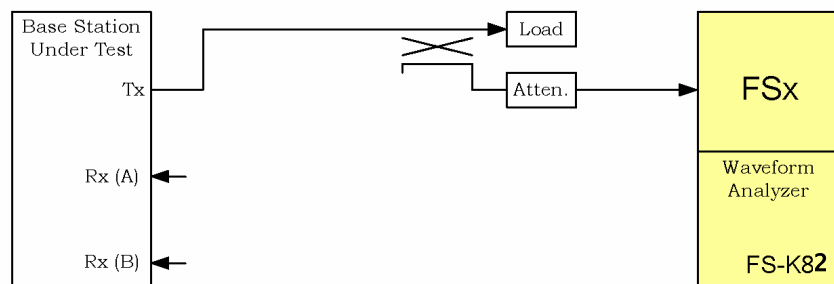


Fig. 4.2.1.1.1 - Pilot Timing Tolerance Test Setup

The test must be done for all CDMA channels (sector or alternate frequencies).

#### Test implementation hints

- Use of external trigger**  
 Select external trigger in order to make this measurement. If free-run trigger is selected, the result is -.- instead of a correct measurement value because the timing difference cannot be measured.  
 For demonstration, the SMIQ generates a frame trigger using TRIG OUT 1. Please connect option SMIQ-Z5 (BNC Adapter for rear panel) to the SMIQ and connect TRIG OUT 1 to EXT TRIGGER of FSx.

## cdma2000 BS Measurement According to C.S0010-A

- **Cable length compensation for external trigger**  
If the external trigger cable is very long, set up an external trigger delay to compensate the signal propagation delay.

### Remote Control Programming Example

The Remote Control Programming Example will:

- generate a BS signal using SMIQ and SMIQ-B60  
(for demonstration purposes only)
- setup the FS-K82 for pilot timing tolerance measurement
- read the trigger to frame value and display it.

### Typical measurement result



Fig. 4.2.1.1.2 - Pilot Timing Tolerance measurement result

### 4.2.1.2 Pilot Channel to Code Channel Timing Tolerance

Purpose	Basic instrument	Options	Used to
<i>measurement</i>	FSP, FSU or FSQ	FS-K82	measurement <b>item:</b> <i>timing offset</i>
<i>+ demonstration</i>	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate cdma2000 signal (BS simulation) <b>signal type:</b> <i>BS test model</i>

#### Test purpose

This test measures the error in timing between the radiated pilot channel and the other code channels transmitted out of the RF output port containing the same pilot channel within one Forward CDMA Channel.

#### Test method

The function setup for this test is shown below:

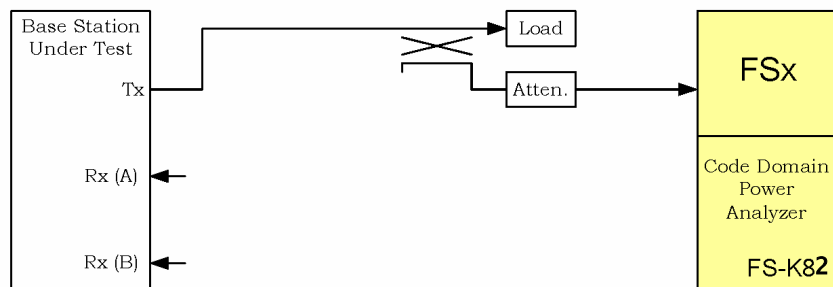


Fig. 4.2.1.2.1 - Pilot to Code Timing Tolerance Test Setup

The test must be done for all supported band classes.

#### Test implementation hints

- Dedicated code number measurement**  
 The measurement is only done for the active channels. The test model which is used in this test contains the pilot, the sync channel and 6 traffic channels.  
 If the corresponding code numbers are known, query the results direct from the FSx using the `SENS : CDP : CODE<x>` command.  
 If the code numbers are unknown, use the channel table mode and the `TRACE` query command.

**Remote Control Programming Example**

The Remote Control Programming Example will:

- generate a BS signal using SMIQ and SMIQ-B60 (for demonstration purposes only)
- setup the FS-K82 for pilot to code timing tolerance measurement
- read the pilot to code timing errors for all channels contained in the BS test model and display it.

**Typical measurement result**

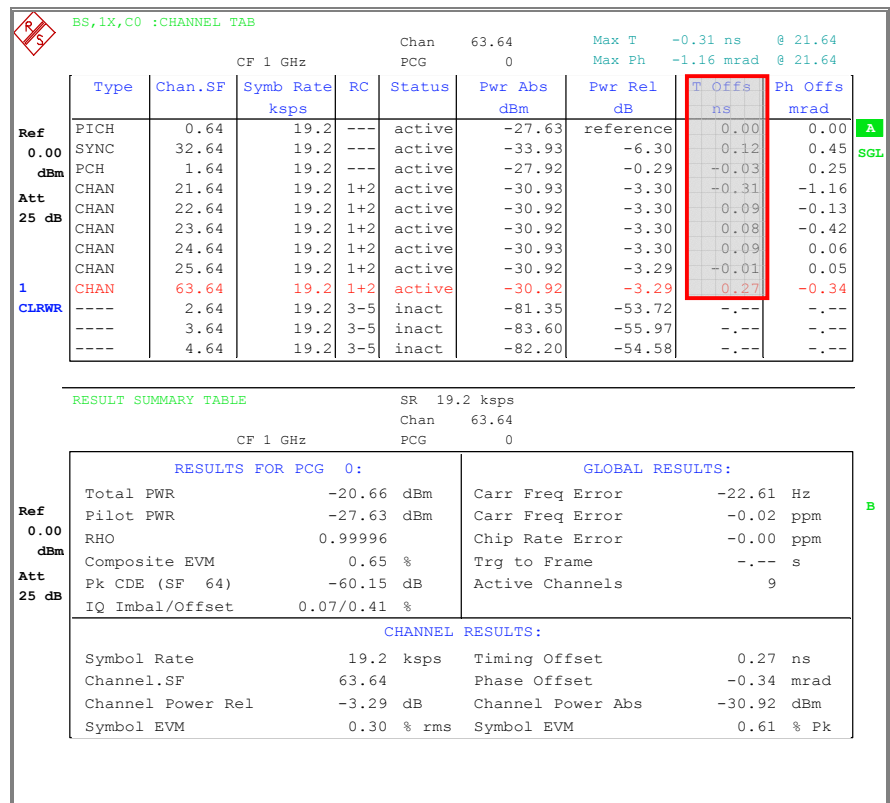


Fig. 4.2.1.2.2 - Pilot to Code Timing Tolerance measurement result

### 4.2.1.3 Pilot Channel to Code Channel Phase Tolerance

Purpose	Basic instrument	Options	Used to
<i>measurement</i>	FSP, FSU or FSQ	FS-K82	measurement <b>item:</b> <i>phase offset</i>
<i>+ demonstration</i>	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate cdma2000 signal (BS simulation) <b>signal type:</b> <i>BS test mode</i>

#### Test purpose

This test measures the error in phase between the radiated pilot channel and the other code channels transmitted out of the RF output port containing the same pilot channel within one Forward CDMA Channel.

#### Test method

The function setup for this test is shown below:

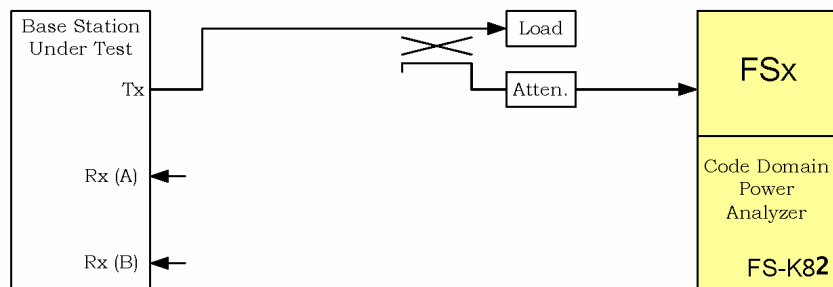


Fig. 4.2.1.3.1 - Pilot to Code Phase Tolerance Test Setup

The test must be done for all supported band classes.

#### Test implementation hints

- Dedicated code number measurement**  
 The measurement is only done for the active channels. The test model which is used in this test contains the pilot, the sync channel and 6 traffic channels.  
 If the corresponding code numbers is known, you can query the results direct from the FSx using the `SENS:CDP:CODE<x>` command.  
 If the code numbers is unknown, you can use the channel table mode and the `TRACE` query command.

**Remote Control Programming Example**

The Remote Control Programming Example will:

- generate a BS signal using the SMIQ and SMIQ-B60 (for demonstration purposes only)
- setup the FS-K82 for pilot to code phase tolerance measurement
- read the pilot to code phase errors for all channels contained in the BS test model and display it.

**Typical measurement result**

BS,1X,C0 :CHANNEL TAB									
						Chan 63.64	Max T 0.42 ns	@ 22.64	
						PCG 0	Max Ph 0.82 mrad	@ 22.64	
	Type	Chan.SF	Symb Rate ksp/s	RC	Status	Pwr Abs dBm	Pwr Rel dB	T Offs ns	Ph Offs mrad
Ref 0.00 dBm	PICH	0.64	19.2	---	active	-27.60	reference	0.00	0.00
	SYNC	32.64	19.2	---	active	-33.90	-6.30	0.26	-0.41
	PCH	1.64	19.2	---	active	-27.90	-0.30	0.26	-0.09
Att 25 dB	CHAN	21.64	19.2	1+2	active	-30.90	-3.30	0.22	0.19
	CHAN	22.64	19.2	1+2	active	-30.90	-3.30	0.42	0.82
	CHAN	23.64	19.2	1+2	active	-30.90	-3.30	0.39	0.22
	CHAN	24.64	19.2	1+2	active	-30.90	-3.30	0.06	0.39
	CHAN	25.64	19.2	1+2	active	-30.90	-3.30	0.22	0.17
1 CLRWR	CHAN	63.64	19.2	1+2	active	-30.90	-3.29	0.13	-0.03
	----	2.64	19.2	3-5	inact	-82.56	-54.95	--	--
	----	3.64	19.2	3-5	inact	-82.42	-54.82	--	--
	----	4.64	19.2	3-5	inact	-82.23	-54.63	--	--

RESULT SUMMARY TABLE									
						SR 19.2 ksp/s			
						Chan 63.64			
						PCG 0			
	RESULTS FOR PCG 0:					GLOBAL RESULTS:			
Ref 0.00 dBm	Total PWR		-20.63 dBm			Carr Freq Error		-23.21 Hz	
	Pilot PWR		-27.60 dBm			Carr Freq Error		-0.02 ppm	
	RHO		0.99996			Chip Rate Error		0.01 ppm	
Att 25 dB	Composite EVM		0.64 %			Trg to Frame		-- s	
	Pk CDE (SF 64)		-59.54 dB			Active Channels		9	
	IQ Imbal/Offset		0.06/0.41 %						
CHANNEL RESULTS:									
	Symbol Rate		19.2 ksp/s			Timing Offset		0.13 ns	
	Channel.SF		63.64			Phase Offset		-0.03 mrad	
	Channel Power Rel		-3.29 dB			Channel Power Abs		-30.90 dBm	
	Symbol EVM		0.26 % rms			Symbol EVM		0.46 % Pk	

Fig. 4.2.1.3.2 - Pilot to Code Phase Tolerance measurement result



## 4.2.2 Waveform Quality

Purpose	Basic instrument	Options	Used to
<i>measurement</i>	FSP, FSU or FSQ	FS-K82	measurement <b>item:</b> <i>rho factor</i>
<i>+ demonstration</i>	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate cdma2000 signal (BS simulation) <b>signal type:</b> <i>F-PCH only</i>

### Test purpose

This measurement verifies the correlation between ideal and real waveform. Errors like wrong filter coefficients or IQ modulator problems can be seen very easily using this test setup.

### Test method

The function setup for this test is shown below:

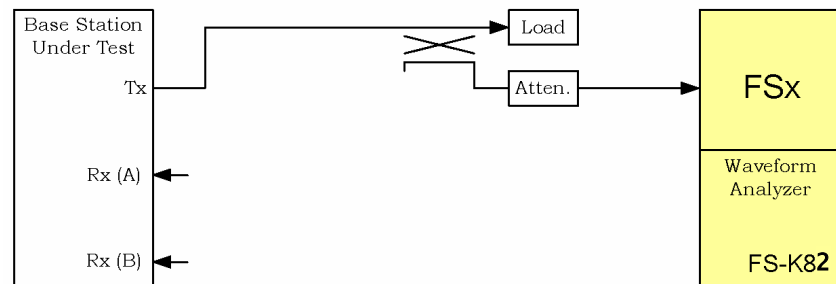


Fig. 4.2.2.1 - Waveform Quality Test Setup

The test must be done for all supported band classes.

The test must be done for both normal and - if supported - transmit diversity mode.

The test is done with a signal containing only the Forward Pilot Channel (F-PICH) or - if supported and tested - the Transmit Diversity Pilot Channel (F-TDPICH).

### Test implementation hints

- Use of external trigger**  
 The standard describes the use of an external trigger (system time reference signal) from the base station. Because the cdma2000 personality FS-K82 can synchronize to the test signal, the external trigger need not be used for this test.

**Remote Control Programming Example**

The test signal can be provided from either the base station or SMIQ (for demonstration and evaluation). The Remote Control Programming Example will:

- generate a F-PICH signal using the SMIQ and SMIQ-B60 (for demonstration purposes only)
- setup the FS-K82 for waveform quality measurement
- read the RHO factor and display it.

**Typical measurement result**

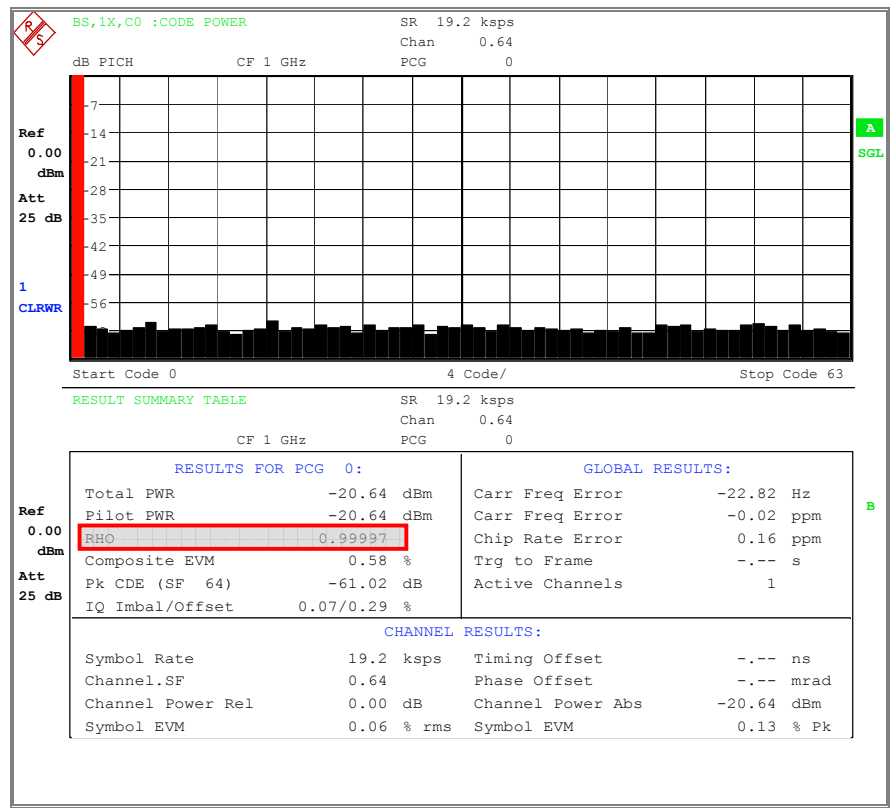


Fig. 4.2.2.1 - Waveform Quality measurement result

## 4.3 RF Output Power Requirements

### 4.3.1 Total Power

Purpose	Basic instrument	Options	Used to
<i>measurement</i>	FSQ, FSU or FSP	---	measurement <b>item: total signal power</b>
<i>+ demonstration</i>	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate cdma2000 signal (BS simulation) <b>signal type: BS test model</b>

#### Test purpose

The total power is the mean power delivered to a load with resistance equal to the nominal load impedance of the transmitter.

This test verifies that the power control and output RF components work correctly and provide the specified output power.

#### Test method

The function setup for this test is shown below:

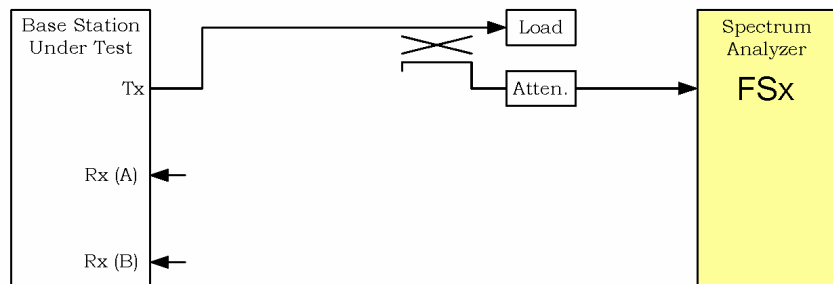


Fig. 4.3.1.1 - Total Power Test Setup

The test must be done for all supported band classes with the standard test model.

#### Test implementation hints

- Measurement with power meter**  
 This measurement can also be done very easily using the NRP power meter and NRP-Z11 power sensor.  
 Please refer to the manual of the NRP in order to get more informations about the cdma2000 functionality.

### Demo IEEE bus example

The two Remote Control Programming Examples will:

- generate a BS signal using SMIQ and SMIQ-B60  
(for demonstration purposes only)
- setup either the FS-K82 or the normal analyzer function for channel power measurement
- read the power value and display it.

### Typical measurement result

The measurement result is shown for the FS-K82 power measurement function.

The standard spectrum analyzer function has a similar display.

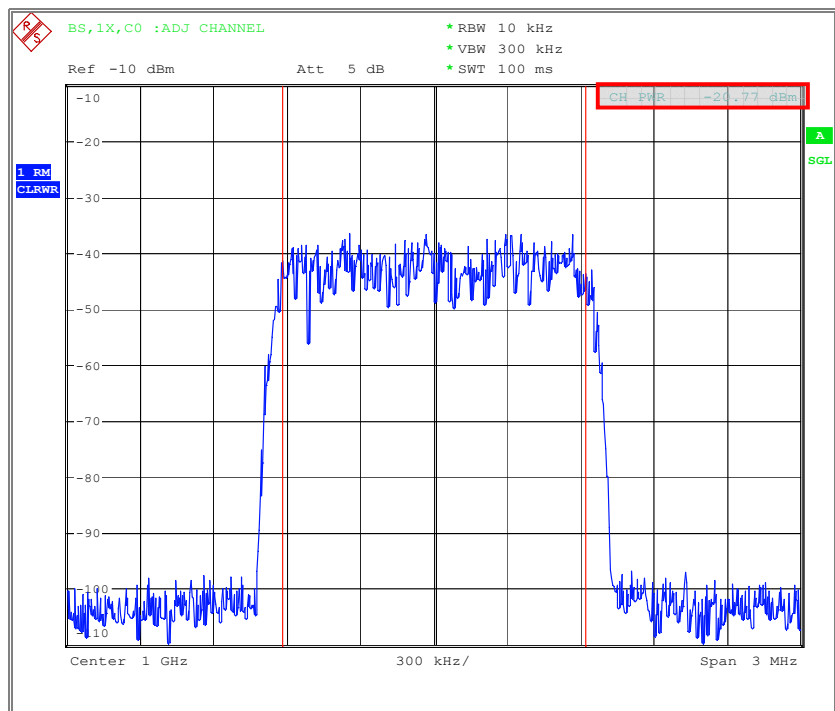


Fig. 4.3.1.1 - Total Power measurement result

### 4.3.2 Pilot Power

Purpose	Basic instrument	Options	Used to
measurement	FSP, FSU or FSQ	FS-K82	measurement <b>item:</b> <i>pilot power</i>
+ demonstration	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate cdma2000 signal (BS simulation) <b>signal type:</b> <i>BS test model</i>

#### Test purpose

The Pilot Channel power to total power ratio is the power attributed to the Pilot Channel divided by the total power. The Code Domain Power Analyzer is used to determine the ratio of the Pilot Channel power to the total power.

This ensures that the spreading rate and the baseband I/Q data scaling are implemented correct.

#### Test method

The function setup for this test is shown below:

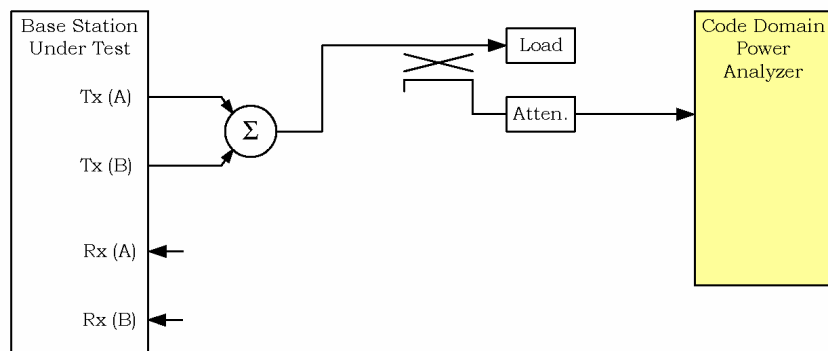


Fig. 4.3.2.1 - Pilot Power Test Setup

The test must be done for all supported band classes.

The ratio between the Pilot Channel power and the total power is measured in this test.

#### Test implementation hints

---

**Remote Control Programming Example**

The Remote Control Programming Example will:

- generate a BS signal using SMIQ and SMIQ-B60 (for demonstration purposes only)
- setup the FS-K82 for code domain measurement to measure total and pilot power
- read out the total and pilot power and display it.

**Typical measurement result**

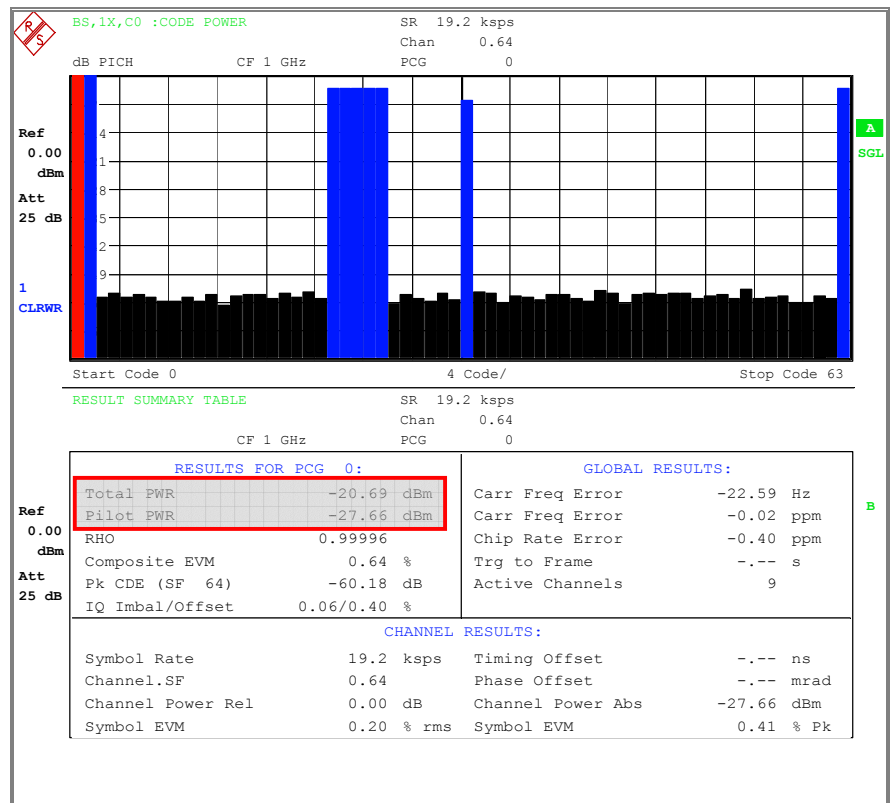


Fig. 4.3.2.2 - Pilot Power measurement result

### 4.3.3 Code Domain Power

Purpose	Basic instrument	Options	Used to
measurement	FSP, FSU or FSQ	FS-K82	measurement <b>item: code domain power</b>
+ demonstration	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate cdma2000 signal (BS simulation) <b>signal type: Fund. Test Modes</b>

#### Test purpose

This measurement evaluates the orthogonality between the different codes. It ensures that the spread code generation and the I/Q-modulator are working correctly. Error can be verified if the code domain power in unused slots gets too high.

#### Test method

The function setup for this test is shown below:

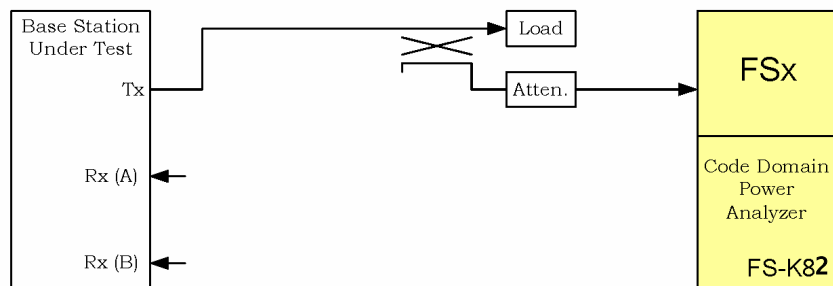


Fig. 4.3.3.1 - Code Domain Power Test Setup

The test must be done for all supported band classes and all supported radio configurations (grouped in 3 different sub-groups 1+2, 3+4 and 5+6) at maximum output power.

It must be done for transmit diversity if supported by the base station.

Depending on the radio configuration, the power in all inactive channels must be 27 to 33 dB below the total output power of the carrier.

#### Test implementation hints

---

#### Remote Control Programming Example

The Remote Control Programming Example will:

- generate a BS signal using SMIQ and SMIQ-B60  
(for demonstration purposes only)
- setup the FS-K82 for code domain measurement to measure total and pilot power
- read out the power of the individual channels and display it.

Typical measurement result

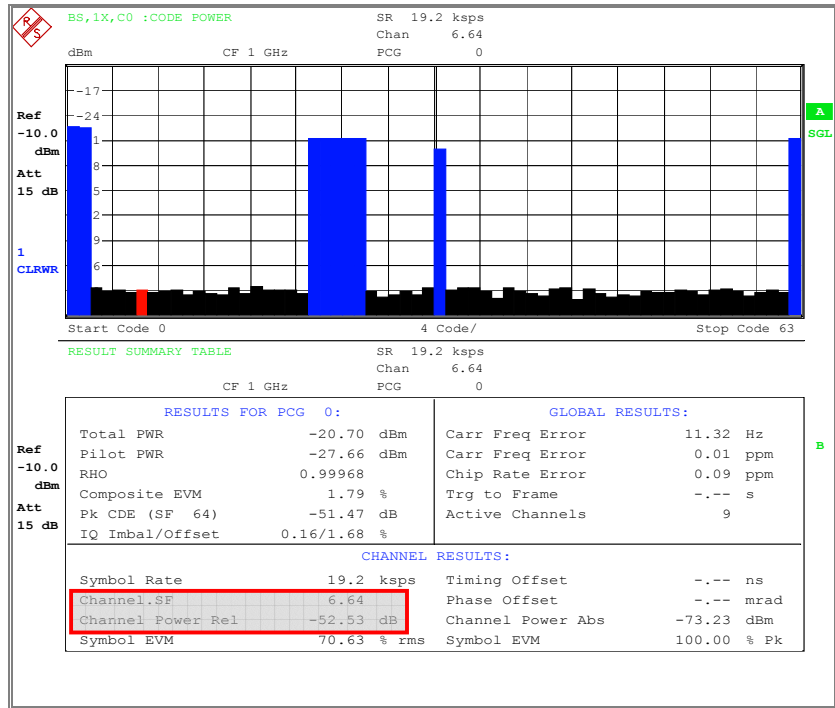


Fig. 4.3.3.2 - Code Domain Power measurement result



## 4.4 Limitations on Emissions

### 4.4.1 Conducted Spurious Emissions

Purpose	Basic instrument	Options	Used to
<i>measurement</i>	FSP, FSU or FSQ	---	measurement <b>item:</b> <i>spurious emission level</i>
<i>+ demonstration</i>	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate cdma2000 signal (BS simulation) <b>signal type:</b> <i>BS test model</i>

#### Test purpose

This measurement verifies that there are no harmonic or oscillator breakdowns which have significant influence on the Tx output signal.

#### Test method

The function setup for this test is shown below:

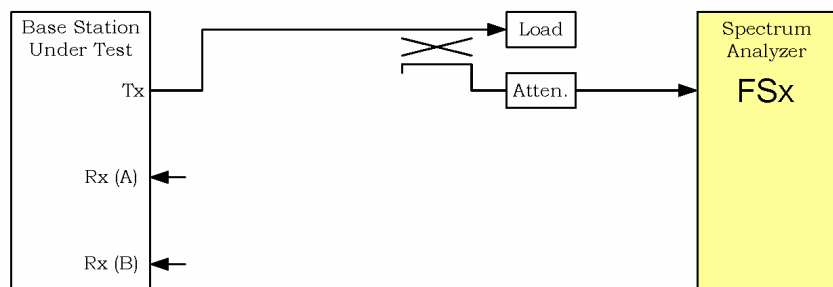


Fig. 4.4.1.1 - Conducted Spurious Emissions Test Setup

This test must be done for all supported band classes. Run the test in the presence of a standard test model signal at the Tx output. If the feature is supported by the base station, the test must also be done for multi carrier output.

#### Test implementation hints

- Spectrum emission mask measurement using FS-K82 personality**  
 The test must be performed with different frequency limits and different resolution bandwidth filters (RBW). For the measurement close to the carrier (with up to 4 MHz spacing from the carrier), the spectrum emission mask measurement feature from the cdma2000 personality FS-K82 can be used. This feature takes into account the selected band class and the channel power (for relativ limits) and does a very quick limit check.

## cdma2000 BS Measurement According to C.S0010-A

- **Special 1MHz bandwidth measurement**  
For a standard measurement with setting start and stop frequency and resolution bandwidth, the bandwidth of 1 MHz for measurement in the range of 2.25 to 4 MHz around the carrier is not sufficient to suppress the carrier. So, a different filter type (channel filter) must be selected to get a sufficient suppression.
- **Band Class 6 limits**  
The additionally defined limits for BC 6 are hard to measure. Use an additional filter to suppress the Tx signal and then measure the spurious signals.

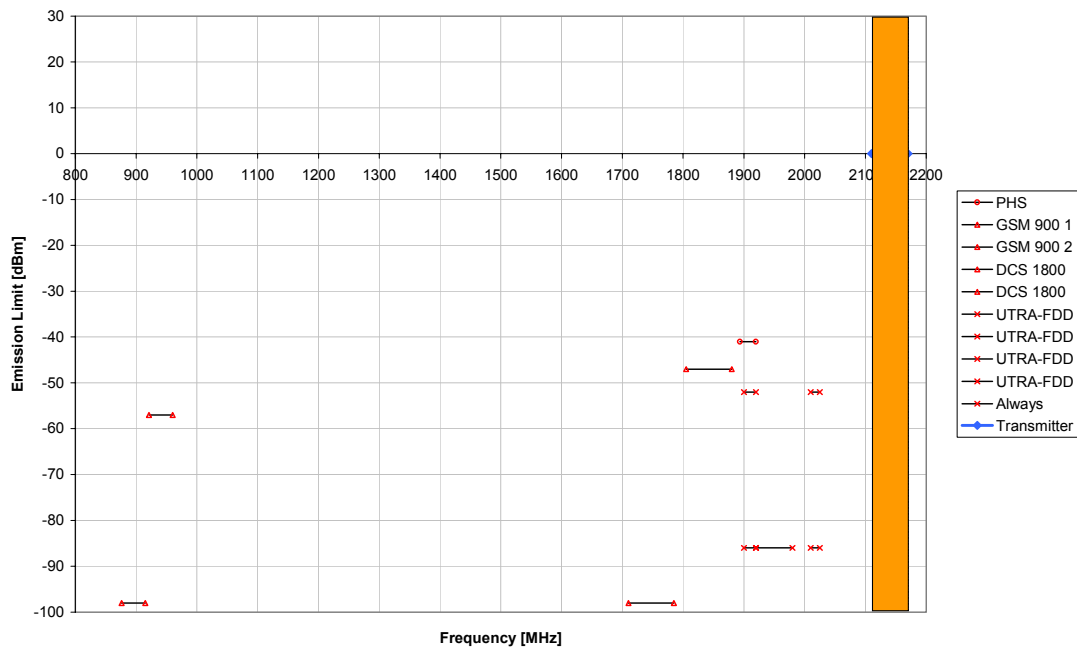


Fig. 4.4.1.2 - BC 6 Tx spurious emission limits

### Remote Control Programming Example

The Remote Control Programming Example will:

- generate a BS signal using SMIQ and SMIQ-B60  
(for demonstration purposes only)
- measure all conducted spurious emission limits using a spectrum analyzer in individual single sweep mode and display it.

## **4.4.2 Radiated Spurious Emissions**

<b>Purpose</b>	<b>Basic instrument</b>	<b>Options</b>	<b>Used to</b>
<i>measurement</i>	FSP, FSU or FSQ	---	measurement item: <i>spurious emission level</i>

### **Test purpose**

Current region-specific radio regulation rules shall apply.

### **Test method**

For testing radiated spurious emissions, an antenna must be connected to the spectrum analyzer, and the radiated power must be measured.

No receiver radiated spurious emissions are explicitly stated. Current region-specific radio regulation rules shall apply.

Please refer to the standard documents for your region in order to test radiated spurious emissions.

### **Test implementation hints**

---

### **Remote Control Programming Example**

Because this is a region-specific tests, there is no IEEE example provided for this test.

The structure is the same as in test 4.4.1 - Conducted Spurious Emissions.

### **Typical measurement result**

---

### 4.4.3 Inter-Base Station Transmitter Intermodulation

Purpose	Basic instrument	Options	Used to
measurement	FSP, FSU or FSQ	---	measurement <b>item:</b> <i>spurious emission level</i>
	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate interfering BS signal (External Base Station) <b>signal type:</b> <i>BS test model</i>
+ demonstration	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate cdma2000 signal (BS simulation) <b>signal type:</b> <i>BS test model</i>

#### Test purpose

The test verifies that conducted spurious emissions are still met with the presence of an external base station signal at a level 30 dB below the usefull base station signal and with offset frequency at the Tx output.

#### Test method

The function setup for this test is shown below:

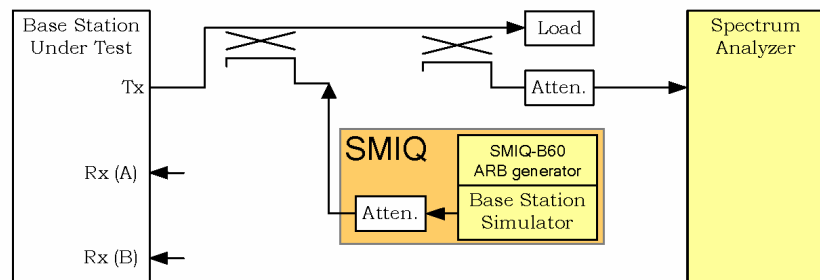


Fig. 4.4.3.1 - Inter-Base Station Transmitter Intermodulation Test Setup

This test must be done for all supported band classes. The test is done in the presence of a standard test model signal at the Tx output.

#### Test implementation hints

- Spectrum Analyzer frequency choice:**  
The center frequency must be set to a frequency equal to 2 x the BS Under Test frequency minus the External BS frequency.  
So, if the BS Under Test frequency is 1000 MHz, the External BS frequency must be set to (1000 + 1.25) MHz and (1000 - 1.25) MHz, the Spectrum Analyzer must be set to (1000 - 1.25) and (1000 + 1.25) MHz.
- Emission Limits**  
The emission limits are the same as required in test 4.4.1 – Conducted Spurious Emissions.  
For the Remote Control Programming Example, the channel power in the adjacent channel region is measured. For spurious emission measurement, you can use the sequences provided with test 4.4.1 for the BC you want to measure.

### Remote Control Programming Example

The Remote Control Programming Example will:

- generate a BS signal using SMIQ and SMIQ-B60  
(for demonstration purposes only)
- setup the FSx to measure channel power and measure the channel power of the BS
- set the SMIQ level and frequency to generate the signal as required for the interfering BS for positiv and negativ offset frequency
- measure the power in the adjacent channel relativ to the power of the BS and display it.

### Typical measurement result

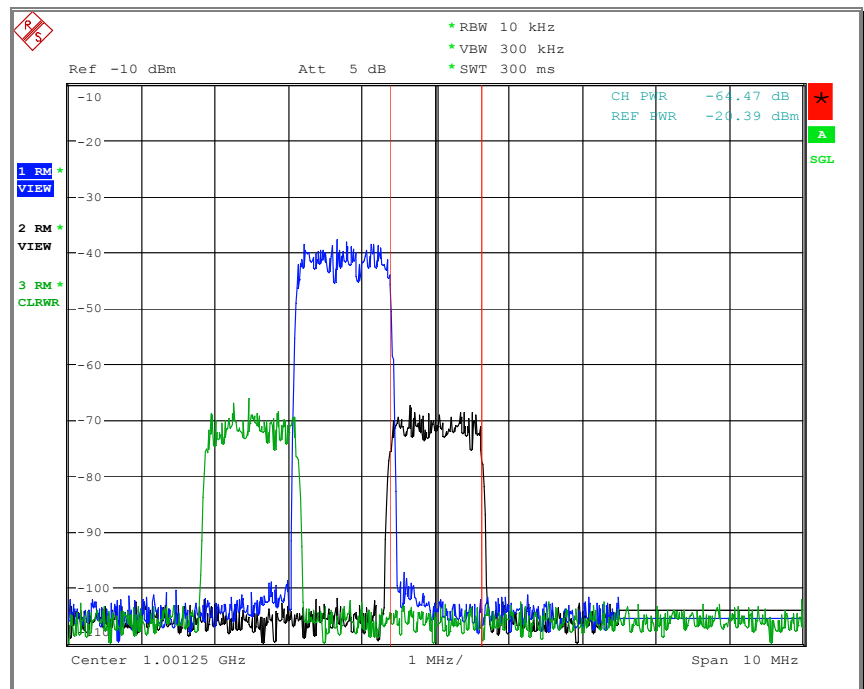


Fig. 4.4.3.2 - Inter-Base Station Transmitter Intermodulation measurement result

### 4.4.4 Occupied Bandwidth

Purpose	Basic instrument	Options	Used to
<i>measurement</i>	FSP, FSU or FSQ	---	measurement item: <i>OBW</i>
<i>+ demonstration</i>	SMIQ + SMIQB60 or SMIQ + AMIQ	SMIQ-K12 or AMIQ-K12	generate cdma2000 signal (BS simulation) signal type: <i>BS test model</i>

#### Test purpose

This test verifies the correct width of the transmitted signal. Effects such as wrong modulation filter or clock rate can lead to a occupied bandwidth that is too wide.

#### Test method

The function setup for this test is shown below:

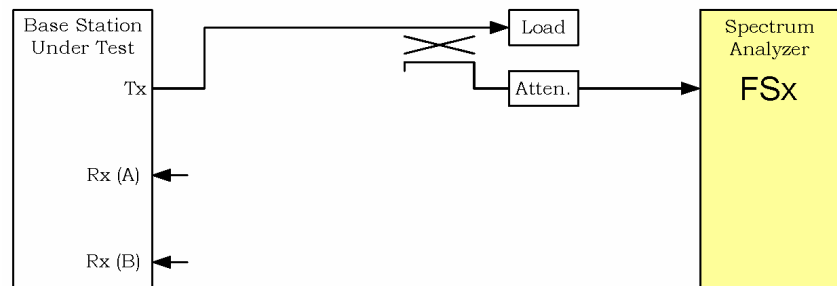


Fig. 4.4.4.1 - Occupied Bandwidth Test Setup

The test applies to Band Classes 3 and 6 only and calculates the bandwidth where 99 % of the signal power can be found.

The test is done using a 30 kHz RBW filter.

#### Test implementation hints

---

#### Remote Control Programming Example

The Remote Control Programming Example will:

- generate a BS signal using SMIQ and SMIQ-B60  
(for demonstration purposes only)
- setup the FS-K82 for occupied bandwidth measurement
- read out the measurement value and display it.

**Typical measurement result**

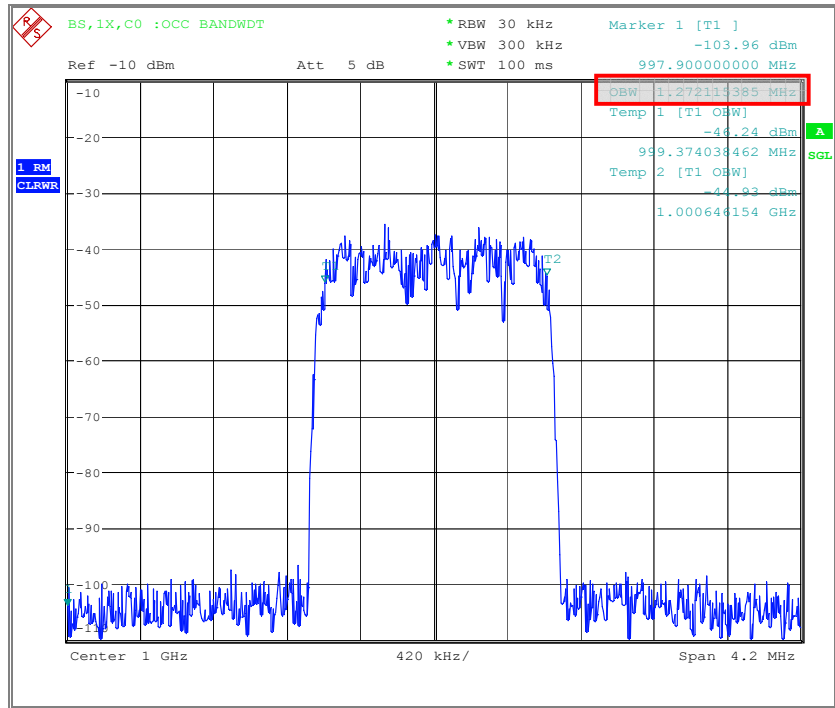


Fig. 4.4.4.2 - Occupied Bandwidth measurement result

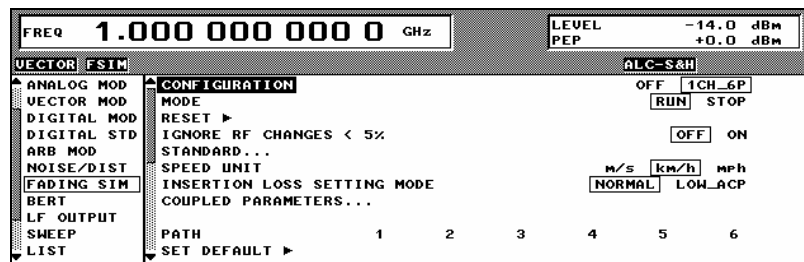
## 5. Manual fading simulator configuration

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

The individual profiles are listed in the table below:

Configuration	I	II	III	IV
Base station fading configuration according to 3GPP2 C.S0010-A	1	2	3	4
Speed [km/h]	3	8	30	100
Number of paths	1	2	1	3
Power, path 2 [dB]	---	0	---	0
Power, path 3 [dB]	---	---	---	-3
Delay, path 1 [ $\mu$ s]	0	0	0	0
Delay, path 2 [ $\mu$ s]	---	2.0	---	2.0
Delay, path 3 [ $\mu$ s]	---	---	---	14.5

## General Settings



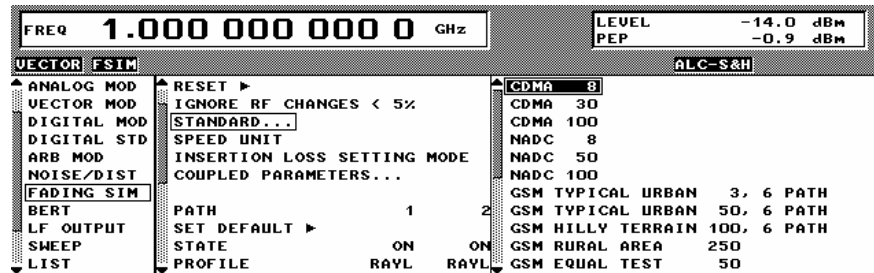
## Configurations

### Configuration I

This configuration has to be set manually:

### Configuration II

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





**Configuration III**

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

FREQ <b>1.000 000 000 0</b> GHz		LEVEL -14.0 dBm
		PEP -2.7 dBm
<b>VECTOR</b> <b>FSIM</b>	<b>ALC-S&amp;H</b>	
ANALOG MOD	RESET ▶	CDMA 8
VECTOR MOD	IGNORE RF CHANGES < 5%	<b>CDMA 30</b>
DIGITAL MOD	STANDARD...	CDMA 100
DIGITAL STD	SPEED UNIT	NADC 8
ARB MOD	INSERTION LOSS SETTING MODE	NADC 50
NOISE/DIST	COUPLED PARAMETERS...	NADC 100
<b>FADING SIM</b>		GSM TYPICAL URBAN 3, 6 PATH
BERT	PATH 1 2	GSM TYPICAL URBAN 50, 6 PATH
LF OUTPUT	SET DEFAULT ▶	GSM HILLY TERRAIN 100, 6 PATH
SWEEP	STATE ON OF	GSM RURAL AREA 250
LIST	PROFILE RAYL RAYL	GSM EQUAL TEST 50

**Configuration IV**

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

FREQ <b>1.000 000 000 0</b> GHz		LEVEL -14.0 dBm
		PEP +0.0 dBm
<b>VECTOR</b> <b>FSIM</b>	<b>ALC-S&amp;H</b>	
DIGITAL STD	CONFIGURATION	CDMA 8
ARB MOD	MODE	CDMA 30
NOISE/DIST	RESET ▶	<b>CDMA 100</b>
<b>FADING SIM</b>	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		GSM HILLY TERRAIN 100, 6 PATH
UTILITIES	PATH 1 2	GSM RURAL AREA 250
HELP	SET DEFAULT ▶	GSM EQUAL TEST 50

## 6. Notes

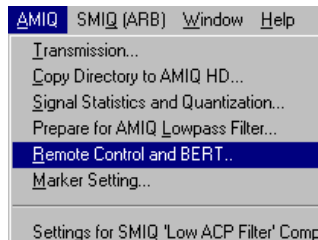
### Enabling the WinIQSIM Option for cdma2000

The AMIQ-K12 or the SMIQ-K12 option as applicable must be enabled to 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:

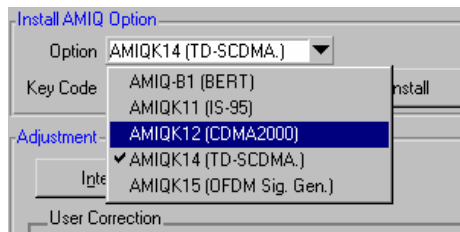
1. Open the dialog box for remote control of the AMIQ:



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

To install the option in SMIQ, select the following submenu:

## cdma2000 BS Measurement According to C.S0010-A

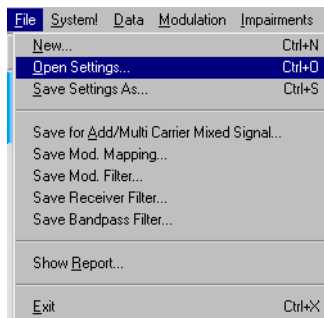


Enter the installation key.

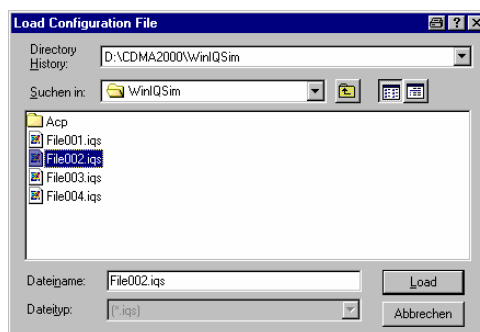
## Loading WinIQSIM Files onto AMIQ

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

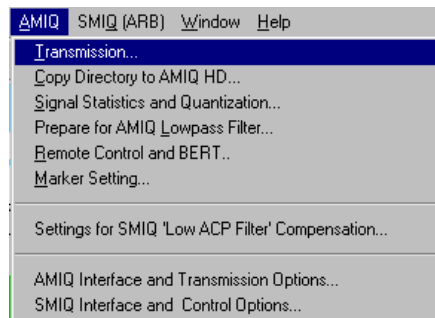
1. Open the dialog box for loading settings:



2. Select the appropriate file:

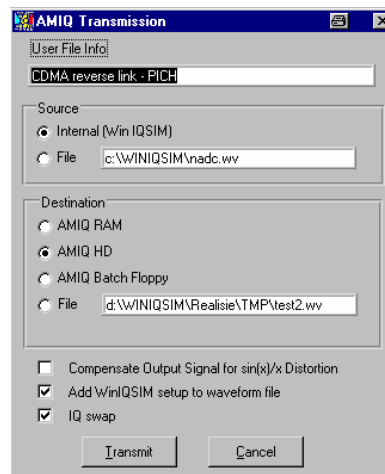


3. Select the option for transmission to AMIQ:



4. Select the destination for the waveform:

- 5.



- "Destination – AMIQ RAM": The waveform is loaded directly into the main memory of the AMIQ.
- "Destination – AMIQ HD": The waveform is copied onto the hard disk.

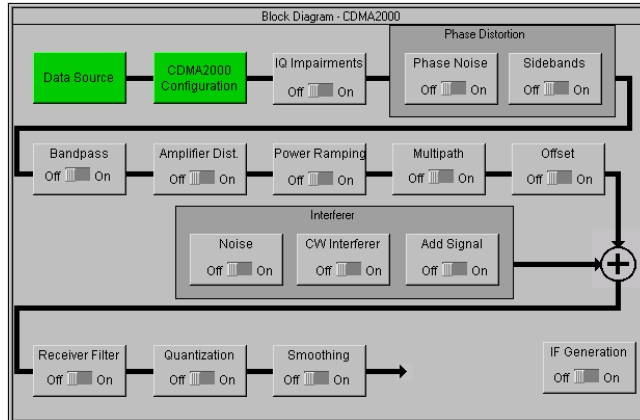
**NOTE:**

To generate cdma2000 signals the cdma2000 option for the AMIQ must be enabled.

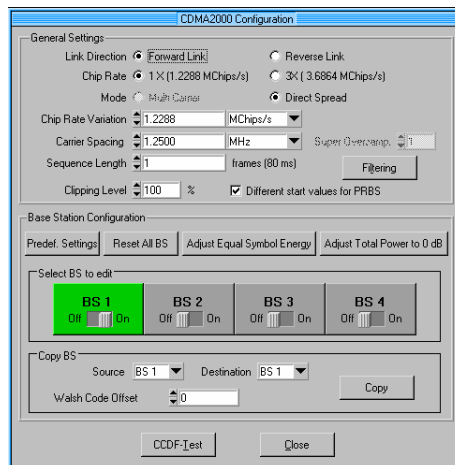
## Straightforward Setups in WinIQSIM

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

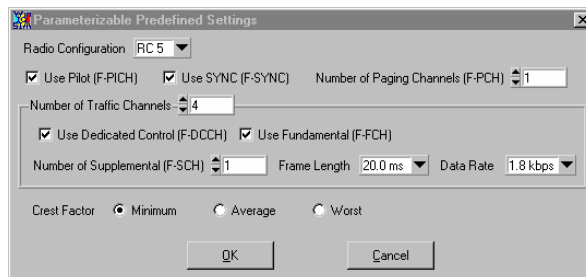
1. Select “CDMA2000 Configuration” from the Block Diagram window:



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.

## **7. 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? SYNC FAILED appears on the screen, and all channels show nearly the same power.**
  - Is RF power applied at the correct frequency and level?
  - Is there a cdma2000 signal with correct PN offset?
  - 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 is it that code power of the unused channels is too high?**

The send signal is perhaps 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 (LEVME)"**

The standard is open to interpretation in this respect, and for this reason there is no reverse filter as such, only a reverse filter and an equalizer filter that is used in conjunction with the reverse filter in the forward link. Consequently, you should use the following

- "CDMA2000 1x + Equalizer (LEVME)" 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 you use EVM optimized filters when creating signals for vector signal evaluation. WinIQSIM can also be used to create manufacturer-specific filters for proprietary applications.

## 8. Appendix

### Abbreviations

<b>Abbrev.</b>	<b>Meaning</b>
<b>ACH</b>	Access Channel
<b>ACP</b>	Adjacent Channel Power
<b>ACPR</b>	Adjacent Channel Power Ratio
<b>AWGN</b>	Additive White Gaussian Noise
<b>BC</b>	Band Class (set of uplink and downlink frequencies)
<b>BER</b>	Bit Error Rate
<b>BS</b>	Base Station
<b>CCH</b>	Common Control Channel
<b>CDMA</b>	Code Division Multiple Access
<b>CDP</b>	Code Domain Power
<b>CW</b>	Continuous Wave (unmodulated signal)
<b>DS</b>	Direct Sequence (mode for accessing the air interface)
<b>F-...</b>	Forward ...
<b>FCH</b>	Fundamental Channel
<b>FCH</b>	Fundamental Channel
<b>FER</b>	Frame Error Rate
<b>FL</b>	Forward Link (from BS to MS)
<b>LSO</b>	Loopback Service Option
<b>MAC</b>	Medium Access Control
<b>MC</b>	Multi Carrier (mode for accessing the air interface)
<b>MS</b>	Mobile Station
<b>MSO</b>	Markov Service Option
<b>PCH</b>	Paging Channel
<b>PEP</b>	Peak Average Power
<b>PICH</b>	Pilot Channel
<b>PRBS</b>	Pseudo Random Noise Sequence
<b>R-...</b>	Reverse ...
<b>RBW</b>	Resolution Bandwidth
<b>RC</b>	Radio Configuration
<b>RL</b>	Reverse Link (from MS to BS)
<b>RSQI</b>	Received Signal Quality Indicator
<b>Rx</b>	Receive
<b>SCCH</b>	Supplemental Code Channel
<b>SCH</b>	Supplemental Channel
<b>SO</b>	Service Option
<b>SR</b>	Spreading Rate
<b>SYNC</b>	Sync Channel
<b>TD</b>	Transmit Diversity
<b>TDPICH</b>	Transmit Diversity Pilot Channel
<b>TDSO</b>	Test Data Service Option
<b>Tx</b>	Transmit

## Enclosed WinIQSIM Files and SMIQ-B60 operation

The following files are provided with this Application Note:

File Name	Mode	RC	Channels	Crest	Used for Test
1xBsMod	Forward 1x	1	PICH, SYNC, PCH FCH, 5xSCH	10,32	4.2.1.2, 4.2.1.3, 4.3.1 4.3.2, 4.4.1, 4.4.3, 4.4.4
1xFFCH1	Forward 1x	1	PICH FCH @ 9.6 kbps	7,57	4.2.3 4.3.3
1xPilot	Forward 1x	1	PICH	6,81	4.1.2, 4.2.1.1 4.2.2
1xRACH	Reverse 1x	1	ACH	5,37	3.2
1xRCCCH	Reverse 1x	1	CCCH	4,47	3.3.1 3.3.2
1xRFCH1	Reverse 1x	1	FCH @ 9.6 kbps	5,33	3.4.1, 3.4.2, 3.4.3, 3.5.1, 3.5.2 3.5.3, 3.5.4, 3.5.5, 3.7

**For all signals (unless otherwise stated):**

**Length** 1 Frame (80 ms)  
**Oversampling** 2  
**Used AMIQ blocks** 4  
**Forward filter** is95eq320.ifl

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]**).

Due to the internal memory organization, the SMIQ always uses the internal memory in blocks of 65.527 samples and can hold 22 blocks in its nonvolatile memory.

A frame with 80 ms length uses 196.608 samples and occupies 4 blocks. So, 5 different cdma2000 waveforms can be stored in SMIQ-B60 at one time.



## **9. Additional Informations**

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

## **10. Literature**

1. *Generating and Analyzing cdma2000 Signals*, Application Note 1MA34, Rohde & Schwarz
2. *Digital standards IS-95 and CDMA2000 – Supplement to SMIQ, AMIQ and WinIQSIM, PD 757.5908.2*
3. *cdmaOne Base Station Tests – Application Firmware Module FSIQK71*, Operation Manual
4. *cdma2000 Base Station Test - Application Firmware R&S FS-K82*, Operation Manual
5. *Recommended Minimum Performance Standards for cdma2000 Spread Spectrum Base Stations, 3GPP2 C.S0010*
6. *Recommended Minimum Performance Standard for Base Stations Supporting Dual-Mode Spread Spectrum Cellular Mobile Stations, ANSI/TIA/EIA-97*
7. *Recommended Minimum Performance Standards for cdma2000 Spread Spectrum Base Stations, ARIB STD-T64-C.S0010*
8. *Loopback Service Options (LSO) for cdma2000 Spread Spectrum Systems, 3GPP2 C.S0013*
9. *Test Data Service Option (TDSO) for cdma2000 Spread Spectrum Systems, 3GPP2 C.S0026*
10. *Markov Service Option (MSO) for cdma2000 Spread Spectrum Systems, 3GPP2 C.S0025*
11. *Physical Layer Standard for cdma2000 Spread Spectrum Systems, IS-2000-2*

## 11. Ordering Information

### **I/Q Modulation Generator**

R&S AMIQ	Max. 16 Msamples I and Q	1110.2003.04
R&S AMIQ-K12	cdma2000 option	1122.2503.02
R&S SMIQ-B60	Max. 512 Ksamples I and Q	1136.4390.02
R&S SMIQ-K12	cdma2000 option	1105.0435.02
R&S WinIQSIM	IQ simulation software (Version 3.50 or later)	1110.3600.02

### **Vector Signal Generator**

R&S SMIQ02B	0.3 ... 2.2 GHz	1125.5555.02
R&S SMIQ03B	0.3 ... 3.3 GHz	1125.5555.03
R&S SMIQ04B	0.3 ... 4.4 GHz	1125.5555.04
R&S SMIQ06B	0.3 ... 6.4 GHz	1125.5555.06
R&S SMIQ03HD	0.3 ... 3.3 GHz	1125.5555.33
R&S SMIQ-Z5	BNC Adapter for rear panel	1104.8555.02
R&S SMIQ-B14	Fading Simulator	1085.4002.02
R&S SMIQ-B17	Noise and Distortion Simulator	1104.9000.02

### **Signal Analyzer, Spectrum Analyzer and Options**

R&S FSIQ3	20 Hz ... 3.5 GHz	1119.5005.13
R&S FSIQ7	20 Hz ... 7 GHz	1119.5005.17
R&S FSIQ26	20 Hz ... 26.5 GHz	1119.6001.27
R&S FSIQ40	20 Hz ... 40 GHz	1119.6001.40
R&S FSIQK71	cdmaOne BTS test	1126.4498.02
R&S FSP3	9 kHz ... 3 GHz	1093.4495.03
R&S FSP7	9 kHz ... 7 GHz	1093.4495.07
R&S FSP13	9 kHz ... 13 GHz	1093.4495.13
R&S FSP30	9 kHz ... 30 GHz	1093.4495.30
R&S FSP40	9 kHz ... 40 GHz	1093.4495.40
R&S FS-K82	cdma2000 BS Personality	1157.2316.02
R&S FSU3	20 Hz ... 3.6 GHz	1129.9003.03
R&S FSU8	20 Hz ... 8 GHz	1129.9003.08
R&S FSU26	20 Hz ... 26,5 GHz	1129.9003.26
R&S FS-K82	cdma2000 BS Personality	1157.2316.02
R&S FSQ3	20 Hz ... 3.6 GHz	1155.5001.03
R&S FSQ8	20 Hz ... 8 GHz	1155.5001.08
R&S FSQ26	20 Hz ... 26,5 GHz	1155.5001.26
R&S FS-K82	cdma2000 BS Personality	1157.2316.02

### **Power Meter and Options**

R&S NRP	Power Meter	1143.8500.02
R&S NRP-Z11	Power Sensor 10 MHz ... 8 GHz	1138.3004.02
R&S NRP-Z3	USB Adapter (active)	1146.7005.02
R&S NRP-Z4	USB Adapter (passive)	1146.8001.02



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