

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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 $\mathsf{CDMA2000}$ is a registered trademark of the Telecommunications Industry Association (TIA -USA)

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

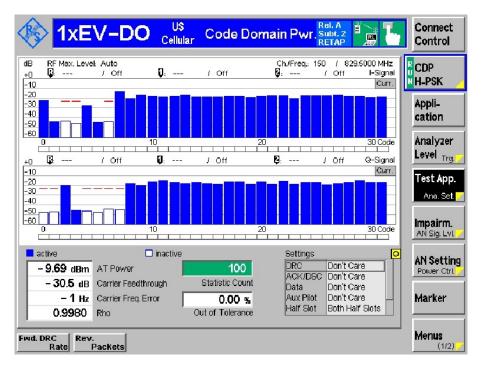
- Power (incl. max. power and min. power, open loop power)
- Modulation (incl. frequency error, transmit time error, I/Q imbalance, carrier feedthrough, Rho factor, error vector magnitude, magnitude error, and phase error)
- I/Q analyzer (constellation/vector diagram, I phase, Q phase with the option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

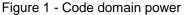
RX measurements

- 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.





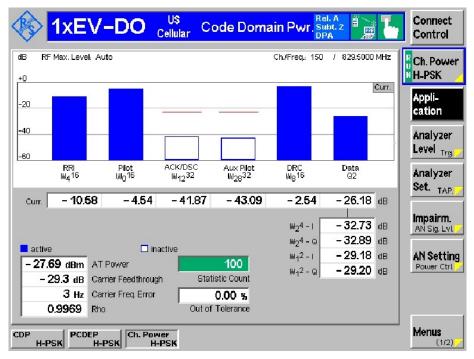




Figure 3 shows a reverse link $\ensuremath{I/Q}$ measurement that is of interest primarily for development.

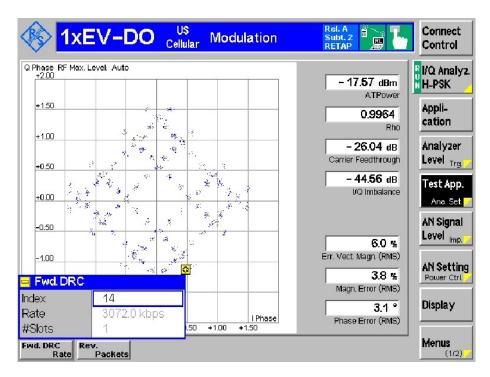


Figure 3 - I/Q analyzer

Figure 4 shows a PER measurement in RETAP mode.

			Cellular			RETAP		Control
Rate@1	MAC Pkts	Revers	e Link PER		Termina	ation Target P	ER	Rvrse.Lir
sub- frame	TXed	MAC Pkt. Errors	Conf. Level	PER	Target MAC Pkt. Errors	Conf. Level	PER	PER
0.0	0	0						Appli-
19.2	0	0	0.00 %	0.00 %				cation
38.4	0	0	0.00 %	0.00 %				Analyzer
76.8	0	0	0.00 %	0.00 %				Level Tre
115.2	0	0	0.00 %	0.00 %				
153.6	0	0	0.00 %	0.00 %				Test App
230.4	0	0	0.00 %	0.00 %				Ana. Set
307.2	0	0	0.00 %	0.00 %				
460.8	0	0	0.00 %	0.00 %				Impairm.
614.4	106	0	65.35 %	0.00 %				AN Sig. Lv
921.6	120	0	69.88 %	0.00 %				AN Setti
1228.8	225	0	89.46 %	0.00 %				Power Ctr
1843.2	0	0	0.00 %	0.00 %				
Total	451	0	98.90 %	0.00 %				

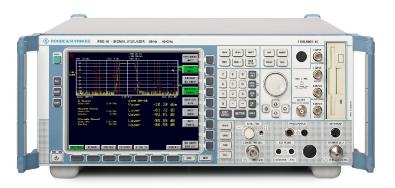
Figure 4 - PER and throughput

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_ct_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

7

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

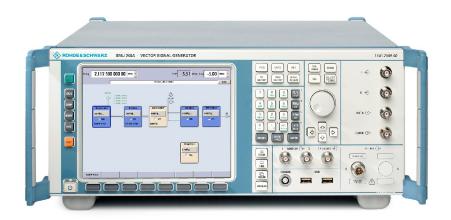
Both the traffic and the access mode, as well as all five channels (PICH, RRI, DATA, ACK, and DRC) are supported. The signals for every half slot are evaluated.

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).

1xEV-D0 Configuration							
- General Settings							
Link Direction 💿 Downlink/Forward Link 🔿 Uplink/Reverse Link							
Chip Rate Variation 1.2288 Mcps 🗾 Set to standard							
Sequence Length 륒 1 frames à 26,67 ms PRBS Init different start values 💌							
Clipping Level 🗧 100 % 💿 vector: i+jq] 🔿 scalar: i , q							
Filtering							
Base Station Configuration							
Reset All BS							
Select BS to edit							
BS1 BS2 BS3 BS4 Off On Off On Off On Off On							
Copy BS							
Source BS1 💌 Destination BS2 💌 Copy							
CCDF- <u>I</u> est <u>C</u> lose							

Figure 5 - WinIQSIM: 1xEV-DO

1xEV-DO - Test Solutions

Mobile Statio	n Configuration
Common Mobile Station Settings MS 1 State Mode Traffic Off On Disable PN Short Code Long Code Mask I 000 00000000	Channel Coding Complete
DRC Channel State ON Power -1.00 dB DRC Value 0x1: 38.4 kbps (16 slots) Start Slot = 0 Cover = 0 Length = 1 slot(s) Gating	ACK Channel State ON Power -2.00 dB Start Slot 1 ACK/NACK Distance 1 ACK(0)/NACK(1) 0 Pattern
Pilot/RRI Channel Pilot State ON RRI State G	DN Pilot/RRI Power -3.00 dB
Traffic Channel State ON Power -4.00 dB Reverse Data Rate 9.6 kbps Data Frame Offset -0 slots	Number of packets to send 1 Data Source PRBS
Reset MS 0	<u>Cancel</u>

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

	Base Station	n Configuration			
Common Base Station Settings BS 1 State BS Power \$0.00 dB Off 0 Disable Scrambling Code	PN Offset 💂		Channel Coding Comp Preamble State ON	-	
Traffic Channel State ON MAC Index \$5	MAC RPC Cha Common MAC		ON		
Data Rate 2457.6 kbps (1 slots) 💌 Data Source PRBS 🔻	MAC Index	Gain/dB	Data Pattern	State Sc	ge rolling
	5	-10.00	0	ON	
Data Frame Offset 0 slots Number of packets	6	- 16.00	0	OFF	
Number of packets to send	7	- 15.00	0	OFF	
	8	-14.00	0	OFF	
Modulation	9	÷13.00	0	OFF	
	10	- 12.00	0	OFF	
MAC RA Channel	11	- 11.00	0	OFF	
MAC RA State ON	12	-10.00	0	OFF	
Gain \$-5.00 dB	13	- 9.00	0	OFF	
Pattern 0	14	-8.00	0	OFF	
Pattern Repetition RAB Length 16 slots RAB Offset 0 slots	[Multi Channel	Edit Channel C	àraph	
Reset BS	<u>0</u> K		Cancel		

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 $\ensuremath{\text{I/Q}}\xspace$ was to be enabled in the $\ensuremath{\text{I/Q}}\xspace$ 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:

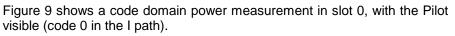
- Pilot
- MAC (RA channel: 16 slots, -5 dB; RPC channel: index 5, -10 dB)
- Traffic (index 5, 2457.6 kbit/s, 10 packets, 16 QAM), Preamble on

The following figures show example measurements with the FSx.

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

RA	BS,DO,C0 :	CHANNEL TA	в	Type	PILOT-I				
X\$				Code	0.32			ATA 15.16	
•		C	F 1 GHz	Slot	0	Max Ph -0.	53 mrad @ Di	ATA 11.16	
	Туре	Chan.SF	Symb Rate	Modulatic	n Pwr Abs	Pwr Rel	T Offs	Ph Offs	
			ksps		dBm	dB	ns	mrad	
Ref	PILOT	0.32	38.4	BPSK-	I -29.39	-0.00	0.00	0.00	А
-20.0	MAC	2.64	19.2	BPSK-			0.00	0.00	
dBm	MAC	34.64	19.2	BPSK-	~		-0.02	0.31	
Att	PRE64	2.32	38.4	BPSK-	I -29.39	-0.00	0.00	0.00	TRG
5 dB	DATA	0.16	76.8	16-QA	M -41.40	-12.06	0.00	0.00	
5 00	DATA	1.16	76.8	16-QA			-0.03	-0.26	
	DATA	2.16	76.8	16-QA			0.08	-0.23	
	DATA	3.16	76.8	16-QA			0.11	-0.15	
1	DATA	4.16	76.8	16-QA			0.06	-0.20	
CLRWR	DATA	5.16	76.8	16-QA			-0.08	-0.35	
	DATA	6.16	76.8	16-QA			0.13	-0.27	
	DATA	7.16	76.8	16-QA	M -41.40	-12.06	0.06	-0.26	
-	GENERAL RE	SULTS		Type	ALL				-
	CF 1 GHz								
		C	-						7
					lts for Set	0:			
	Carr Fre	eq Error		6.48 Hz	RHO Pilot		1.00000		
Ref	Carr Fre	eq Error		0.24 ppm	RHO ov-1/	-2 1.000	000/1.00000)	в
-20.0	Chip Rat	te Error		0.22 ppm	RHO MAC		1.00000)	
dBm	Trg to H	Frame	170.42	5366 ns	RHO DATA		1.00000)	_
Att			Res	ults for S	et 0 / Slo	t 0:			
5 dB	Power Pl	ILOT	- 2	9.39 dBm	Data Modu	lation Type	16-QAM	4	
	Power MA	AC	- 2	9.39 dBm	Act. MAC	Channels	2	2	
	Power DA	ATA	- 2	9.33 dBm	Act. DATA	Channels	16	5	
1	Power PH	REAMBLE	- 2	9.39 dBm	Preamble	Length	64	4 Chips	
CLRWR	Composit	te EVM		0.17 %	RHO		1.00000)	
	Max. Pwi	r DATA	- 1	4.57 dB	Max. inac	t. Pwr MAC	-69.09) dB	
	Min. Pwi	r DATA	- 1	5.82 dB					
	ι								_

Figure 8 - Forward link: results



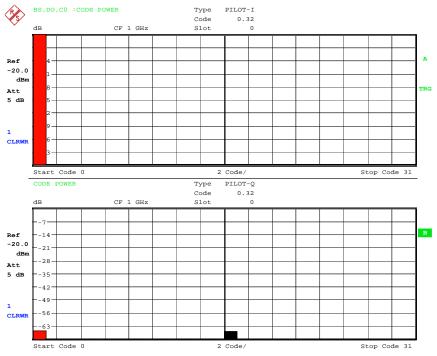


Figure 9 - Forward link: CDP, Pilot

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).

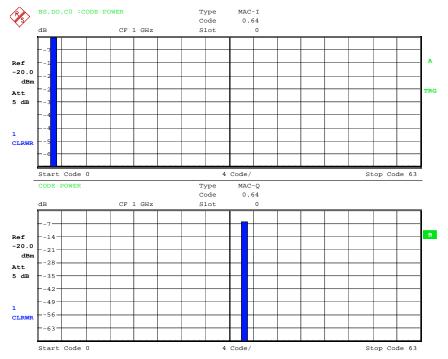


Figure 10 - Forward link: CDP, MAC

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.

R	MS,DO,C0 :	CHANNEL TA	в							
× s								08 ns @	DRC 8.16	
•		C	F 1 GHz		Half SI	Lot 2	Max Ph -0.	09 mrad @	RRI 0.16	_
	Type	Chan.SF	Symb Rate	Map	Status	Pwr Abs	Pwr Rel	T Offs	Ph Offs	
			ksps			dBm	dB	ns	mrad	
Ref	PILOT	0.16	76.8	I	active	-33.79	-6.66	0.00	0.00	А
-20.0	RRI	0.16	76.8	I	active	-33.79		0.04	-0.09	
dBm	DATA	2.4	307.2	Q	active	-34.79		0.06	0.08	
Att	ACK	4.8	153.6	I	active	-32.79			-0.01	TRG
5 dB	DRC	8.16	76.8	Q	active	-31.79		0.08	-0.05	
5 000		0.16	76.8	Q	qinact	-95.73				
		1.16	76.8	I	inact	-100.11				
		1.16	76.8	Q	inact	-98.89				
1		2.16	76.8	I	qinact	-98.34				
CLRWR		3.16	76.8	I	inact	-98.78				
		3.16	76.8	Q	inact	-99.02				
		4.16	76.8	Q	qinact	-97.23	-70.10			
RESULT SUMMARY TABLE SR 76.8 ksps									-	
	Chan 0.16 -I									
	CF 1 GHz Half Slot 2									
]	Results	s for Set	0 / Hal	f Sl	ot 2:	Glob	al results	for Set	0:	1
	Total PW	VR.	- 2	7.1	3 dBm	Carr Freq	Error	236.3	7 Hz	
Ref	Pilot PV	VR.	- 3	3.79	9 dBm	Carr Freg	Error	0.2	4 ppm	в
-20.0	RRI PV	VR.	- 3	3.79	9 dBm	DELTA RRI	/PICH	-0.0	0 dB	
dBm	RHO		1.0	0000	C	RHO overa	11	1.0000	0	
Att	Composit	e EVM		0.1	5 %	Trg to Fr	ame -	108.00757	6 ns	
5 dB	Pk CDE ((SF 16/I)	- 6	9.63	2 dB	Chip Rate	Err	-0.2	3 ppm	
	IQ Imbal	L/Offset	0.04/	0.03	3 %	Active Ch	annels		5	
		Chann	el results			Mapping			I	1
1	Symbol F	Rate		76.1	3 ksps	Timing Of	fset	0.0	0 ns	1
CLRWR	Channel.			0.10	-	Phase Off		0.0		
CLINIK		Power Re			- 5 dB	Channel P		-33.7		1
	Symbol E				5 % rms	Symbol EV		0.1		1
l	2,				1110	2,		0.1		1

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.

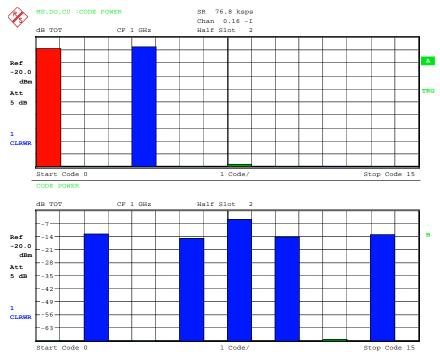


Figure 13 - Reverse link: CDP, half slot 2

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
ТХ	transmit

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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@rsd.rohde-schwarz.com

Ordering Information 7

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

Software Option: 1xEV-DO PCS

Software Option: 1xEV-DO IMT2000

1200.8500.02

1200.8600.02



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