R&S®CMU 200 Universal Radio Communication Tester

Powerful signaling for CDMA2000® 1xEV-DO

The CDMA2000® 1xEV-DO mobile radio standard is gaining in importance worldwide; the first networks using the enhanced CDMA2000® 1xEV-DO Rev. A variant were already put into commercial use in the second half of 2006. With a new signaling option, the R&S®CMU 200 covers all test scenarios relevant in the development and production of 1xEV-DO access terminals, thus presenting an all-in-one test solution for both CDMA2000® 1x and 1xEV-DO. It is already preconfigured to handle 1xEV-DO Rev. A.

CDMA2000® widely in use

The CDMA2000® 1xEV-DO standard has evolved from the well-known CDMA2000® 1x 3G mobile radio standard, which is not only widely used in North and South America and Asia but is also becoming increasingly important in Eastern Europe in the 450 MHz band. There are over 275 million subscribers using CDMA2000® (1x and 1xEV-DO) worldwide.

CDMA2000® 1xEV-DO (referred to as EV-DO in the following) 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 only ("evolution – data optimized"). The EV-DO access terminals currently being sold are nearly exclusively multimode devices, supporting both the existing CDMA2000® 1x standard and the new technology.
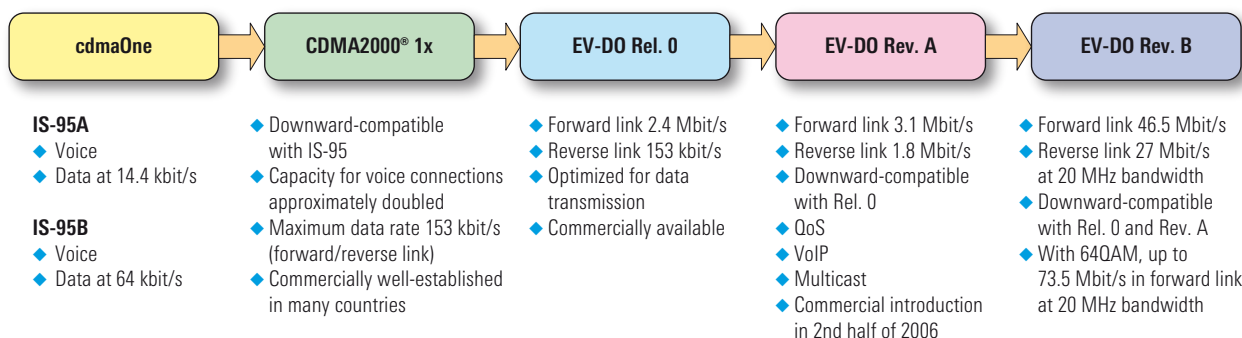
Attractive upgrade path for network operators

The spectral characteristics have not changed with respect to CDMA2000® 1x, which enables in-band migration. The protocol stack, however, is completely different from that of CDMA2000®.

This makes the upgrade path very attractive for network operators, since the measures necessary to modify the radio access network (RAN) are more or less reduced to exchanging a channel card. Network operators, therefore, are installing hybrid mobile radio networks that support both CDMA2000® 1x and CDMA2000® 1x EV-DO, which allows them to optimize the capacity for voice connections while at the same time offering modern, profitable data services.

EV-DO Rel. 0 supports data rates up to 2.4 Mbit/s in the forward link (from the base station to the mobile station) and 153.6 kbit/s in the reverse link (from the mobile station to the base station). Unlike CDMA2000® 1x, EV-DO uses a time division multiple access method.

FIG 1   Evolution of the CDMA2000® family of standards.

cdmaOne	CDMA2000® 1x	EV-DO Rel. 0	EV-DO Rev. A	EV-DO Rev. B
IS-95A ◆ Voice ◆ Data at 14.4 kbit/s **IS-95B** ◆ Voice ◆ Data at 64 kbit/s	◆ Downward-compatible with IS-95 ◆ Capacity for voice connections approximately doubled ◆ Maximum data rate 153 kbit/s (forward/reverse link) ◆ Commercially well-established in many countries	◆ Forward link 2.4 Mbit/s ◆ Reverse link 153 kbit/s ◆ Optimized for data transmission ◆ Commercially available	◆ Forward link 3.1 Mbit/s ◆ Reverse link 1.8 Mbit/s ◆ Downward-compatible with Rel. 0 ◆ QoS ◆ VoIP ◆ Multicast ◆ Commercial introduction in 2nd half of 2006	◆ Forward link 46.5 Mbit/s ◆ Reverse link 27 Mbit/s at 20 MHz bandwidth ◆ Downward-compatible with Rel. 0 and Rev. A ◆ With 64QAM, up to 73.5 Mbit/s in forward link at 20 MHz bandwidth

Similar to HSDPA, EV-DO employs hybrid ARQ (automatic repeat request), higher-order modulation modes (up to 16QAM), adaptive modulation and coding as well as receiver diversity.

EV-DO Revision A (TIA-856-A) is the first stage in a series of planned upgrades of the EV-DO standard (FIG 1). Revision A increases capacity in the forward link, supports realtime applications and quality of service (QoS), and provides substantial improvements for the reverse link (FIG 2). The main differences between EV-DO Release 0 and the new Revision A are:
◆ Improvements to reverse link (regarding peak data rate and sector throughput)
◆ Improved QoS mechanisms
◆ Expanded broadcast / multicast applications

Improved adaptation of the data packet size to the data rate as well as the introduction of new packet types have boosted the peak data rate in the forward link from 2.4 Mbit/s (Release 0) to 3.1 Mbit/s and in the reverse link from 153 kbit/s (Release 0) to 1.8 Mbit/s. With these characteristics, EV-DO Rev. A offers performance comparable to that of the HSUPA (high speed uplink packet access) technology, which is an expansion of the WCDMA standard. The first EV-DO Rev. A networks were put into commercial use in the second half of 2006. With the introduction of EV-DO Rev. A and a number of improvements to the core network, operators can now offer voice over Internet protocol (VoIP) services as well as videotelephony and video conferences with several subscribers.

| Forward link	Reverse link
Shorter data packets for applications with lower data rates and short latency (e. g. VoIP, gaming)	Higher-order modulation modes (QPSK, 8PSK) for higher data rates
Larger data packets for data rates up to 3.072 Mbit/s	Multicode reverse transmission – a 1xEV-DO mobile station (access terminal) can transmit on multiple code channels
Nearly twice as many active subscribers	Optional reverse auxiliary pilot – additional pilot channel for high data rates and multicode transmission
Additional data packet types and rates for the control channel	Reverse hybrid ARQ for more efficient use of available capacity and transmission link
Additional MAC channel (ARQ) to support reverse hybrid ARQ	Enhanced access channel
Multicast data packets – sub packets for various subscribers are included in a larger data packet	MAC layer ARQ – handles the detection of missing data packets and retransmission
Broadcast channel	

FIG 2   New features in the physical / MAC layer for CDMA2000® 1xEV-DO Rev. A.

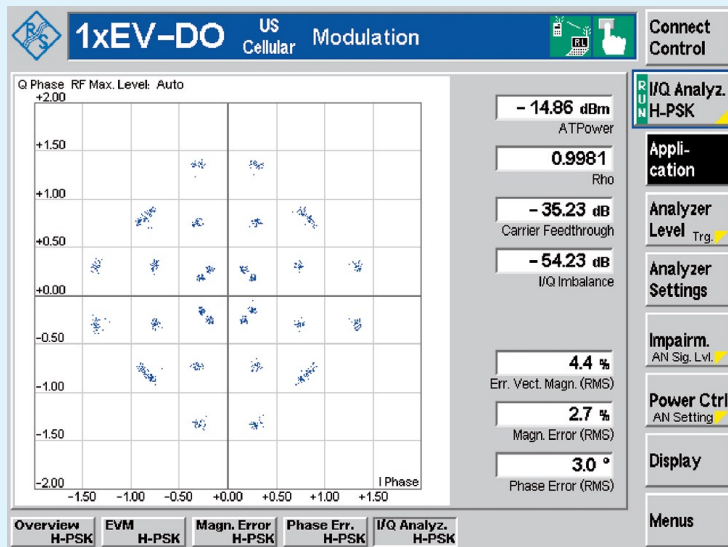## Options for the R&S®CMU 200 for CDMA2000® 1xEV-DO signaling

1xEV-DO signaling for the R&S®CMU 200 is based on the **optional R&S®CMU-B83 (Var. 22) CDMA2000® signaling unit**. To upgrade the mobile radio tester to include full 1xEV-DO functionality, the following options are required:

R&S®CMU-B83 (Var. 22)	**CDMA2000® signaling unit**
R&S®CMU-B89	1xEV-DO signaling module for CDMA2000® for the R&S®CMU-B83 (Var. 22) signaling unit
R&S®CMU-B87	Interface for CDMA2000® data test
R&S®CMU-K839	Software option: 450 MHz band
R&S®CMU-K849	Software option: cellular band
R&S®CMU-K859	Software option: PCS band
R&S®CMU-K869	Software option: IMT 2000 bands

The **R&S®CMU-U83 (Var. 22) option** is a favorably priced upgrade for instruments already equipped with the previous version, i. e. Var. 12, of the R&S®CMU-B83 CDMA2000® signaling unit. The R&S®CMU-U83 (Var. 22) is required for the R&S®CMU-B89 1xEV-DO signaling module.
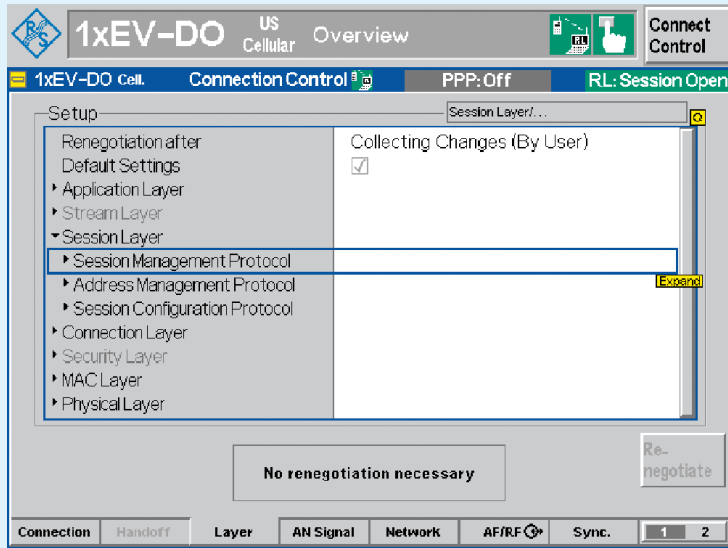
FIG 3
The R&S®CMU 200 offers comprehensive configuration parameters for CDMA2000® 1xEV-DO signaling.

FIG 4
Constellation diagram of a CDMA2000® 1xEV-DO signal.

FIG 5
Menu with list of results of receiver measurements.

▶ The R&S®CMU 200 stands ready

Rohde & Schwarz has therefore systematically expanded its R&S®CMU 200 product portfolio to offer complete EV-DO signaling in addition to the well-established test solution optimized for production applications. The EV-DO functionality will be expanded step by step to include EV DO Rev. A functionality. The R&S®CMU 200 supports all currently defined band classes, including the extended IMT 2000 band classes and the various expansions and modifications of the 450 MHz band. The comprehensive set of parameters is easy to configure, and the setup menu is organized in accordance with the layer structuring of the EV-DO protocol stack (FIG 3). The R&S®CMU 200 supports several connection types, e. g. forward / reverse test application protocol (FTAP / RTAP), default signaling application, and default packet application. The EV-DO option for the R&S®CMU 200 not only offers all required transmitter measurements, including modulation, fast spectrum measurement, code domain power, and various types of power measurements (FIG 4), but also comprehensive receiver measurements based on FTAP / RTAP connections (FIG 5), including the following:

◆ Statistical overview – all FTAP / RTAP-based measurements at a glance
◆ Control channel PER, forward / reverse link PER
◆ Reverse link quality
◆ Forward / reverse link performance

Separate receiver and transmitter measurements

Using FTAP- and RTAP-based measurements, the quality of the receiver and the transmitter of a DUT can be tested separately, i. e. without the receiver and transmitter mutually influencing each other.

With an FTAP connection, the quality of a DUT receiver is determined up to a maximum data rate of 2.4 Mbit/s. In this measurement, the DUT returns, via the reverse link, statistics and counts of received packets and errored packets that provide information about the connection quality. The EV-DO option of the R&S®CMU 200 evaluates the information received in various ways, e. g. by carrying out packet error and performance measurements to determine the actual throughput as a function of the packet size.

With an RTAP connection, the R&S®CMU 200 not only determines the quality of the DUT's transmitter and modulator, but also checks the number of packet errors and performs statistical evaluations. This can be done for data rates ranging from 9.6 kbit/s up to the maximum rate of 153.6 kbit/s. The DUT can thus be tested not only at a fixed data rate but also over a data rate range.

Wide variety of applications

The EV-DO option provides the basis for extensive end-to-end data test applications (support of simple / mobile IP). Using the default packet application, the R&S®CMU 200 can operate as a host for an incoming dial-up IP connection. If the R&S®CMU-B87 option is installed, an external server can be used as a data source for end-to-end tests.

In conjunction with a baseband fading simulator from Rohde & Schwarz, more accurate and cost-effective solutions can be implemented than by using an RF fader.

Summary

With the CDMA2000® 1xEV-DO option, the R&S®CMU 200 hardware and software concept proves its flexibility now also for the 3GPP2 technologies. The

R&S®CMU 200 is thus optimally prepared to handle the new 1xEV-DO Rev. A evolution of the CDMA2000® family of standards.

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More information and data sheet at
www.rohde-schwarz.com
(search term: CMU200)

REFERENCES
– Universal Radio Communication Tester R&S®CMU 200: CDMA2000® – a new challenge for 3G mobile radio testers. News from Rohde & Schwarz (2002) No. 173, pp 4–8
– Universal Radio Communication Tester R&S®CMU 200: Transmitter and receiver measurements for CDMA2000® 1xEV-DO. News from Rohde & Schwarz (2003) No. 179, pp 10–12

R&S®CMU 200 Universal Radio Communication Tester

Blazing trails with voice codecs: GSM-8PSK-AMR and WB-AMR

The R&S®CMU 200 universal radio communication tester – the trailblazer when it comes to voice functionality – expands its position with two new voice codecs.

GSM-8PSK-AMR

The adaptive multirate (AMR) voice codec has established itself as a standard, since it allows data rate and error protection to be dynamically adapted to connection quality. The R&S®CMU 200 provided the necessary measurement equipment for this right from the start[1]. Currently eight full-rate and six half-rate voice codecs are specified for GSM-AMR. Half rate is used to reduce net-

work load in the short term, for example during large-scale events such as the Soccer World Cup, when many subscribers within one cell want to make calls at the same time.

A major disadvantage of the AMR half-rate voice codec is that up to now only the data rates from 4.75 kbit/s to 7.95 kbit/s can be used with it (FIG 1); however, the best voice quality is achieved at 12.2 kbit/s. This disadvan-

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