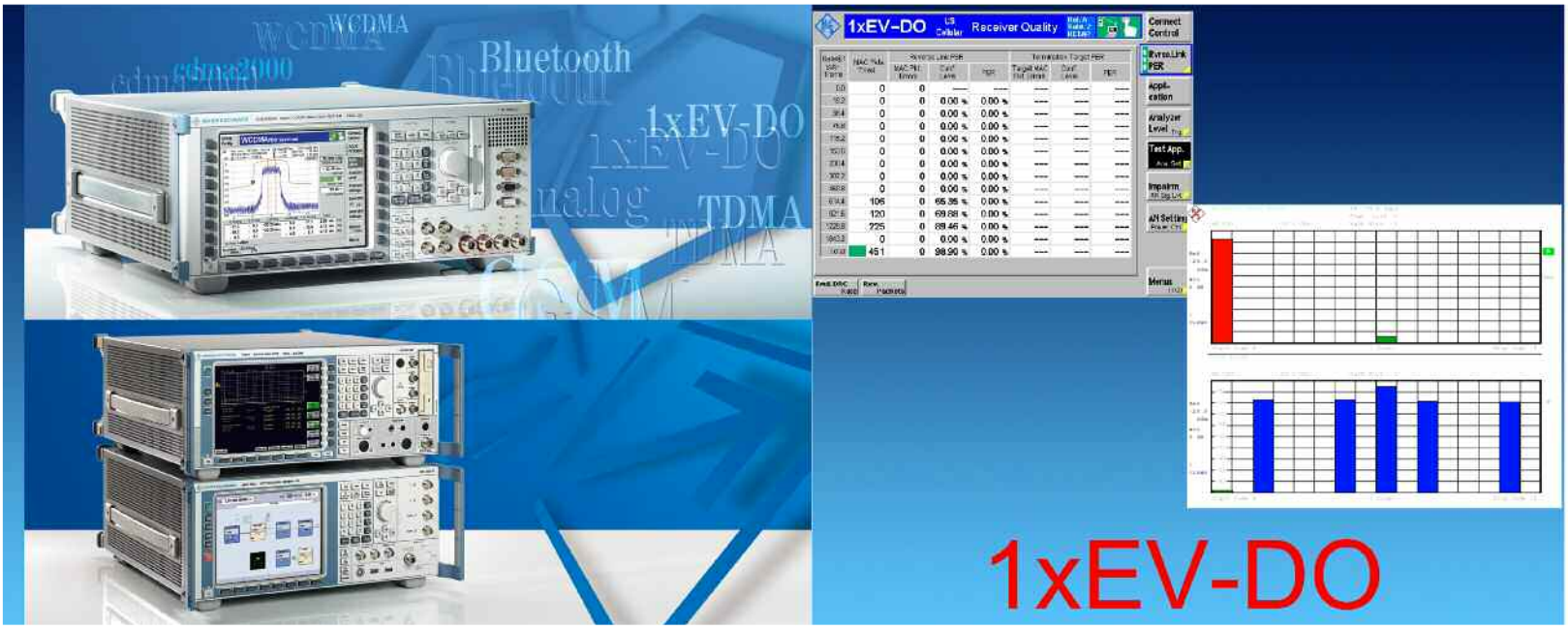

Products: R&S® SMU200A Vector Signal Generator, R&S® FSP, R&S® FSU, R&S® FSQ Spectrum Analyzers, R&S® CMU200 Radio Communication Tester

1xEV-DO – Test Solutions

Application Note 1MA112

This application note provides a summary of the current test solutions available with Rohde & Schwarz equipment. The opportunities provided by the individual devices are presented briefly and a demonstration using a spectrum analyzer and a vector signal generator is described.

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The following abbreviations are used in this application note for Rohde & Schwarz test equipment:

- The R&S® SMU vector signal generator is referred to as SMU.
- The R&S® FSP spectrum analyzer is referred to as FSP.
- The R&S® FSU spectrum analyzer is referred to as FSU.
- The R&S® FSQ signal analyzer is referred to as FSQ.
- The FSP, FSU, and FSQ are referred to in common as FSx.
- The R&S® CMU200 is referred to as CMU.

1 Overview

CDMA2000® 1xEV-DO (TIA/EIA-856-A), officially recognized by the ITU as an IMT-2000 3G standard, is the latest step in CDMA2000 evolution. CDMA2000 1xEV-DO has been developed in order to make full use of the advantages of an all-IP network; the air interface has been optimized for data transmission.

Unlike CDMA2000 1xRTT, 1xEV-DO uses a time division multiple access method. The spectral characteristics have not changed with respect to CDMA2000 1xRTT, which enables in-band migration. The protocol stack, however, is completely different from that of CDMA2000 1xRTT.

There is a “hybrid mode” in which a terminal is registered at both a CDMA2000 and a 1xEV-DO base station simultaneously and transmits data (voice and IP) alternately over the two.

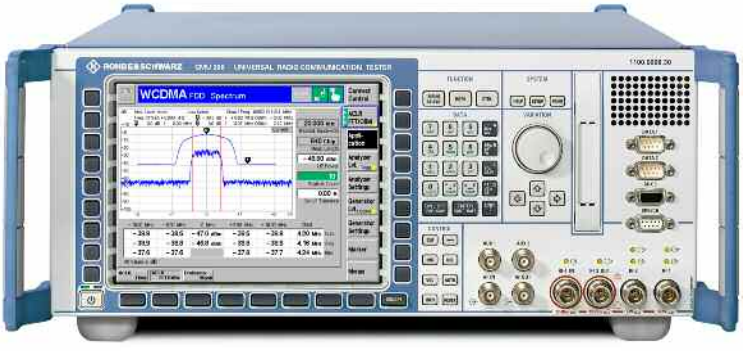
New concepts are AN (access network) for the base station and AT (access terminal) for the mobile station. The transmit direction from AN to AT is called the forward link and the direction from AT to AN is the reverse link. At present, there are two versions of the standard, Revision 0 and Revision A.

This application note describes the currently available test solutions using Rohde & Schwarz equipment. In addition, the opportunities provided by the individual devices are briefly presented and a example measurement with the FSx and SMU is described.

For a more detailed description of 1xEV-DO, refer to [4].

2 CMU200 Radiocommunication Tester

The CMU200 radiocommunication tester allows various standards such as GSM, IS-136, AMPS, CDMA2000, 1xEV-DO, WCDMA, HSPA, and Bluetooth to be measured quickly and accurately.



The CMU is the solution for measuring and testing mobile stations (AT). It supports measurements in both non-signaling and signaling mode.

With firmware version V4.30, 1xEV-DO in signaling mode is available for Release 0 and Revision A.

In addition to the test applications defined by the 1xEV-DO standard (FTAP/FETAP, RTAP/RETAP), the CMU also supports the default packet application (DPA) for testing the data throughput and the RF performance under real-world conditions.

The following measurements are possible with the CMU:

TX measurements

- Power (incl. max. power and min. power, open loop power)
- Modulation (incl. frequency error, transmit time error, I/Q imbalance, carrier feedthrough, Rho factor, error vector magnitude, magnitude error, and phase error)
- I/Q analyzer (constellation/vector diagram, I phase, Q phase with the option of decoding the data channel modulation)
- Spectrum (ACP)
- Code domain power (general as well as channel-specific [Pilot, RRI, ACK, DRC, Data])

RX measurements

- Packet error rate in the control channel
- Throughput in the forward and reverse link

The following figures show various example measurements for a connection based on Revision A.

Figure 1 and Figure 2 each show a code domain power measurement (CDP) in the reverse link. The first measurement shows all Walsh codes, while the second measurement shows only the individual, relevant channels.

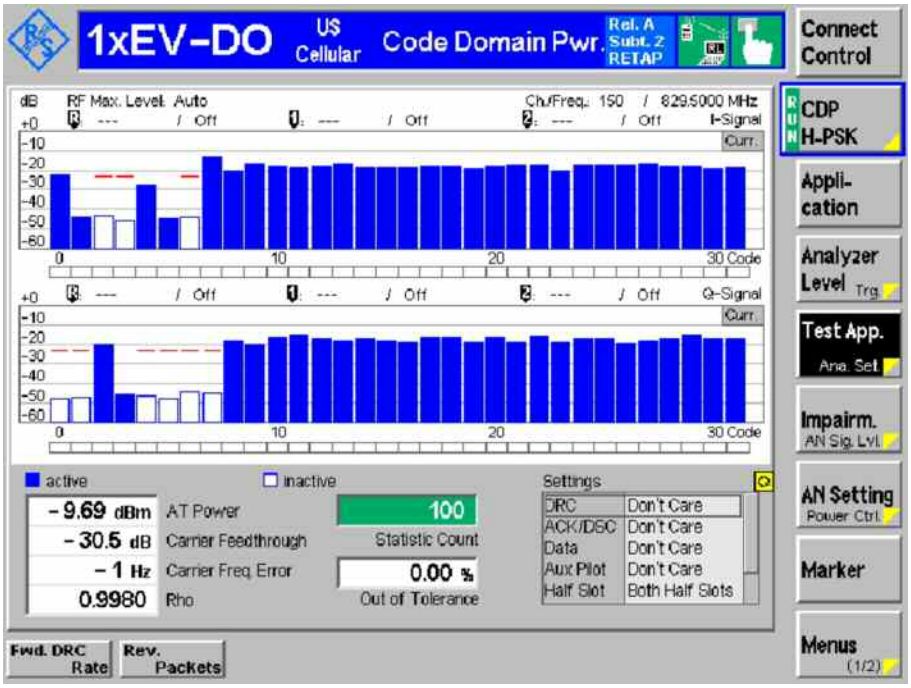


Figure 1 - Code domain power

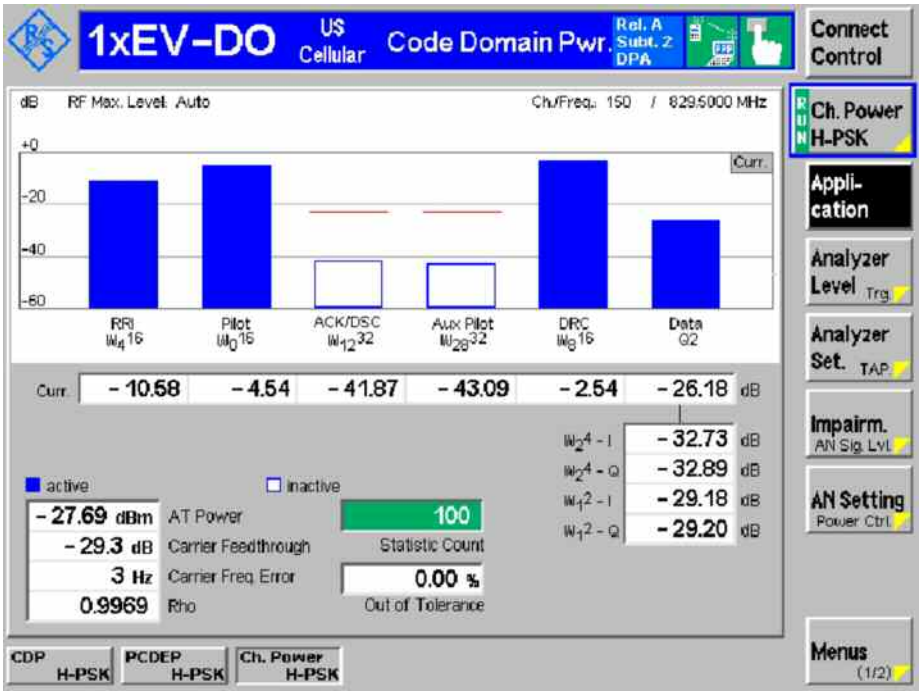


Figure 2 - Code domain power, channel power

Figure 3 shows a reverse link I/Q measurement that is of interest primarily for development.

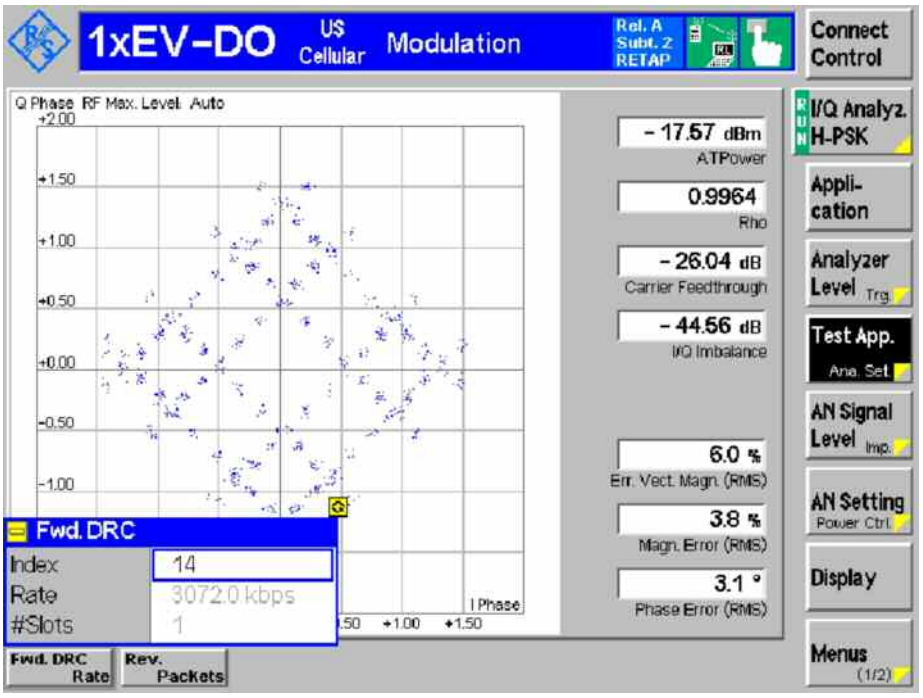


Figure 3 - I/Q analyzer

Figure 4 shows a PER measurement in RETAP mode.

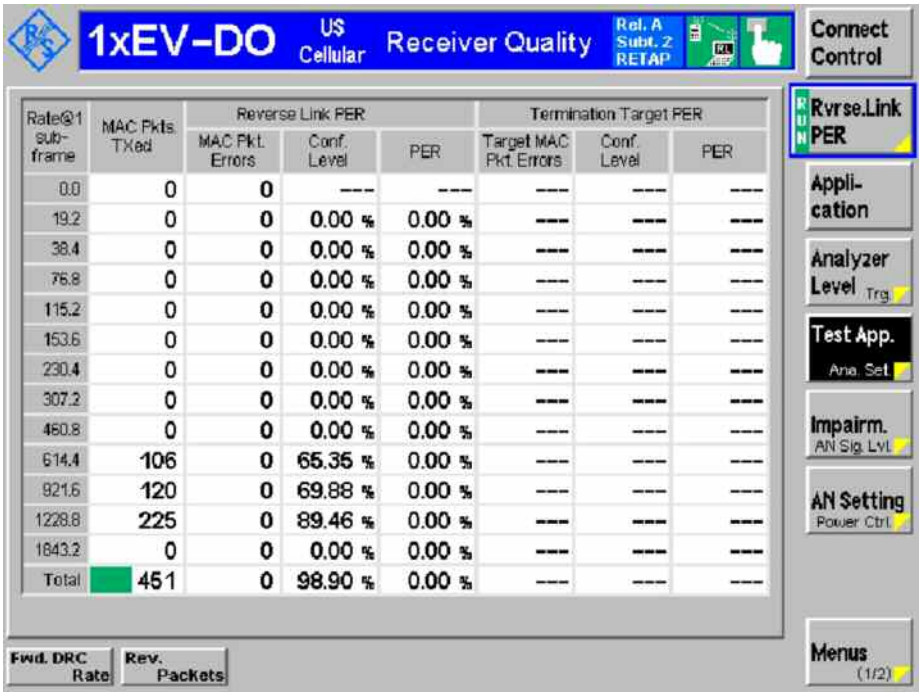


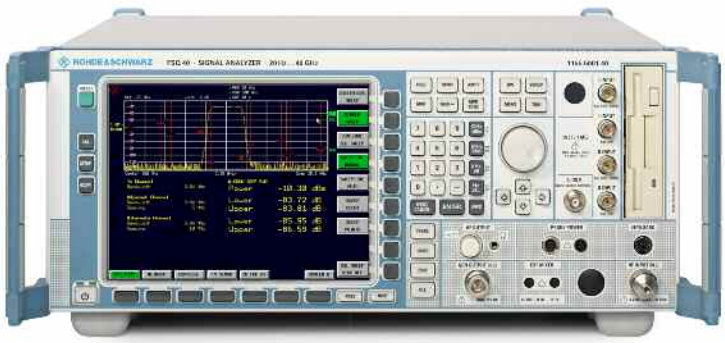
Figure 4 - PER and throughput

The CMUgo freeware PC program for remotely controlling the CMU200 also supports 1xEV-DO. For downloads and a description, go to

http://www2.rohde-schwarz.com/en/products/test_and_measurement/product_categories/mobile_radio/testers/CMU200-|-Tools-|-67-|-1858.html

3 FSQ, FSU, and FSP Spectrum Analyzers

The FSQ and FSU top-class analyzers, as well as the FSP medium-class analyzer, allow measurements based on various mobile radio standards, including GSM/EDGE, 3GPP WCDMA, HSDPA, TD-SCDMA, CDMA2000®, 1xEV-DO, Bluetooth, and WLAN 802.11a/b/g/j.



See Section 5 for example screenshots.

Measurements on the base station (forward link)

The FSU, FSP, and FSQ analyzers with the FS-K84 software option support measurements on 1xEV-DO base stations (access network). Revision A is also supported. The following measurements are supported in the code domain:

- Code domain power
- Channel occupancy table
- EVM
- Frequency error
- RHO factor

All channels (PILOT, MAC and DATA) are supported. In the DATA channel, the modulation mode is detected automatically and reevaluated in every slot.

Measurements can also be carried out in the spectral range:

- Channel power
- Adjacent channel power
- Occupied bandwidth
- Spectrum emission mask

Measurements on the mobile station (reverse link)

The FSU, FSP, and FSQ analyzers with the FS-K85 software option support measurements on 1xEV-DO mobile stations (access terminal). While the CMU supports Revision A in both non-signaling and signaling mode, the FS-K85 permits measurements in line with Revision 0. The following measurements are supported in the code domain:

- Code domain power
- Channel occupancy table
- EVM
- Frequency error
- RHO factor

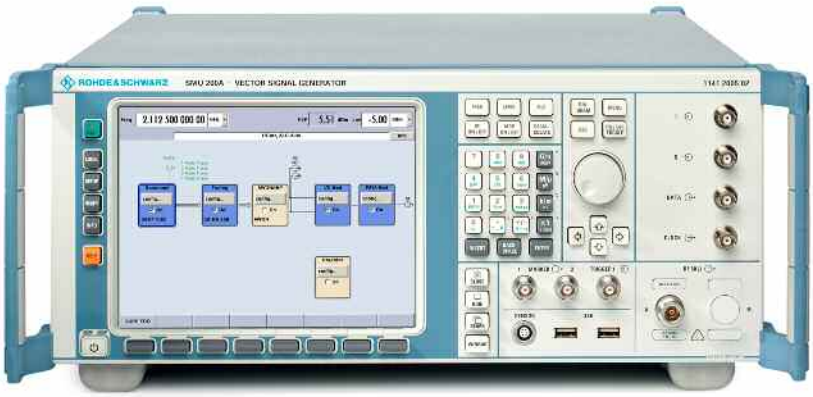
Both the traffic and the access mode, as well as all five channels (PICH, RRI, DATA, ACK, and DRC) are supported. The signals for every half slot are evaluated.

Measurements can also be carried out in the spectral range:

- Channel power
- Adjacent channel power
- Occupied bandwidth
- Spectrum emission mask

4 SMU200A, SMJ100A Vector Signal Generator

The main use of the SMU is the generation of digitally modulated signals for development and production. The SMU uses I/Q (vector) modulation in the digital baseband. Digital data (internal or ARB files) is converted to I/Q baseband signals. The SMU can be equipped with two independent RF paths (1st path: up to 6 GHz, 2nd path: up to 3 GHz).



At present, the SMU supports 1xEV-DO (Revision 0) via ARB files that are generated using the external WinIQSIM software. An internal software option (including Revision A) will follow later. Signals are generated for the forward link as well as for the reverse link.

WinIQSIM

The free, external WinIQSIM PC program from Rohde & Schwarz is available for generating the ARB files.

Under SYSTEM!, click 1xEV-DO. Select either the forward or reverse link to display and individually assign the parameters for the mobile station (MS) or base station (BS).

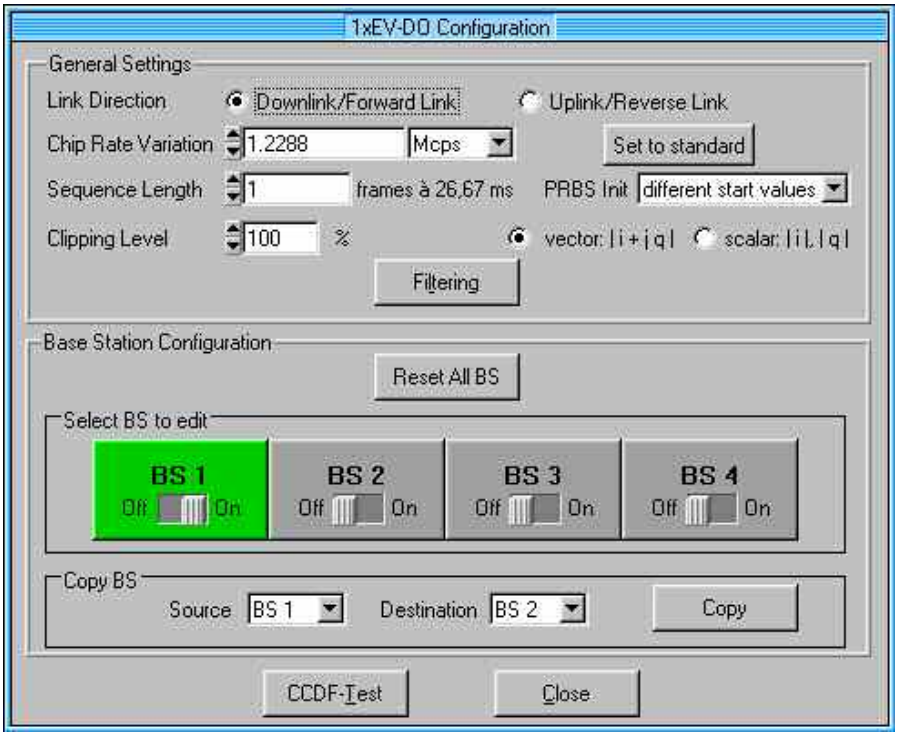


Figure 5 - WinIQSIM: 1xEV-DO

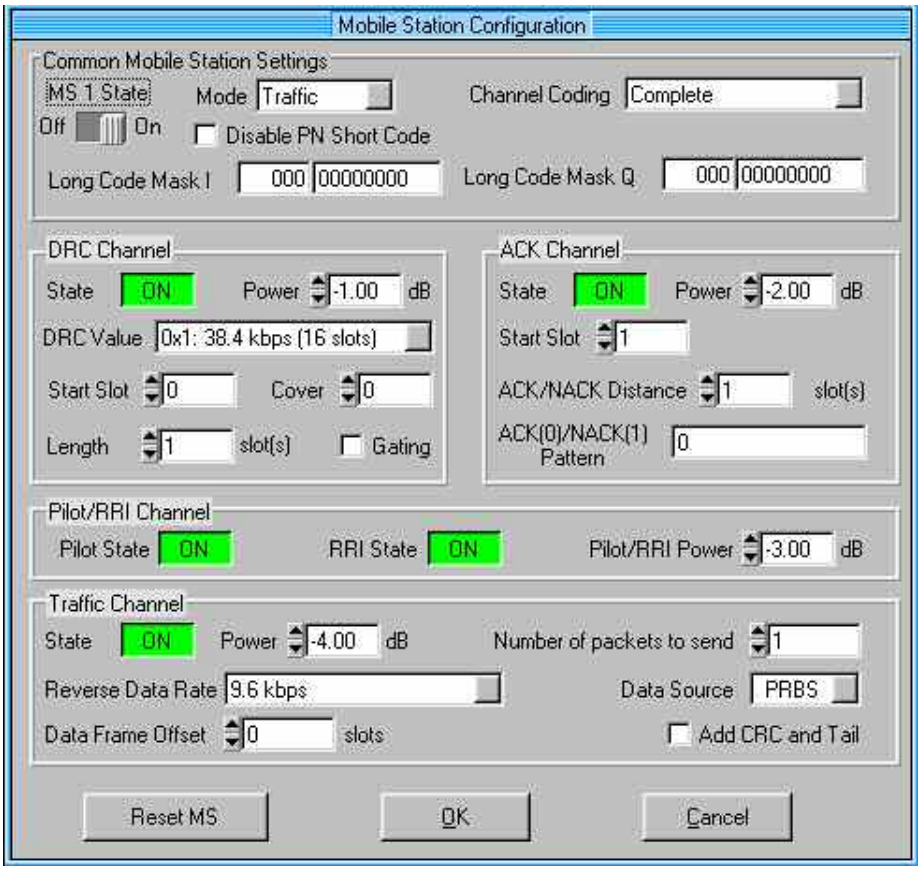


Figure 6 - WinIQSIM: 1xEV-DO, mobile station settings

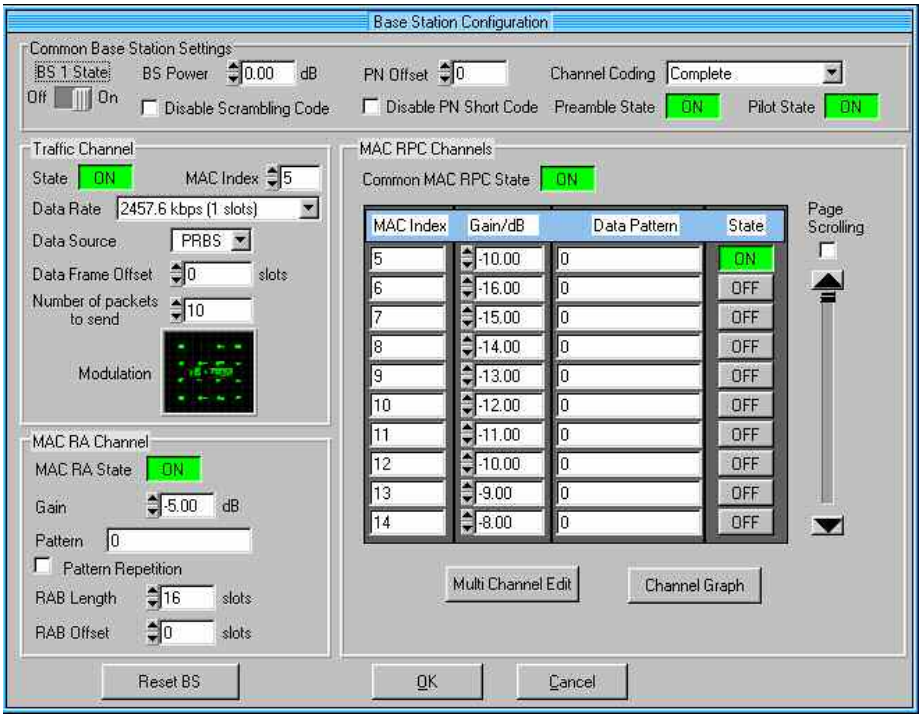


Figure 7 - WinIQSIM: 1xEV-DO, base station settings

The generated ARB files can be copied directly using WinIQSIM either via remote control (GBIP, LAN) or manually. WinIQSIM generates an IQS file on the PC and then generates a WV file for the SMU. In the BASEBAND section of the SMU, select ARB and the appropriate file under LOAD WAVEFORM.

Please note that **I/Q Swap** has to be enabled in the I/Q Modulator section of the SMU.

5 SMU – FSx Example

For the demonstration, WinIQSIM was used to generate two examples as ARB files. These files must then be loaded on the SMU.

For the demonstration, the SMU and FSx are connected directly. In addition, the SMU should trigger the FSx. To do this, the FSx must be set to TRIGGER|EXTERN. On the SMU, the MARKER1 connector on the front panel can be set to RESTART.

Please note that **I/Q Swap** has to be enabled in the I/Q Modulator section of the SMU.

Finally, the send and receive frequencies must be set the same on both the SMU and the FSx.

Forward link

In the forward link, the SMU generates the base station signal (AN), and the FSx carries out the measurement using the K-84 software option.

The Forward setup (files `Forward.iqs` and `Forward.wv`) is defined as an example of the forward link. A base station generates a signal with the following settings:

- Pilot
- MAC (RA channel: 16 slots, –5 dB; RPC channel: index 5, –10 dB)
- Traffic (index 5, 2457.6 kbit/s, 10 packets, 16 QAM), Preamble on

The following figures show example measurements with the FSx.

Figure 8 shows the channel occupancy table and the measurement results.

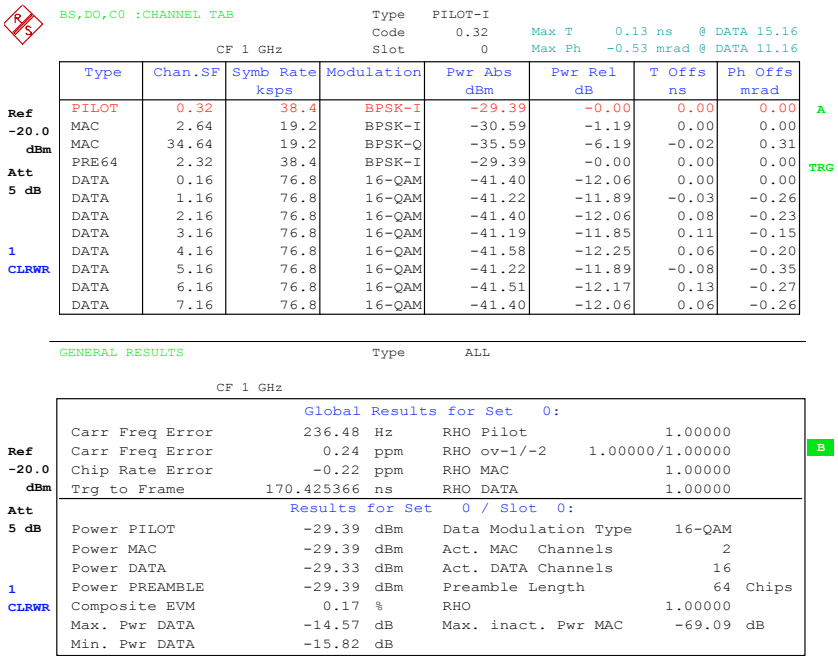


Figure 8 - Forward link: results

Figure 9 shows a code domain power measurement in slot 0, with the Pilot visible (code 0 in the I path).

Figure 9 - Forward link: CDP, Pilot

Figure 10 shows a code domain power measurement in slot 0, with a MAC visible (RAB on code 2 in the I path, RPC on code 34 in the Q path).

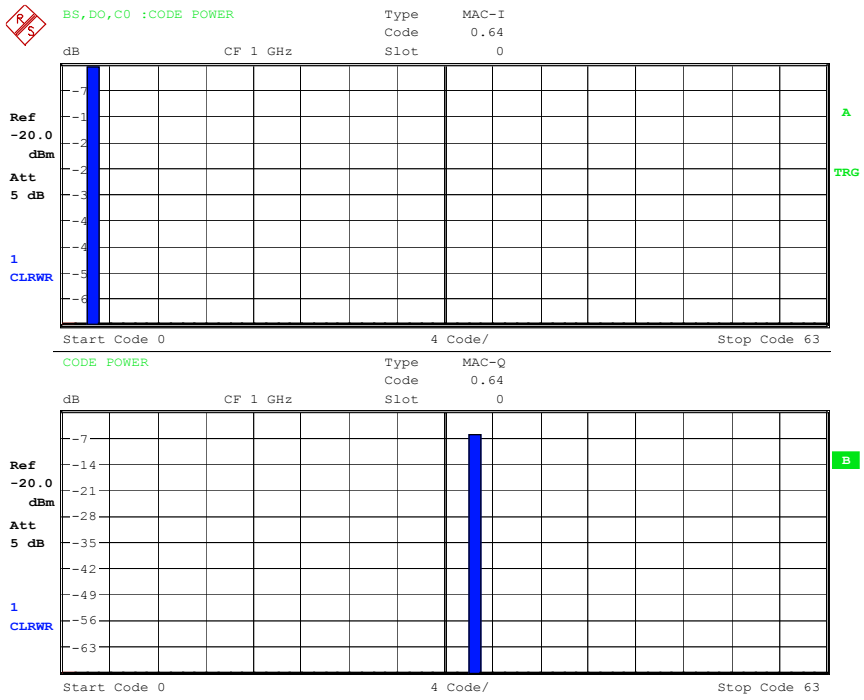


Figure 10 - Forward link: CDP, MAC

Reverse link

In the reverse link, the SMU generates the signal as a mobile station (AT), and the FSx carries out the measurement using the K85 software option.

The Reverse setup (`Reverse.iqs` and `Reverse.wv`) is defined as an example of the reverse link. A mobile station generates a signal with the following settings:

- Pilot
- RRI
- DRC channel
- ACK channel
- Traffic channel (9.6 kbit/s, 1 packet)

The following figures show example measurements with the FSx.

Figure 11 shows the channel occupancy table and the measurement results.

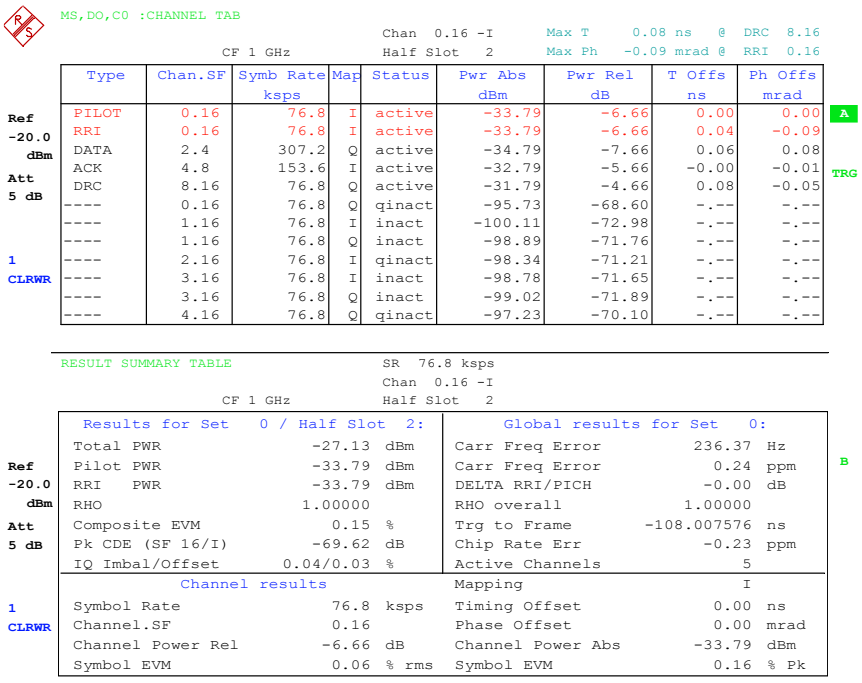


Figure 11 – Reverse link: results

Figure 12 shows a code domain power measurement in half slot 0, with the Pilot (code 0 in the I path) and Data (code 2 in the Q path [and aliasing in 6, 10, and 14]) visible.

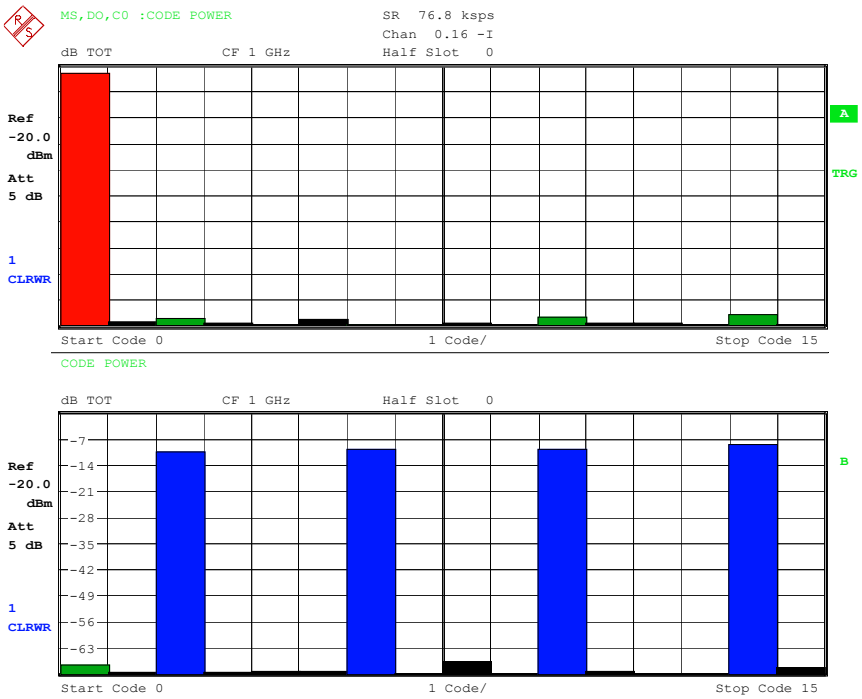


Figure 12 - Reverse link: CDP, half slot 0

Figure 13 shows a code domain power measurement in half slot 2, with the Pilot (code 0 in the I path), ACK (code 4 in the I path), DRC (code 8 in the Q path), and Data (code 2 in the Q path [and aliasing in 6, 10, and 14]) visible.

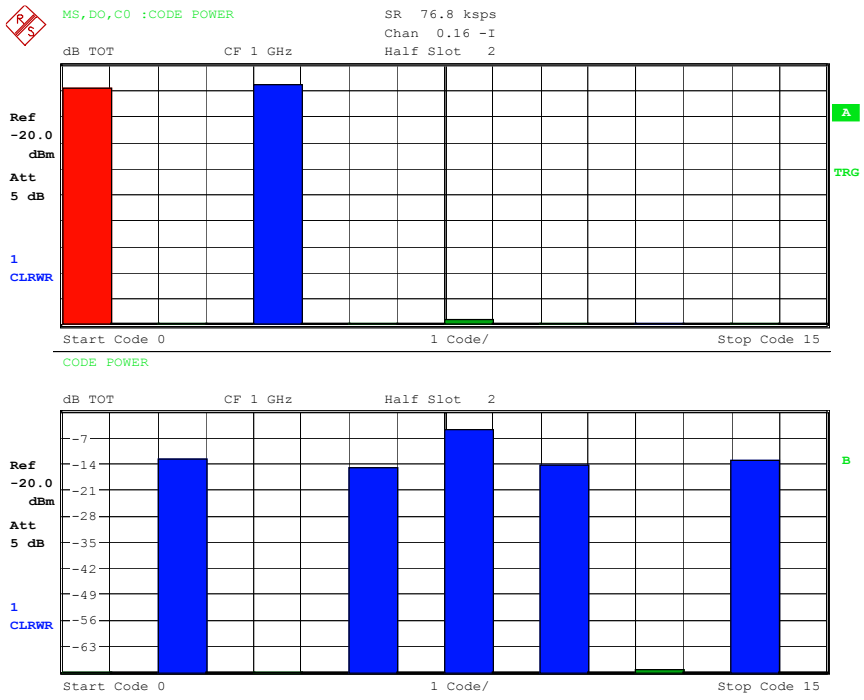


Figure 13 - Reverse link: CDP, half slot 2

6 Appendix

Abbreviations

Abbrev.	*Meaning*
ACP	adjacent channel power
AN	access network
AT	access terminal
ACK	acknowledge
BER	bit error ratio
CDP	code domain power
DPA	default packet application
DRC	data rate control
F-…	forward …
FER	frame error ratio
FL	forward link (from BS to MS)
F(E)TAP	forward (enhanced) test application
MAC	medium access control
PER	packet error ratio
R-…	reverse …
RL	reverse link (from MS to BS)
R(E)TAP	reverse (enhanced) test application
RX	receive
TX	transmit

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Figure 13 - Reverse link: CDP, half slot 2 15

References

[1] 3GPP2: **cdma2000 High Rate Packet Data Air Interface Specification, Revision A (Version 1.0)**, C.S0024-A v1.0, 03/2004

[2] Rohde & Schwarz: **Manual: SMU200A Vector Signal Generator**, 1007.9845.32-09-I

[3] Rohde & Schwarz: **Software Manual: cdma2000/1xEV–DV Base Station Test (R&S® FS–K82 Application Firmware)**, 1007.9797.44-04

[4] Rohde & Schwarz: **Application Note: 1xEV-DO Revision A, White Paper,** 1MA114, 04/2007

Additional information

For demonstration, the files `Forward.iqs` and `Forward.wv` as well as `Reverse.iqs` and `Reverse.wv` are supplied.

Please send your comments and suggestions regarding this application note to **TM-Applications@rohde-schwarz.com**

7 Ordering Information

SMU200A Vector Signal Generator		
R&S® SMU200A		1141.2005.02
R&S® SMU-B102	RF Path A: 100 kHz to 2.2 GHz	1141.8503.02
R&S® SMU-B103	RF Path A: 100 kHz to 3 GHz	1141.8603.02
R&S® SMU-B104	RF Path A: 100 kHz to 4 GHz	1141.8703.02
R&S® SMU-B106	RF Path A: 100 kHz to 6 GHz	1141.8803.02
R&S® SMU-B202	RF Path B: 100 kHz to 2.2 GHz	1141.9400.02
R&S® SMU-B203	RF Path B: 100 kHz to 3 GHz	1141.9500.02
R&S® SMU-B10	Baseband with ARB (64 Msamples)	1141.7007.02
R&S® SMU-B13	Baseband Main Module	1141.8003.02
R&S® SMU-B14	Fading Simulator	1160.1800.02
R&S® SMU-K46	Software: CDMA2000 BS	1160.9876.02
Signal Analyzer, Spectrum Analyzer, and Options		
R&S® FSP3	9 kHz to 3 GHz	1093.4495.03
R&S® FSP7	9 kHz to 7 GHz	1093.4495.07
R&S® FSP13	9 kHz to 13 GHz	1093.4495.13
R&S® FSP30	9 kHz to 30 GHz	1093.4495.30
R&S® FSP40	9 kHz to 40 GHz	1093.4495.40
R&S® FSU3	20 Hz to 3.6 GHz	1129.9003.03
R&S® FSU8	20 Hz to 8 GHz	1129.9003.08
R&S® FSU26	20 Hz to 26.5 GHz	1129.9003.26
R&S® FSQ3	20 Hz to 3.6 GHz	1155.5001.03
R&S® FSQ8	20 Hz to 8 GHz	1155.5001.08
R&S® FSQ26	20 Hz to 26.5 GHz	1155.5001.26
R&S® FS-K84	Software: 1xEV-DO BS	1157.2851.02
R&S® FS-K85	Software: 1xEV-DO MS	1300.6689.02
Communication Tester		
R&S® CMU200		1100.0008.02
R&S® CMU-B83v22	CDMA Signaling Unit	1150.0301.22
R&S® CMU-B89	Signaling Module 1xEV-DO	1159.3090.02
R&S® CMU-B85	Speech Codec CDMA2000	1100.7002.22
R&S® CMU-U65v4	Measurement DSP Module	1100.7402.04
R&S® CMU-B41 (optional)	Audio Generator and Analyzer	1100.5300.02
R&S® CMU-K839	Software Option: 1xEV-DO 450 MHz	1200.8300.02
R&S® CMU-K849	Software Option: 1xEV-DO Cellular	1200.8400.02
R&S® CMU-K859	Software Option: 1xEV-DO PCS	1200.8500.02
R&S® CMU-K869	Software Option: 1xEV-DO IMT2000	1200.8600.02

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