Products: CMU200

CDMA2000® 1xRTT / 1xEV-DO

Measurement of time relationship between CDMA RF signal and PP2S clock

Application Note

This application explains the setup and procedure to measure the exact time relationship between the CDMA RF signal and even-second clock. The accurate knowledge of this time relationship is e.g. necessary for test setups which require the synchronization of the R&S® CMU200's CDMA2000 system with a GPS simulator.

ROHDE&SCHWARZ

Subject to change – Thomas Rösner 11.2007 –1CM33_3e

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1. Overview

In more and more countries worldwide wireless carriers are required to implement so-called position location services to provide the exact location of emergency calls (E9-1-1 regulations). The solution is a position location technology based on GPS. Test scenarios for mobile devices using such systems require a very accurate knowledge about the timing between the PN rollover and the even-second clock of the CDMA system emulator (e.g. the R&S® CMU200). This even-second clock signal is used for the timing synchronization with a GPS simulator.

Requirements for CDMA Test Base Station

The R&S® CMU200 operates in the GPS test set up as a base station simulator. Typically, the general requirements for the CDMA test base station used in such a test set up are:

- CDMA base station RF signal
- Even-second timing strobe
- Known constant time relationship

  CDMA RF signal ↔ even-second clock
- Clean spectrum outside of CDMA frequencies

  (particularly in or near the GPS band)
- Call loss detection ≥ 5 sec.
- 10 MHz reference

The R&S® CMU200 provides CDMA2000 1xRTT signalling with the hardware option R&S® CMU-B83 together with at least one of the software options R&S® CMU-K83, -K84, -K85, -K86. For 1xEV-DO system emulation, in addition, the hardware option R&S® CMU-B89 together with at least one of the software options R&S® CMU-K839, -K849, -K859, -K869 is needed. The even-second clock (=PP2S) is provided with the option CMU-U80 at a BNC connector on the CMU backpanel with the required accuracy of ≤ 20 nsec (the timing accuracy of the CDMA clock signals at AUX3 are not sufficient). The R&S® CMU200 provides either an internal 10MHz reference signal or it may be synchronized to an external 10MHz source. This reference frequency is phase-locked with the CDMA timing and in particular with the even-second clock. The frequency range of the R&S® CMU200 is specified in the range from 10MHz up to 2.7GHz and covers like this all possible applications and all frequency bands of CDMA networks, in particular for CDMA2000 all band classes defined in the TIA/EIA standard (TIA-1030-B).

2. Measurement of time relationship

Background

Typical GPS test setups require the information about the exact timing relationship between the even-second clock (PP2S) and the rollover of the PN-sequence after the inverse equalizer filter. This procedure can be done with a digital oscilloscope with a minimum sampling rate of 250Ms/s (e.g. Tektronix TDS 784D). The calibration procedure is based on Matlab™ (requiring also the Matlab™ toolboxes “Instrument Control” and “Signal Processing”). The Controller PC configures both the oscilloscope and the R&S® CMU200, starts the measurement and reads out the two channels of the oscilloscope automatically. Afterwards the sampled data will be processed offline by the PC.

Test Setup

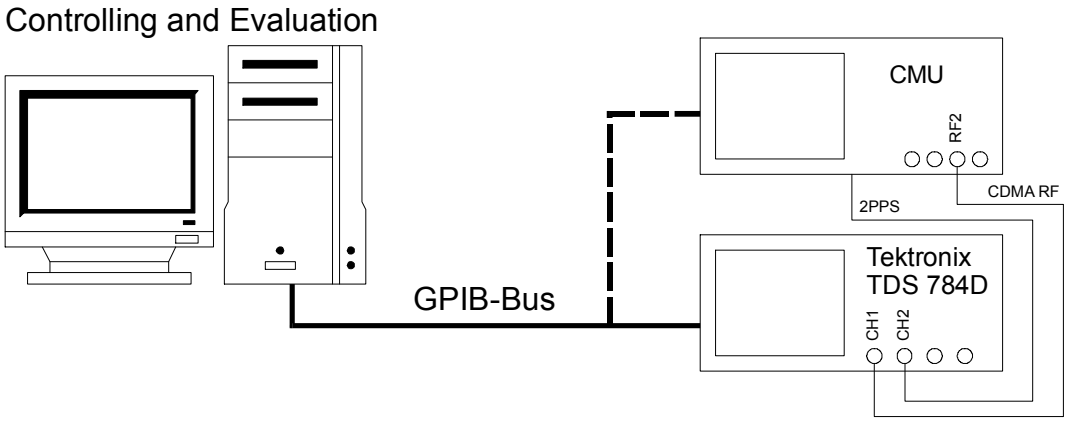

Figure 1: Test setup

Both the oscilloscope and the R&S® CMU200 are controlled via GPIB.

The CDMA RF output signal (CMU RF2 connector) must be connected with channel 1 (CH 1) of the oscilloscope, the Even-second clock with channel 2.

The cable for RF and trigger signal must be of the same type and length to minimize its influence on the timing. The scope has a timing difference between the channels of <50ps with equal Volts/Div and Coupling. Unfortunately these settings are not usable because the CMU has a max. output level of –16dBm (~35mV at 50Ω) and the Trigger has TTL Level at

1MΩ. But tests with a R&S® SMIQ and different settings for CH1 & CH2 (CH1: 500mV/Div, 50Ω; CH2: 500mV/Div, 50Ω) and (CH1: 20mV/Div, 50Ω; CH2: 2V/Div, 1MΩ) have shown only very small differences in the range of 1-2 nsec and are therefore negligible.

Due to the architecture of the R&S® CMU200, the timing relationship between the even-second clock (PP2SPP2S) and the rollover of the PN-sequence will stay constant over the complete frequency range of the R&S® CMU200. Therefore the measurement of the timing relationship is done only at one frequency (50MHz).

Hardware / Software Requirements

Hardware Requirements	
IEC/IEEE BUS	IEC/IEEE bus interface Rohde & Schwarz IEEE-488.2 bus interface **PS-B4**, 1006.6207.04, or National Instruments **ATGPIB/TNT** or **GPIB-PCMCIA** card

Software Requirements	
NI-488.2 v2.42 (or above)	IEC/IEEE - bus driver from National Instruments. See http://www.natinst.com for latest revision.
MATLAB version 7.0 Release 14 (or above) Toolboxes: • Signal Processing • Instrument Control	See http://www.mathworks.com for latest revision.

Installation

Copy all files of the attached self-extracting archive into a directory, which is in your Matlab path or in the current Matlab directory (Annotation: Due to some limitations within Matlab, the path name should not include any blanks).

clk_est_fine.p
est_freq.p
EVAL_TRIG_FRAME_DEL_2chan.p
GPIB_convert.m
GPIB_signal.mat
GPIB_TRIG_FRAME_DEL_2chan.m
h_is95_equ.mat
h_is95_equ_del.mat
interpol3.p
koeffiz.mat
koeffiz.p
mixer_LP.mat
my_resam.p
PN_SEQ_GPS_ONE.mat
TRIG_FRAME_DEL_PAR.m
t_est.p

Procedure

The M-file

- TRIG_FRAME_DEL_PAR.m

defines all parameters for measurement control and evaluation. This file in particular includes the work path and the data path that must be configured before starting the Matlab M-files for the calibration procedure as well as the GPIB configuration.

The actual capturing is done by running the M-file:

GPIB_TRIG_FRAME_DEL_2chan.m

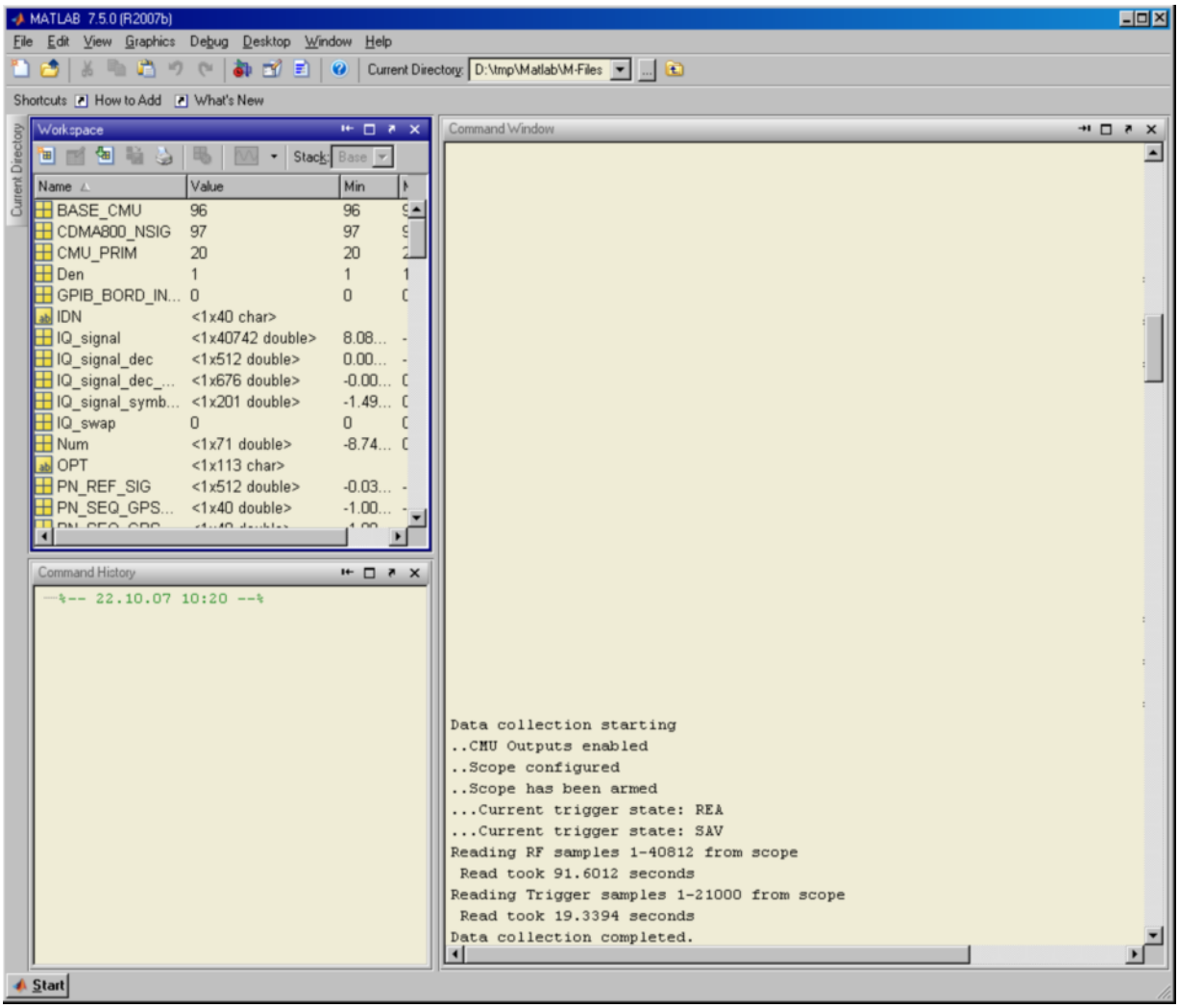

Figure 2: Screenshot of capturing process

The postprocessing of the data can be started by running the following Matlab file:

- EVAL_TRIG_FRAME_DEL_2chan.p

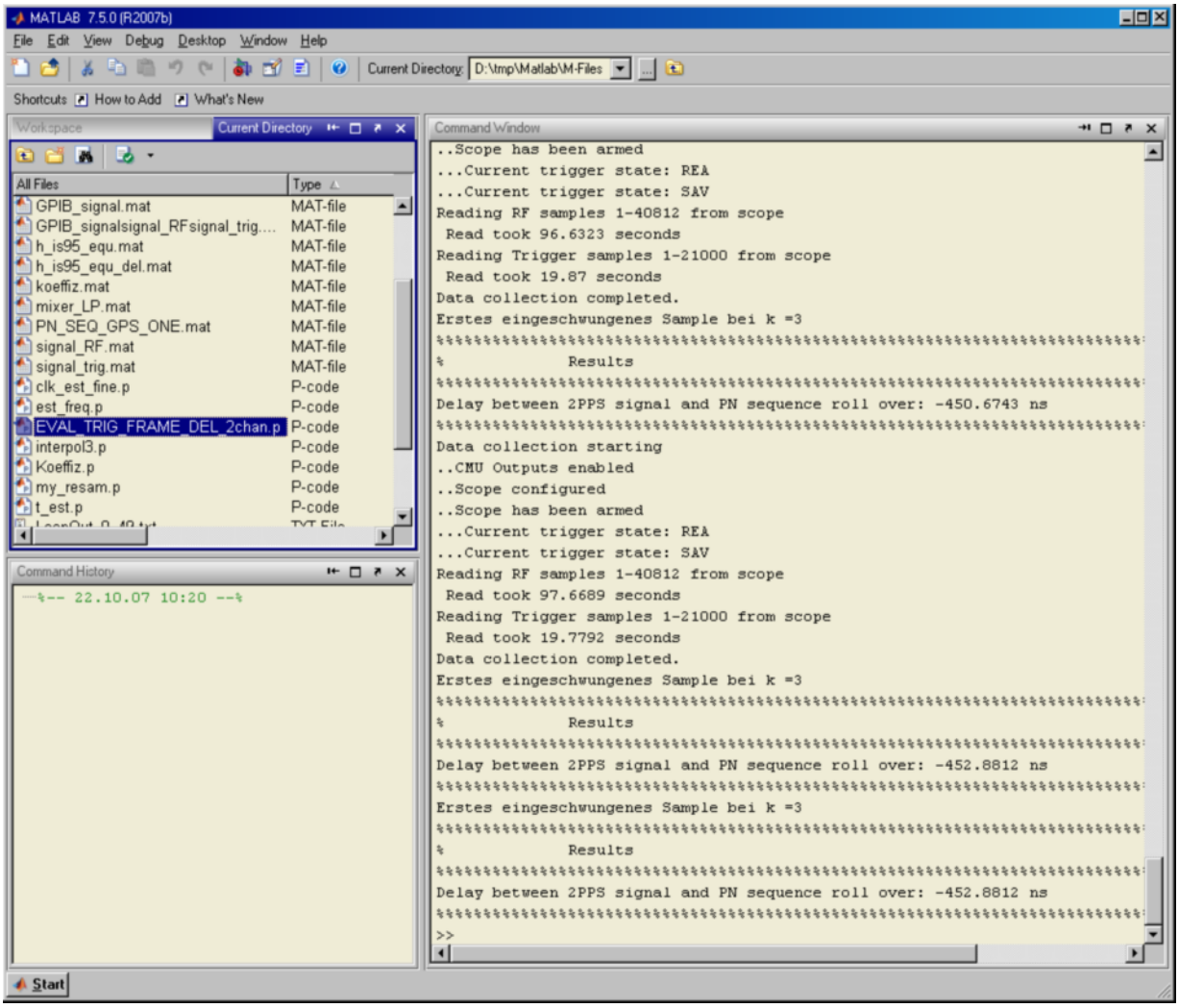

Figure 3: Screenshot of evaluation process

The Matlab program returns the delay between the even-second clock and the rollover of the PN sequence.

By setting the variable plot_on = 1 in the M-file TRIG_FRAME_DEL_PAR.m plots of intermediate results are displayed.

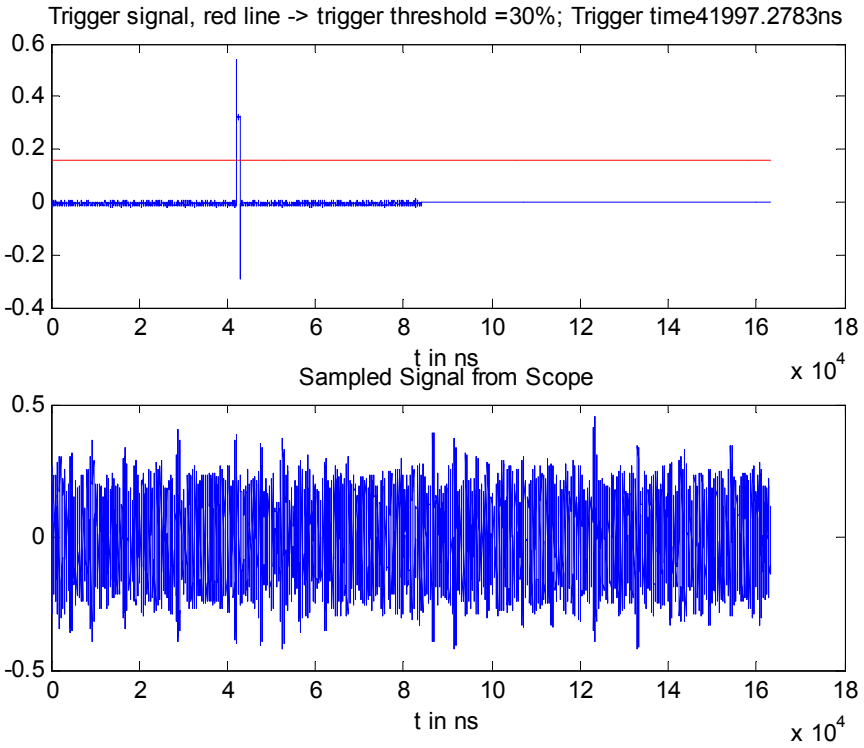

Figure 4: Trigger signal versus sampled CDMA signal

Settings of TDS 784D and R&S® CMU200

CMU200 settings (controlled via GPIB)	
Parameter	***Value***
Module Test	
Generator Control	ON
CDMA Power	-16dBm
Traffic Level	OFF
Paging Level	OFF
Sync Level	OFF
Pilot Level	-7dB
OCNS	OFF
RF Frequency	50 MHz
PN offset	0
Frame offset	0
Rate set	1
Frame rate	FULL

TDS 784D settings (controlled via GPIB)	
Parameter	***Value***
Horizontal Settings	
Main scale	200ns/DIV (with 50 samples/Div, sample rate=250Ms/s)
Channel 1 (RF)	
Bandwidth	FULL
Coupling	DC
Impedance	50Ω
Offset	0
Position	0
Scale	20mV/DIV (for max CMU Level)
Channel 2 (Trigger)	
Bandwidth	FULL
Coupling	DC
Impedance	50Ω
Offset	0
Position	0
Scale	2V/DIV
Trigger Settings	
Source	CH2
Slope	Rising
Level	0.5V
Acquiring Settings	
Repetition	OFF
STOP	AFTER SEQUENCE (only one shot)

Typical results

The maximum drift of the calibration results over the operating range of the CMU200 between 0° C and 50°C is typically 6 nsec (note: this is a typical result, but not specified value).

Figure 5 shows typical results for the delay between PPS2 clock and PN sequence rollover vs an ambient temperature between 0°C and 50°C. Two sets of measurement have been taken, (1) and (2).

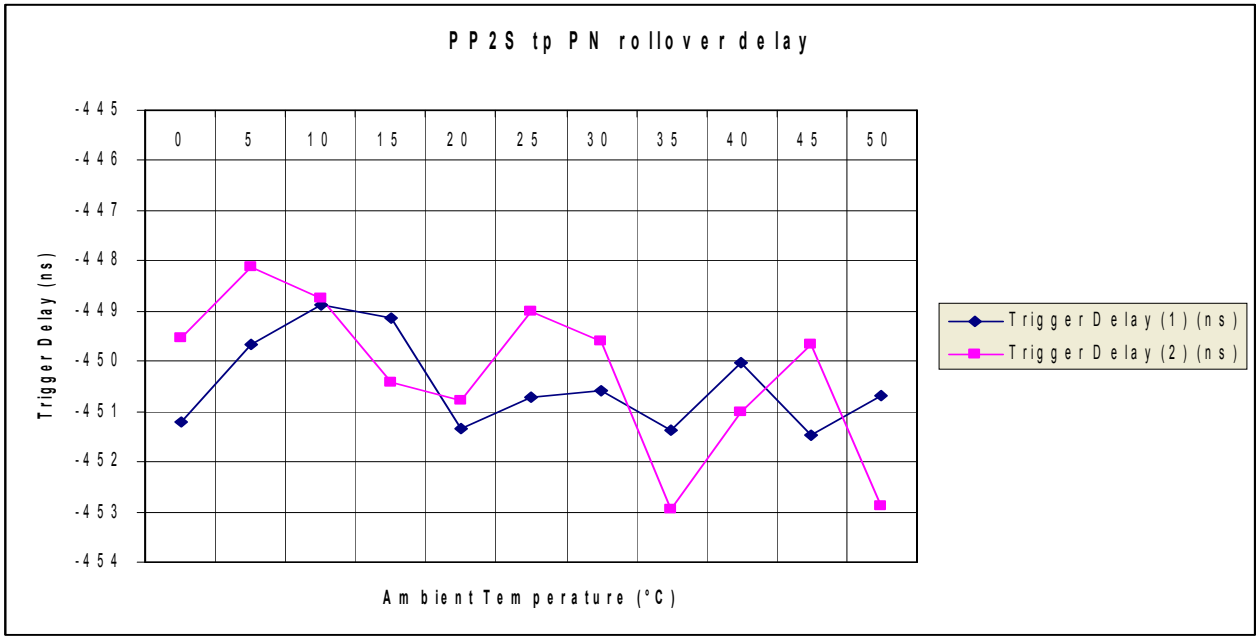

Figure 5: Deviation over temperature

To investigate the longterm stability, 900 timing measurements within 32 hours have been done, the results have a standard deviation of 1.05 nsec.

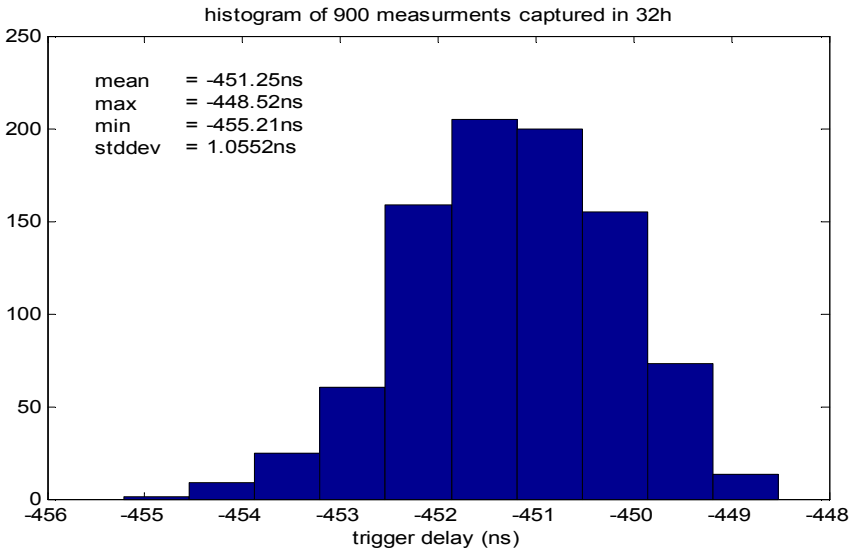

Figure 6: Longterm stability measurement

3. Literature

TIA/EIA/IS-2000.2-A Physical Layer Standard for cdma2000 Spread Spectrum Systems

T/A/EIA/IS-801 Position Determination Service Standard for Dual Mode Spread Spectrum Systems

4. Ordering Information

R&S® CMU200	Universal Radio Communications Tester
R&S® CMU-B83 Var 22	CDMA2000 signalling unit (ready for CMU-B89)
R&S® CMU-U83 Var 22	CDMA2000 signalling unit, upgrade from CMU-B83 Var 12
R&S® CMU-B85 Var 22	Speech Coder for 8K BASIC, 8K EVRC, 13K (CMU-B83 Var 22)
R&S® CMU-U85 Var 22	Speech Coder for 8K BASIC, 8K EVRC, 13K (CMU-B83 Var 22) upgrade from CMU-B85 Var 12
R&S® CMU-U80	Trigger connector
R&S® CMU-B89	1xEV-DO Signaling Module (for CMU-B83 Var 22)
R&S® CMU-K83	CDMA2000 (450 MHz band)
R&S® CMU-K84	CDMA2000 (cellular band)
R&S® CMU-K85	CDMA2000 (PCS band)
R&S® CMU-K86	CDMA2000 (IMT-2000 band)
R&S® CMU-K87	CDMA2000 Data Testing
R&S® CMU-K839	1xEV-DO, 450MHz (Band Class 5, 11)
R&S® CMU-K849	1xEV-DO, Cellular band (Band Class 0, 2, 3, 7, 9, 10, 12)
R&S® CMU-K859	1xEV-DO, PCS band (Band Class 1, 4, 8, 14)
R&S® CMU-K869	1xEV-DO, IMT band (Band Class 6, 13, 15, 16, 17)
R&S® CMU-PK800	SW Package for 1xEV-DO