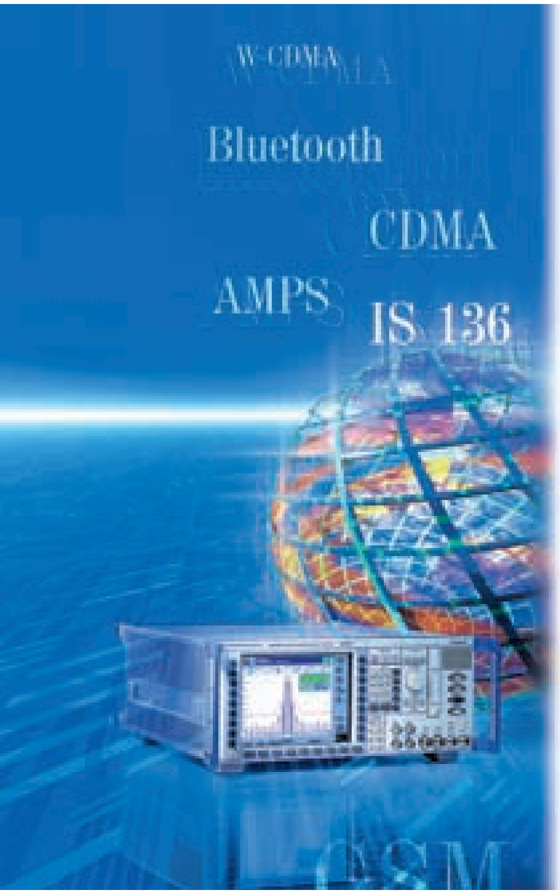


Photo 43 238/11

Universal Radio Communication Tester CMU 200

Adding CDMA now provides full 2G capability

Since the first commercial CDMA network started up in Hong Kong in September 1995, this digital mobile radio standard has established itself internationally. With growth rates rocketing unabated, it today ranks – besides GSM – among the major standards of the second generation. New options now add CDMA test capability to CMU 200 [1].

Important standard – established worldwide

The CDMA digital mobile radio standard has advanced triumphantly far beyond the USA, its country of origin, Korea and Japan. It has established itself globally in various versions. The box on page 9 outlines its major features and development.

Now CMU 200 too can handle all major mobile radio standards of the second generation – in addition to GSM and TDMA (TIA / EIA-136). The CDMA options for CMU 200 (details in box on page 8) not only support the American versions to TIA / EIA-95A, TSB-74 and J-STD-008 but also the standards to ARIB-T53 (Japan) and Korean PCS.

The CDMA world is facing its next decisive step: the future CDMA version cdma2000 1x will enable data rates up to 144 kbit/s. So mobile radio producers require early on a platform affording high measurement accuracy and speed as well as multimode capability. CMU 200 is right in line with the requirement. With its flexible, modular concept it now offers CDMA test technology and a straightforward upgrade scheme for cdma2000 1x.

The menu structure and remote control interface of CMU 200 are largely horizontally compatible with the other standards of the tester, ensuring that users without any CDMA experience can operate the instrument without any problems. Existing remote control programs can easily be adapted to CDMA.

CMU 200 offers two main test modes, non-signalling and signalling. On the production line, a distinction is usually made between two test phases in which CMU 200 is used, module test and final test.

Non-signalling measurements

The module test – without complete call setup – serves for process verification and calibrating the DUT's receiver and transmitter. Measurements in non-signalling mode are used for this purpose. Here CMU 200 offers on the one

Photo 43 263/6

Rohde & Schwarz has broad experience in the field of CDMA testing: Digital Radiocommunication Tester CMD 80* – developed jointly with Tektronix – is one of the most successful CDMA mobile radio testers.

[*] Digital Radiocommunication Tester CMD 80 – CDMA, AMPS and IS-136 measurements with one unit. News from Rohde & Schwarz (1999) No. 161, pp 10–12

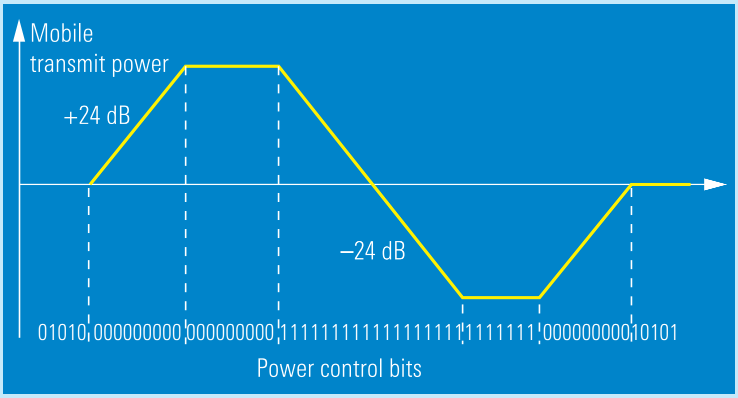


FIG 1 In closed-loop power control, the base station stimulates the CDMA mobile by power control bits to raise or lower its power every 1.25 ms

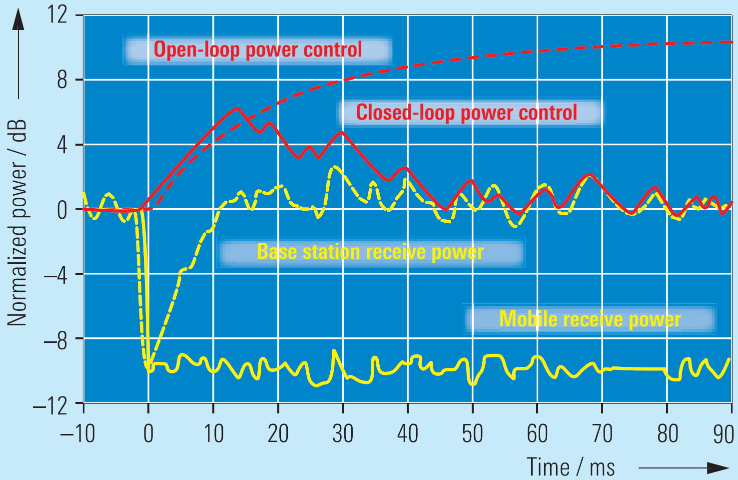


FIG 2 Open-loop and closed-loop power control are used simultaneously to ensure that a mobile sends only at the power actually needed. It also helps to reduce Rayleigh and lognormal fading

hand network-independent functionalities like spectrum analysis, power-versus-time measurement and frequency-selective power measurement. So in this phase of production it is possible to measure adjacent-channel power for example. On the other hand, CMU 200 also offers CDMA-specific measurements in non-signalling mode. It calculates waveform quality (rho factor), for instance, by correlating the measured DUT signal with an ideal reference. The rho factor is a scalar value indicating the quality of a mobile's transmitted signal.

Further non-signalling measurements include power, frequency error, transmit time error, carrier feedthrough and I/Q imbalance (a measure of unequal gain in the I and Q paths of the transmitter modulator).

Plus, CMU 200 incorporates a signal generator for non-signalling measurements that delivers CDMA-specific signals with pilot, sync, paging and traffic channel. All major parameters can be configured, like the relative levels of the individual code channels or the power control bits. The transmitter and receiver of CMU 200 can be set independently of each other and of the frequency bands, which allows analysis of intermediate frequencies for example.

Signalling measurements

In the final test, all major parameters of a mobile are checked with a call established. This is done in accordance with the TIA/EIA-98-C CDMA test standard. Here CMU 200 simulates a CDMA base station, allowing the mobile to be tested as in a real network. Signalling mode is not only needed in production but also in service and development.

The standard stipulates that certain test links be set up (service option 2/9) with defined test parameters in each case. Abundant test functionality is available for each of these loopbacks.

To check DUT voice quality, for example, the mobile first registers with the base station simulated by CMU 200. Then either CMU 200 or the mobile under test can establish a call with voice loopback. CMU 200 saves the audio data picked up via the mobile's microphone and returns them to the mobile after a delay of about 2 s.

CDMA options for CMU 200

Hardware option CMU-B 81 is the CDMA signalling unit for CMU 200, software option CMU-K 81 enables CDMA in the 800 MHz band (US cellular, China cellular, Japan cellular), and software option CMU-K 82 is for CDMA in the 1700/1900 MHz band (Korean PCS, US PCS).

Power measurements

The various power measurements play an important role in CDMA systems. All mobiles that have registered with a CDMA base station transmit at the same frequency - codes are used to distinguish between users. Efficient power control is necessary to prevent any mobile from drowning out others. TIA/EIA-95 provides two mechanisms for this purpose: **closed-loop power con-**

trol and **open-loop power control.** In the latter case, the mobile measures the received base station power and automatically adapts its own transmitted power accordingly. If the mobile is a good distance away from the base station, i.e. the received power very low, it will raise its transmitted power correspondingly.

In **closed-loop power control** the base station stimulates the mobile to raise or lower its power every 1.25 ms during a call (i.e. power control is effected at a frequency of 800 Hz). This is done by uncoded power control bits inserted into the data stream (FIG 1). The two mechanisms – open-loop and closed-loop power control – are always applied simultaneously (FIG 2). CMU 200 offers standard-conformant measurements to verify correct response of the mobile. To measure **open-loop time response**, the base station simulator (i.e. CMU 200) abruptly changes its output power, records the mobile's power response and enters the power characteristic in a tolerance mask (FIG 3).

Two further tests examine the **maximum** and **minimum output power** of a mobile. This is done by a combination of open-loop and closed-loop power control. To measure **minimum output power**, the base station transmits a sequence of power control down bits at high output level. This should stimulate the mobile to reduce its power below a certain level while maintaining adequate signal quality (rho factor). Measurement of **maximum output power** is the reverse of this.

When call activity is low, the mobile decreases its output power by sending not a continuous but a gated signal. The frame rate can be reduced from full to a half, quarter or eighth. CMU 200 checks the length of such a signal burst – a power control group (PCG) – **by a gated output power measurement**. The tem-

Digital mobile radio standard CDMA

CDMA[1] is based on the American TIA/EIA-95 standard and is also referred to as cdmaOne. CDMA is a spread-spectrum transmission method and was in the beginning mainly used for military applications. The CDMA spectrum is similar to a noise signal and so very difficult to detect, decipher or jam by hostile radio reconnaissance.

The availability of low-cost LSI circuits opened up commercial applications. The CDMA concept was first presented and successfully demonstrated in 1989 in San Diego. In 1993 the associated standard IS-95 was defined. In 1993 South Korea and 1997 Japan opted for CDMA as their network standard (FIG 7).

By 1999 there were as many as 50 million users with 83 network providers in 35 countries.

Compared with FDMA[2] (e.g. AMPS[3]) or TDMA[4] systems (e.g. TIA/EIA-136 or GSM), CDMA promises easier frequency planning, higher channel capacity and greater immunity to fading. It offers optimized handoff procedures. CDMA base stations use Walsh codes to differentiate between users. The coded voice signal (9600 bit/s or 14 400 bit/s) is spread to a chip rate of 1.2288 Mchip/s. On the forward link (base station to mobile), QPSK[5] modulation is used, on the reverse link (mobile to base station) O-QPSK[6].

1) Code-division multiple access
2) Frequency-division multiple access
3) Advanced mobile phone system
4) Time-division multiple access
5) Quadrature phase-shift keying
6) Offset quadrature phase-shift keying

FIG 7 The success story of CDMA began in San Diego in September 1989

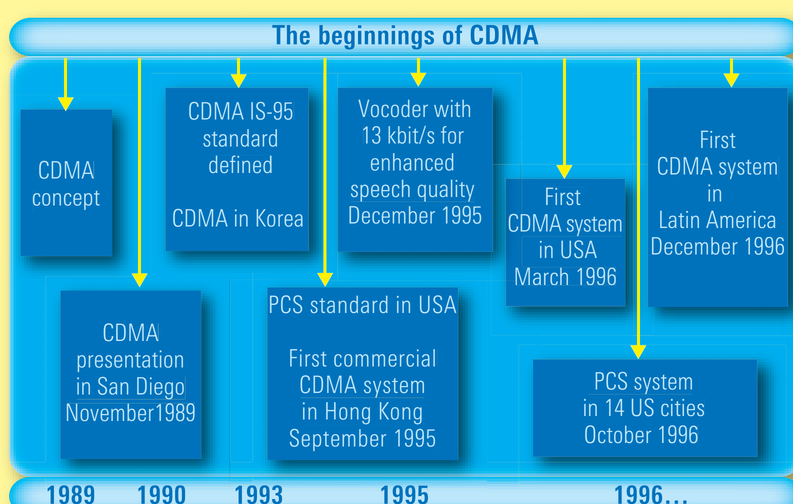


plate conforms to the TIA/EIA-98-C specification but can be modified by the user.

Modulation measurements

Assessment of modulation quality in CDMA is based on the above mentioned waveform quality. In addition to this, CMU 200 carries out in-depth modulation analysis of all essential parameters. It records, synchronizes and demodulates the test signal. From these data it generates an ideal reference signal and compares it with the DUT signal. From this it derives the error vector magnitude, the magnitude error and the phase error and presents them graphically versus time (FIG 4). These parameters as well as frequency error, carrier feedthrough and I/Q imbalance are statistically evaluated and the results displayed. Plus, a menu is available in which all scalar results are displayed in a list.

Receiver measurements

Receiver measurement is based on a comparison of the sent data stream with the data received by a mobile. A loop-back is set up between CMU 200, acting as the base station, and the DUT. The mobile returns the incoming data to the tester. Any transmission errors occurring on the way from the mobile to CMU 200 can usually be neglected. In addition, any frames corrupted on this path are identified by a cyclic redundancy check and not taken into account.

CMU 200 comes with predefined receiver measurements. The **sensitivity test** determines at very low base station levels the sensitivity of the mobile's receiver, the **dynamic range test** examines at very high base station levels whether the mobile is overdriven. In the **traffic channel demodulation test** an additive white Gaussian noise (AWGN) signal is superimposed on the base station signal to simulate more mobiles transmitting at the same frequency.

For overview measurements, CMU 200 can run CDMA transmitter and receiver measurements simultaneously. The parameters can be set independently of each other. In this test mode, the long time taken by receiver measurements on the production line can be utilized for modulation or power measurements in parallel (FIG 5). Reducing this time is not possible as receiver quality measurements are realtime and a large number of frames have to be averaged to obtain conclusive results.

All relevant parameters of CMU 200 in its role as a base station simulator are user-configurable, for example traffic channel, PN offset, frame offset or the power control bits sent to a mobile.

FIG 3 The open-loop time response measurement determines the CDMA mobile's reaction to sudden changes of output power from the base station

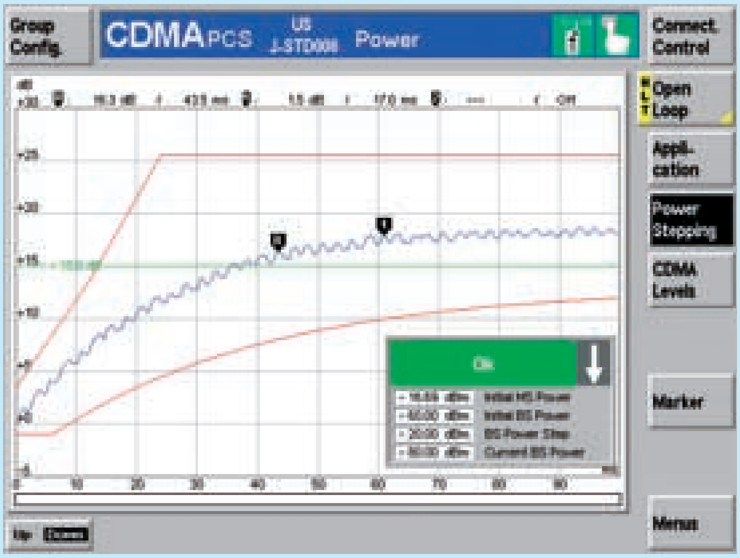
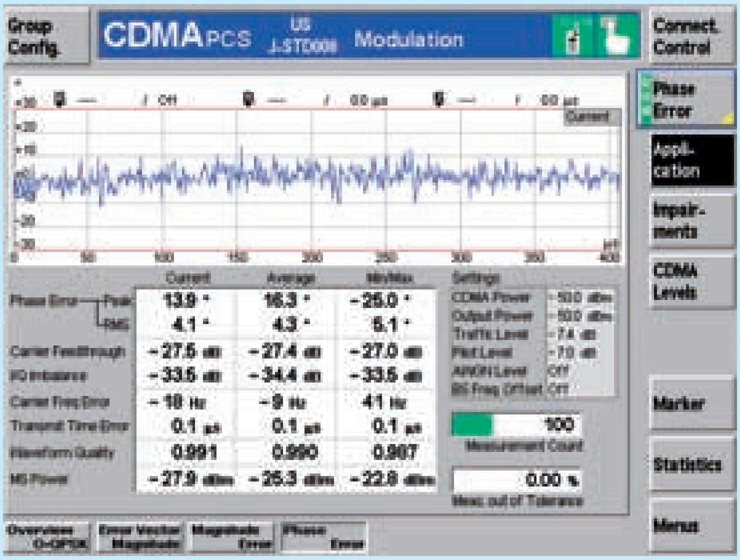


FIG 4 In modulation analysis, CMU 200 presents all results in clear-cut form. All scalar results are statistically evaluated and listed in a table, together with graphical presentation of phase error for example



CMU 200 of course performs implicit handoffs (e.g. RF channel, traffic channel, PN offset) during a call both within CDMA and to AMPS (FIG 6).

AMPS measurements

Especially in North America, practically all CDMA mobiles are offered with dual-mode functionality (CDMA and analog AMPS), so a radio communication tester like CMU 200 must also support this 1G standard.

AMPS functionality in CMU 200 features innovative concepts like multitone measurements to check AF frequency response at the mobile transmitter and receiver end [2].

CMU 200: test platform fit for future requirements

Thanks to their modular hardware and software concept, the CDMA options of CMU 200 today offer innovative technology on a test platform optimally prepared to handle future CDMA generations like cdma 2000.

Thomas Rösner

More information and data sheet at www.rohde-schwarz.com or enter 170/02 on reader service card

CD available free from your Rohde & Schwarz representative

REFERENCES

[1] Universal Radio Communication Tester CMU 200 – On the fast lane into the mobile radio future. News from Rohde & Schwarz (1999) No. 165, pp 4–7

[2] Universal Radio Communication Tester CMU 200 – Successful mobile radio tester now with US TDMA and AMPS standards. News from Rohde & Schwarz (2000) No. 168, pp 10–15

FIG 5 The overview menu allows simultaneous transmitter and receiver measurements

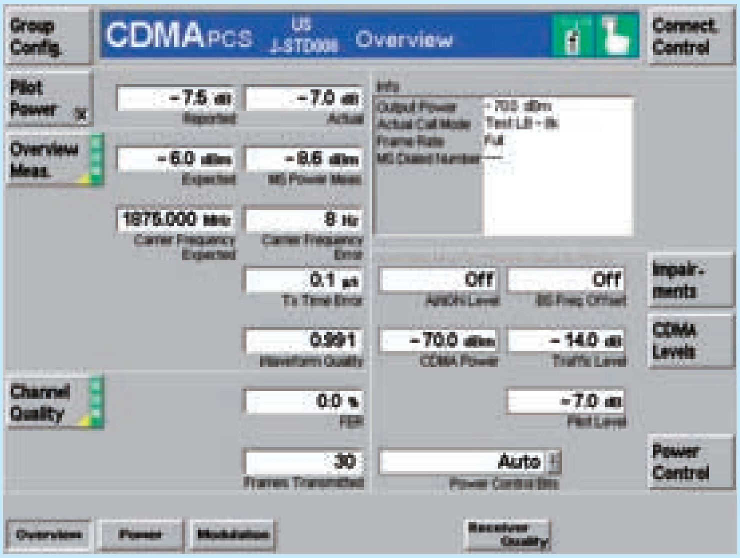


FIG 6 All parameters for handoff can be configured in a separate menu