Universal Radio Communication Tester CMU200

THE multi protocol tester for current and future mobile radio networks

- Extremely high speed testing
- Highly accurate measurements
- Modular future-proof design
- Comprehensive spectrum analyzer
- Fast switching between networks

ROHDE&SCHWARZ

Testing the 3rd generation

For more than 60 years Rohde&Schwarz has always been at the forefront of mobile radio technology. We continue this tradition of RF test and measurement with Universal Radio Communication Tester CMU 200. The CMU 200 is a third generation platform design, that offers true scalable multimode functionality.

CMU 200 reflects the long-standing expertise Rohde&Schwarz has gained in the world of mobile radio. In recent years, the company has helped to launch overwhelmingly successful mobile radio systems.

Rohde&Schwarz is a preferred supplier to many of the leading mobile equipment manufacturers and is the market leader for mobile radio test sets.

The CMU 200 is part of a complete range of mobile radio test equipment, encompassing everything from conformance test systems, to system simulators, turnkey functional board test / final test systems and simple sales counter Go/NoGo testers.

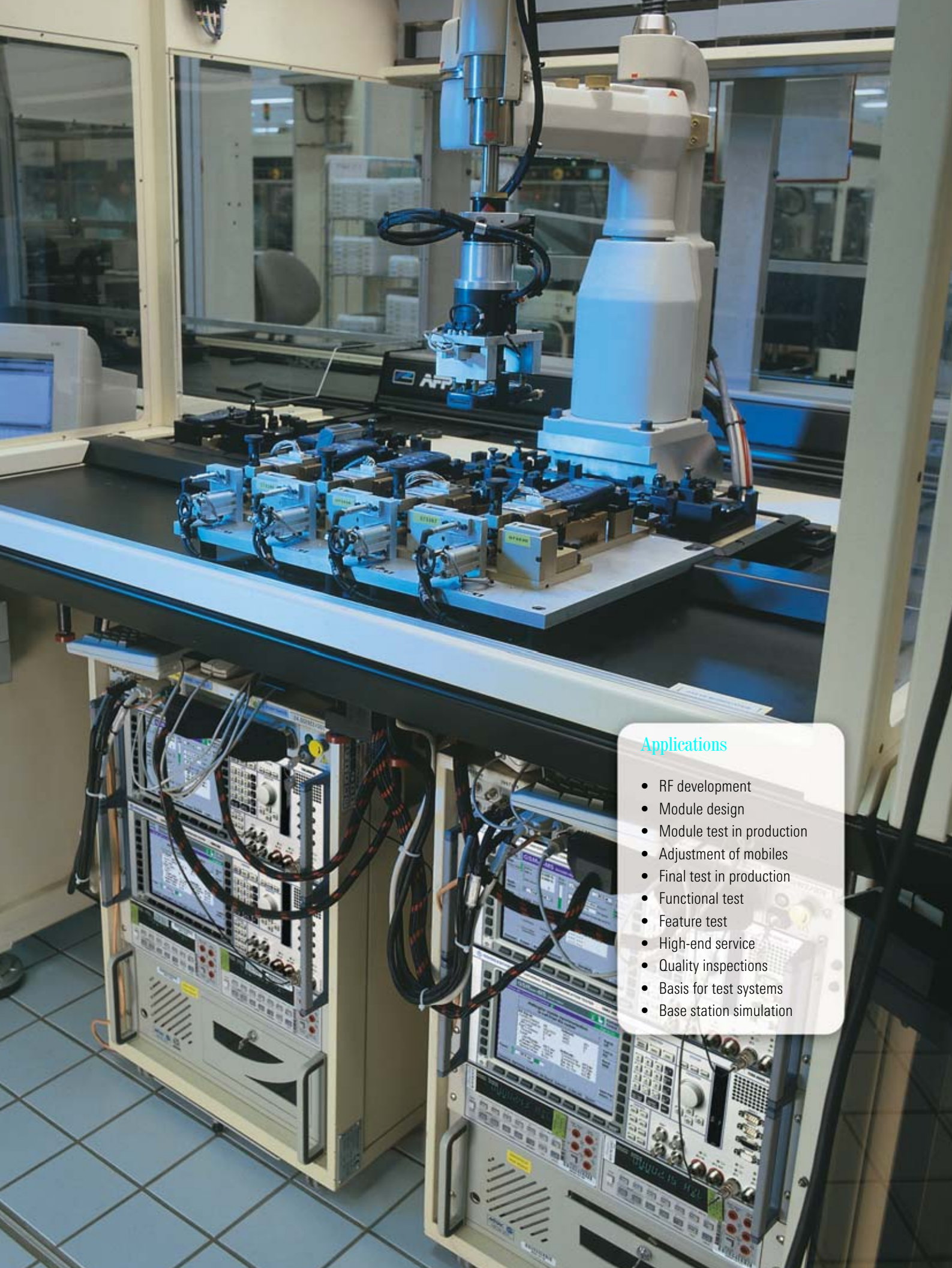
The base unit with its standard-independent module test provides many general purpose measurement facilities for the development of all kinds of standards within its wide and continuous frequency range. If extended by the relevant options, the CMU200 offers the hardware and software necessary to handle your 3G, "2.5G" and previous generation testing applications including analog.

Low cost of ownership

Selecting the CMU 200 is a decision for the future and results in a total cost of ownership which is sure to be among the lowest due to the following factors:

- Completely modular design of hardware and software components avoids unnecessary investments right from the start just because there is a possibility of a feature being needed sometime in the future. You only pay for what you need
- Should an extension become necessary because your needs widen after some time – the modularity of the CMU 200 concept will cater for that. Many extensions to the unit may be installed onsite. You only pay for it when you need it
- The concept allows two complete channels (RF, signalling and evaluation) to be installed in one CMU 200 unit
- Maximum production output in a compact 4-rackunit-height package with minimum power dissipation allows compact production space layout
- With the CMU 200 user interface even less experienced users will intuitively get it right without the need for extensive training
- A new remote interface syntax reflects the inherent modularity of this real multimode tester

The CMU200 targets a wide range of applications, but is primarily optimized for the high accuracy and speed demanded in an ever more quality-conscious manufacturing process. Shown here, the frontpanel for desktop use.



Applications

- RF development
- Module design
- Module test in production
- Adjustment of mobiles
- Final test in production
- Functional test
- Feature test
- High-end service
- Quality inspections
- Basis for test systems
- Base station simulation

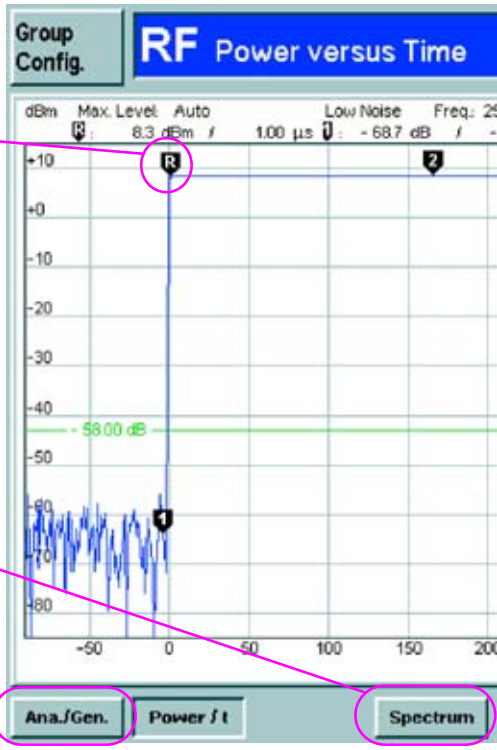
Usability

The CMU200 key strengths

The Radio Communication Tester CMU200 brings premium cost effectiveness through a variety of features, with extremely fast measurement speed and very high accuracy being the two most important ones. In addition, the secondary remote addressing of the unit's modular architecture makes for intelligent and autonomous processing of complete measurement tasks and fast control program design.

Thanks to the high resolution of the extremely bright high-contrast TFT display even the finest details can be displayed

Direct branching to all associated menus makes for a uniquely flat menu structure



Greatest accuracy

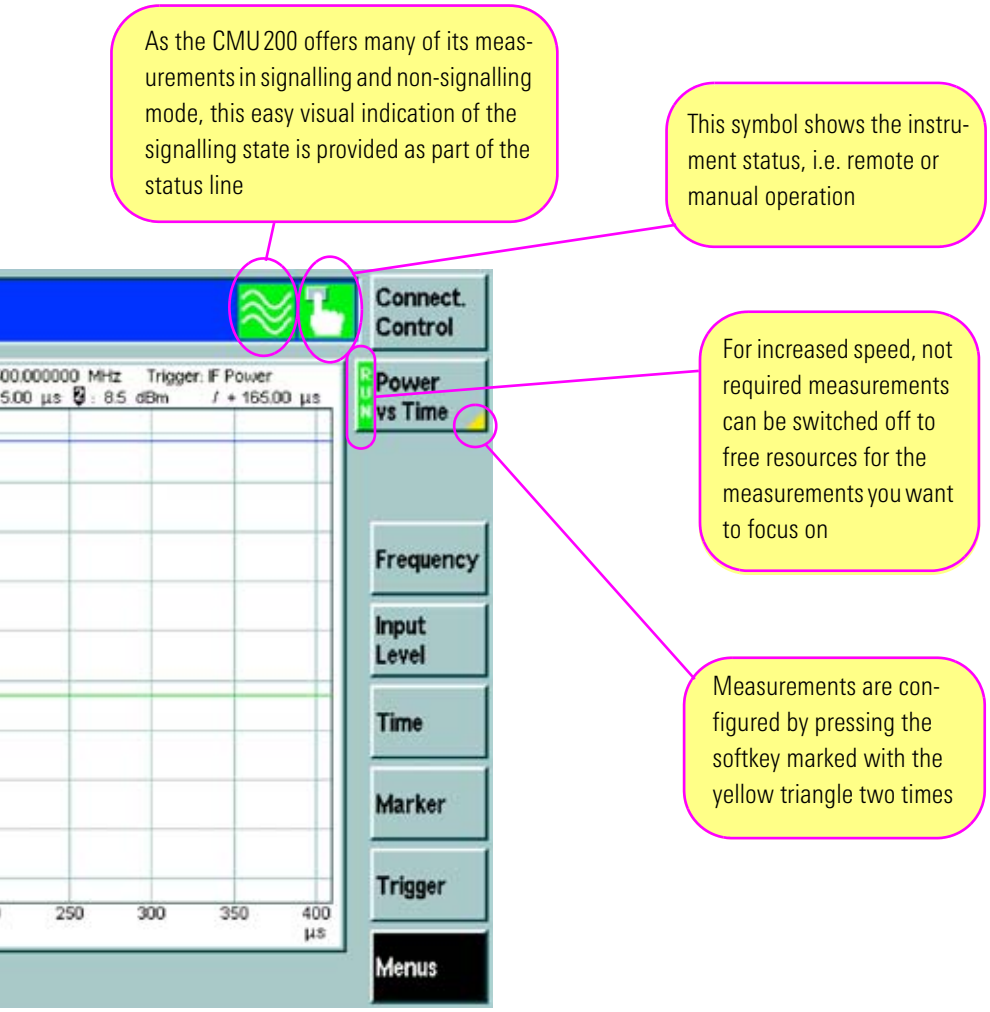
In a production environment the unit's high accuracy allows DUTs (Device under Test) to be trimmed for maximum battery lifetime without compromising quality. In the lab, CMU200 enables the development engineer to partly replace conventional, dedicated premium-quality instruments and save desktop space at the same time. High precision measurement correction over the whole frequency and dynamic range as well as compensation for temperature effects in real time are critical factors for achieving the CMU200's excellent accuracy.

The globally standardized Rohde&Schwarz calibration system can check CMU200 accuracy in a service center close to you or, volume permitting, on your site. A worldwide network of these standardized automatic calibration systems has been implemented in our service centers. Highly accurate and repeatable calibration can be performed wherever you are. Your local Rohde&Schwarz representative offers customized service contracts for the unit. For large scale users of CMU200 a compact level verification system is available, in addition.

Greatest speed

The high processing speed is due to extensive use of ProbeDSP™ technology, parallel measurements and innovative remote command processing.

- ProbeDSP™ technology
  The modular architecture relies on decentralized ProbeDSP™ processing coordinated by a powerful central processor. Like an oscilloscope probe, DSPs dedicated to a specific local data acquisition and evaluation workload help to keep subsystem performance at an uncompromising maximum even if additional modules are fitted to the CMU200 mainframe.
- Parallel measurements
  Several RX and TX measurements can be performed in parallel. This is achieved by the fast response of the CMU200's modular hardware as well as the high overall processing power of the unit and the avoidance of bottlenecks by dedicated operation of the ProbeDSP™ technology employed. Examples of parallel operation are measurements of BER and simultaneous Phase/Frequency error, EVM, Magnitude Error and audio or the various spectrum measurements.
- Innovative remote processing
  The novel secondary addressing mode can address similar functions of each of the CMU200 subsystems (different mobile radio standard) in an almost identical way. Using this type of addressing, new remote test sequences can be programmed by a simple cut and paste operation followed by editing specific commands to adapt the control program to the new application. Secondary addressing is fully SCPI-compliant which means that a subsystem address, for example "WCDMA-FDD", can be replaced by a string denoting a different subsystem, another mobile radio standard.



Greatest reliability

CMU200 employs an ultra effective heat management between housings and individual components as well as between heat sinks and the air flow. Together with the independent cooling cycles for different modules, this adds up to an optimized cooling system.

The base unit

The base unit without any options installed can be used for testing general parameters of 1st, 2nd or 3rd generation mobile phones. The CMU200 base unit is the ideal solution for tasks at module level, i.e. at the early production stages of all cellular standards.

Constituent parts of the CMU200 base unit are the RF generator and RF analyzer which are complemented by a versatile network-independent time domain menu and a comprehensive spectrum analyzer. As an example power versus time measurement is shown above.

By combining graphical and numerical overview menus the optimal view can be chosen when the CMU200 is in manual mode.

The menu structure of the CMU200 is very flat and uses context-sensitive selection, entry and configuration pop-up menus.

Advanced operational ergonomics have been incorporated into a most compact and lightweight, 4 rack units high package.

Key advantages of the CMU200

Speed

- Unrivalled speed of single measurements

Accuracy

- Incomparable accuracy
- Excellent result repeatability

Modularity

- Modular hardware and software concept provides easy extension to further functionality

Reliability

- Extremely low power consumption, and effective heat conduction result in unparalleled reliability

Future-proof

- Easy migration to emerging standards

Optimized solutions for your production test requirements

Rohde&Schwarz supports CMU200 based production test solutions through a comprehensive net of application engineering sites. The backbone to this network is the four system integration centers located in Asia, North America and Europe.

System Integration Services

Regional center project teams offer local system integration, service and support. A team of experts is ready to provide turnkey solutions including test case programming. Custom-tailored project solutions and site process optimization are major aspects of our services. For fully automated production environments we offer inline solutions together with our partners in the field of automation. As an example a fully automated final test fixture including RF test, audio test, keypad test and optical inspection is shown on the picture.

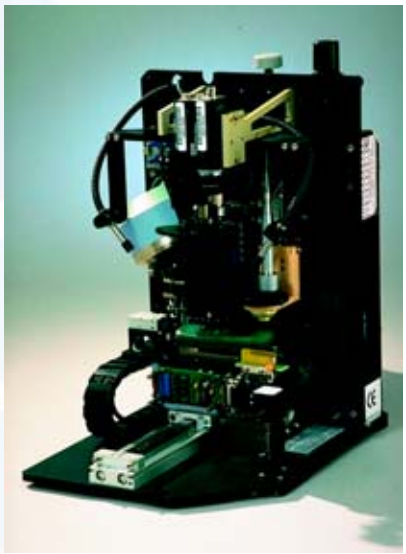
Time to Market

The key to commercial success resides in the time required to get a new product to market in large volume. The crucial point is the fast transition from product development stage to mass production. The TS7100 Cellular Phone Production Test Platform featuring the CMU200 meets this challenge.

TS7100 Description in Brief

The stringent requirements in the production environment of mobile phones make it necessary to implement new strategies in the specification of test systems. The test system architecture is based on two CMU200s to provide the optimum throughput solution.

The TSVP (Test System Versatile Platform) test platform is based on the industry standard Compact PCI/PXI. This new type of bus is up to 6 times faster than previous industry bus standards. The TSVP's CompactPCI frame is 100% compatible to the industry standard but features 14 up to 31 slots. It comprises a state-of-the-art



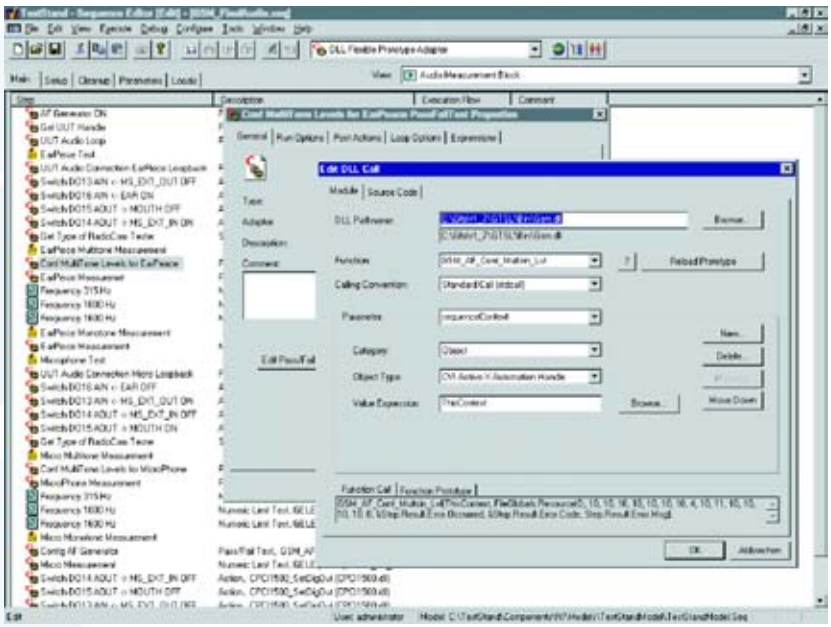
controller PC, digital multimeter and selectable switching and test modules. For each DUT the test hardware for switching and stimulus functions is implemented as a dedicated set of modules.

The TSVP takes up all modules used for control and additional measurements.

Off-the-shelf CompactPCI/PXI modules can be added. Up to 4 sets of modules for testing DUTs can be inserted. The software can thus simultaneously use the resources of the parallel instrumentation to maximize speed in highly automated production. We can offer optimal configured test systems customized to your production environment.

Test Executive & Generic Test Software Library Features

The parallel hardware is fully supported by TestStand, the industry-wide test executive from National Instruments. A user-friendly connection to the available device drivers has been created to provide faster use of the test executive. This connection is established by the Generic Test Software Library (GTSL). At the same time the toolkit concept provides ready-to-run test cases, which can be customized by the user as required.



GTSL in action

TS7100 Example of a 2-channel ultra-low-profile configuration. PSU and switch matrix fitted to the rear of rack

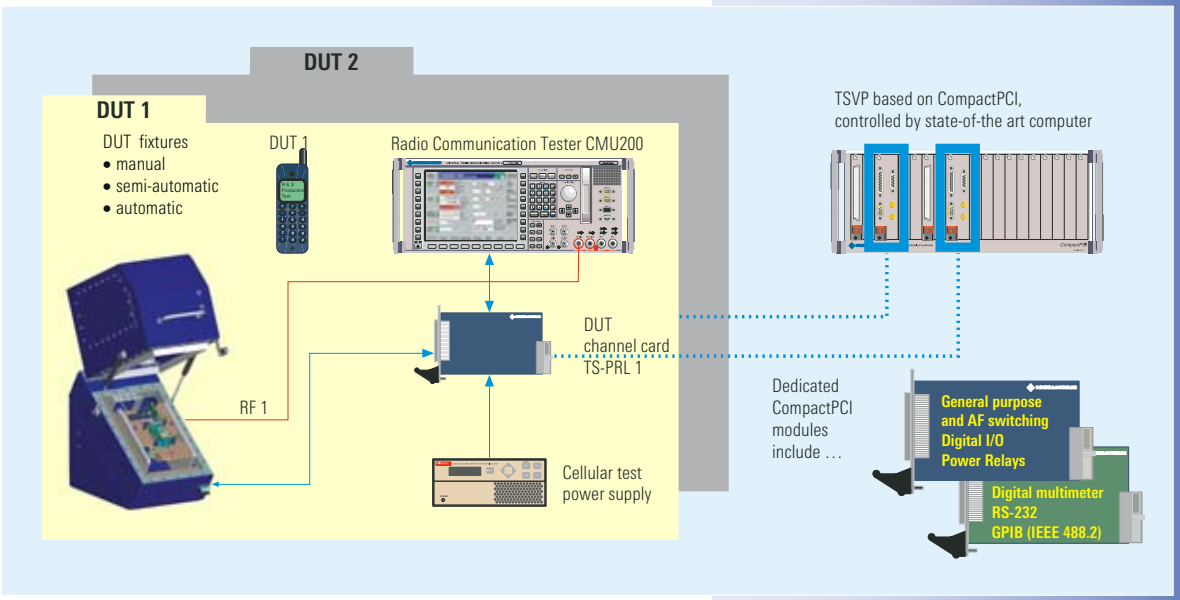
TS7100 Features in Brief

- High throughput by parallel testing of cellular phones
- All hardware and software components based on industrial standards
- System controller based on CompactPCI/PXI bus arcitecture
- One system for functional board test, phone calibration and final test
- One system for all major cellular phone standards
- Easy expansion to 3rd generation technologies
- Ready-to-run Rohde& Schwarz test library for immediate use or customization
- Provides modular and versatile hardware/ software platform
- Reduced costs due to generic concept

Software concept in brief

- Software platform based on LabWindows/CVI and TestStand from National Instruments
- GTSL includes ready-to-run test cases for the standards supported by CMU200
- Functional test sequences for RF test, calibration, signalling test and audio and acoustic test of mobile phones are supported
- Transparent and open library can be extended by the user
- Operator interface and test cases can be easily customized
- Parallel test of multiple cellular phones is fully supported
- GTSL supports multi-threading and instrument sharing if needed
- Test development time is reduced by as much as 80 %

For more detailed information see separate data sheet TS7100 (PD 757.5737)



Blockdiagram for a 2-channel configuration of TS7100

Ready for today's networks ...

GSM today

Since its introduction in the early nineties, the GSM system has won acceptance and undergone an evolution that no one could have foreseen.
The applications of the GSM system are numerous and are currently:

- GSM400
- GSM850
- GSM900 including
  - P-GSM (primary GSM)
  - E-GSM (extended GSM)
  - R-GSM (railway GSM)
- GSM1800 (DCS)
- GSM1900 (PCS)

Whether the application is in production, service or development, the flexible concept of the CMU 200 from basic RF signal generation, frequency, power and spectrum analyzer measurements for alignment of modules in production or development applications, to an instrument with full GSM-specific signalling in any of the above-mentioned bands, as well as module tests on frequencies anywhere in the range from 10 MHz to 2700 MHz.

Signalling mode

The CMU 200 simulates a GSM base station RF interface with the signalling flexibility necessary to test the behaviour of the mobile under the influence of different signalling parameters. These parameters are normally set by the network operator but can be reproduced by the CMU 200 for test purposes. The unit supports the latest fast location update and direct paging features.

ETSI MEMBER
...making the right connections.

Reduced signalling synchronized mode

The CMU 200 provides the same functionality as in the Signalling mode, but discards any signalling reaction from the mobile connected. This mode of operation enables both testing of modules that only have layer 1 operation and very fast RF testing in production environments. It can also skip the location update procedure in order to save time.

Non-signalling mode

This mode serves for generating a signal with GSM-specific midambles and modulation in the entire frequency range from 10 MHz to 2.7 GHz. The analyzer offers the same flexibility for GSM-specific transmitter measurements such as

- modulation analysis
- average and peak burst power
- power versus time, power versus slot, power versus frame
- spectrum due to switching /modulation

GSM development

As an all-round tool for GSM development engineers, the CMU 200 is an unsurpassed solution. The RF interface provides four input and output connectors offering a wide range of signal levels for generation and analysis of RF signals. Input only, as well as combined input/output connectors, can analyze mobiles or modules with a sensitivity down to –80 dBm and up to +47 dBm for the power meter. RF signals can be generated with levels from –130 dBm up to +13 dBm, depending on the selected connector. All measurement tolerances are set by default according to the GSM 11.10 and GSM 05.05 recommendations but may of course be altered to suit individual needs.

Production of mobile phones

Production is a process that calls for cost effectiveness. The CMU 200 concept is optimized for IEC/IEEE-bus speed, measurement accuracy and reproducibility as well as cost of ownership. Thanks to the multitasking feature and parallel measurements, previously unobtainable test times can be achieved.

The ability to process BER data and perform transmitter measurements at the same time, allows phase / frequency error, power versus time and average power (PCL accuracy) to be measured during the time-consuming receiver test.

The accuracy and reproducibility ensure correct and steady measurement results and thus contribute to the quality and reliability of the end product.

GSM Evolution – 2.5G

The amount of data transfer in GSM networks is growing rapidly. Multislot applications such as HSCSD or GPRS together with the innovative 8 PSK modulation scheme EDGE are needed to cater for the evolving data traffic. The CMU 200 platform is not only able to meet today's standards and systems but is also designed for the needs of tomorrow.

Multislot

In the future, mobile phones will be able to use several timeslots simultaneously for data transmission and reception to further increase the data rate. The simultaneous transmission and reception of several timeslots (multislot) is the technological

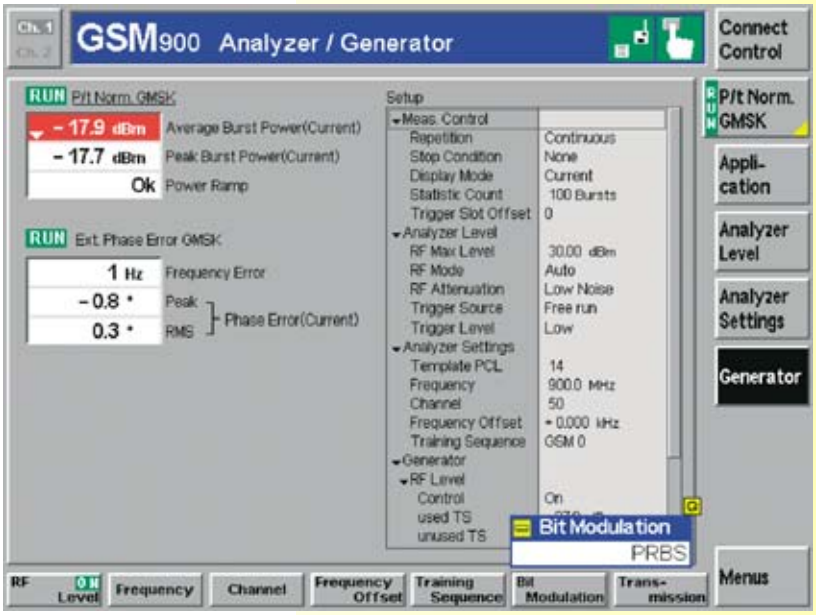
GSM
GLOBAL SYSTEM FOR MOBILE COMMUNICATIONS

challenge for circuit-switched and packet-switched applications. The following extensions of the GSM single-slot measurements enable maximum flexibility in development, and, due to minimum measurement times, maximum throughput in production.

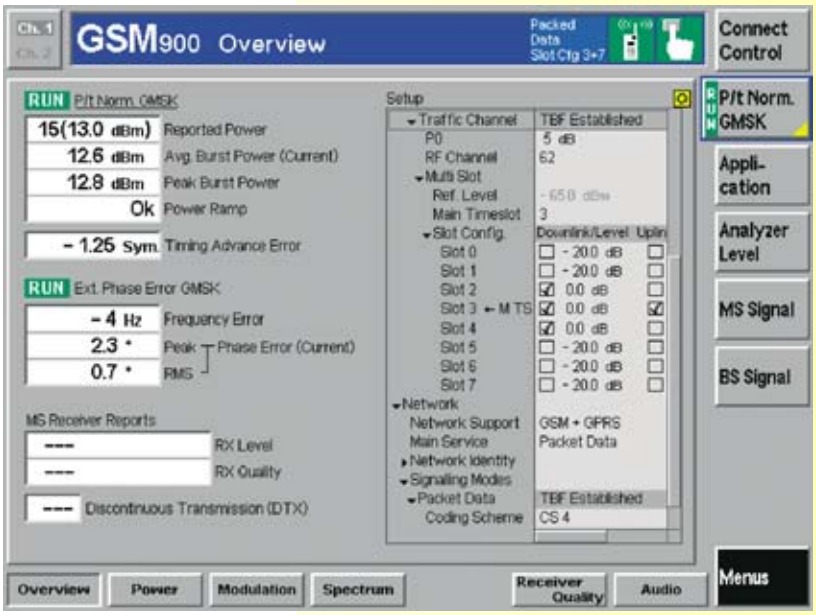
- Individual levels for all timeslots used in the down link (DL). The CMU generates up to eight timeslots per frame in the down link; each timeslot can be assigned a separate level. The excellent level stability of the CMU 200 generators is not impaired by multislot transmission using different levels, and allows the most accurate measurements of receiver sensitivity (BER/DBLER).
- Transmitter and receiver measurements are possible on every timeslot used. The new multislot concept allows independent measurements on any timeslot (TS 0-7) and thus covers the current and future multislot combinations without restrictions.
- Power-versus-time measurement (graphical display) for up to four timeslots in the UL. The templates of this application are evaluated independently for each timeslot - in line with standards and according to recommendations. Both GMSK- and 8PSK-modulated signals are recognized, and the templates of the relevant timeslot are set in realtime.

Multislot measurements are required for HSCSD and ECSD technologies as well as for GPRS and EGPRS.

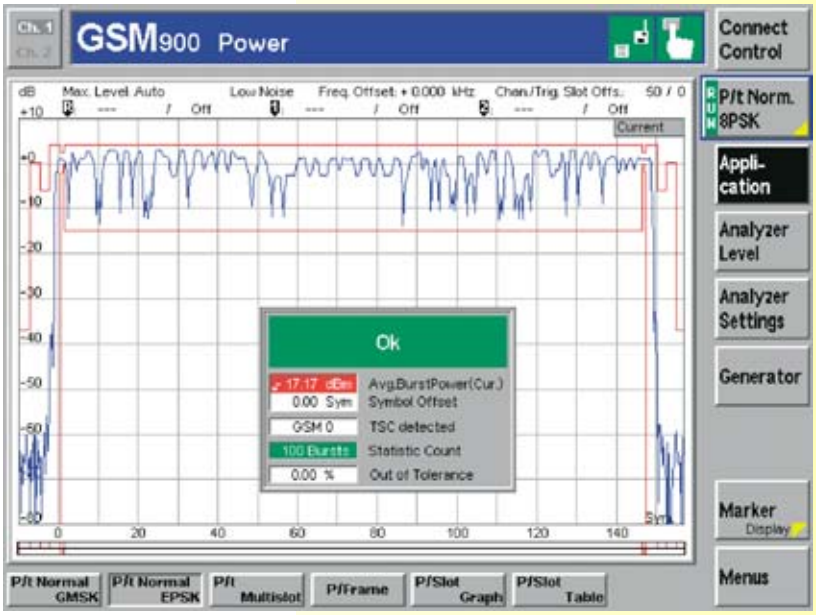
GSM-specific non-signalling test provides generation and analysis of RF signals for testing of RX/TX modules or mobiles in service mode



The overview menu provides fast comprehensive information on the mobile's RF performance. The hotkeys at the bottom of the screen give immediate access to specific and detailed GSM measurements

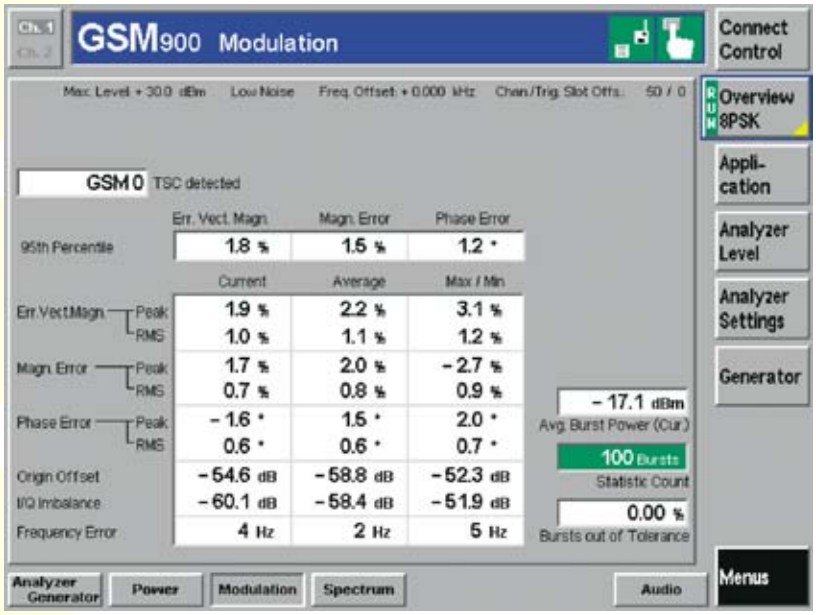


In the GSM non signalling function groups the possibility to switch between GMSK and 8PSK (EDGE) is already implemented. Thus EDGE bursts as shown here can easily be analyzed



8PSK modulation – EDGE

8PSK is besides multislot a further step towards increasing the mobile radio data rate. By using the available GSM frame structure, the gross data rate is three times that obtained with GMSK. The CMU 200 can already perform 8PSK on GSM bursts and analyze them thanks to advanced measurement applications. Error vector magnitude and magnitude error have been added to the range of modulation measurements. New templates for power-versus-time measurements ensure compliance with the specifications, as do the modified tolerances for spectrum measurements. 8PSK will transform HSCSD technologies into ECSD and GPRS into EGPRS. As with all measurements provided by the CMU 200, special attention has been given to achieving maximum measurement accuracy and speed for EDGE too.



In the 8PSK mode the modulation analysis is subdivided. The error vector magnitude, the magnitude error and the phase error can be displayed both numerical as shown above, or graphical.

GPRS/EGPRS

Thanks to the new, future-oriented method of packet data transmission, the radio resources of existing GSM mobile radio networks can be utilized efficiently for data services. As with circuit-switched services, GPRS will also use a combination of several timeslots (multislots) and higher-level modulation in the form of 8PSK (EGPRS) to push up the data rate. The introduction of packet-oriented transmission and the associated temporary assignment of radio resources require new test concepts. The CMU 200 provides the following test modes:

- ETSI Test Mode A: In test mode A, the mobile is induced to continuously transmit the associated UL timeslots. The CMU 200 can carry out all TX measurements available, such as the power ramp measurement of up to four adjacent timeslots simultaneously, or modulation and spectrum measurements.
- ETSI Test Mode B: Test mode B creates a loop back in the telephone so that the mobile retransmits data blocks received from the CMU 200. In addition to the measurments available in the ETSI test mode A, test mode B enables bit and block error rate measurements (BER/DBLER).

GSM specifications – Mobile station test

RF generator

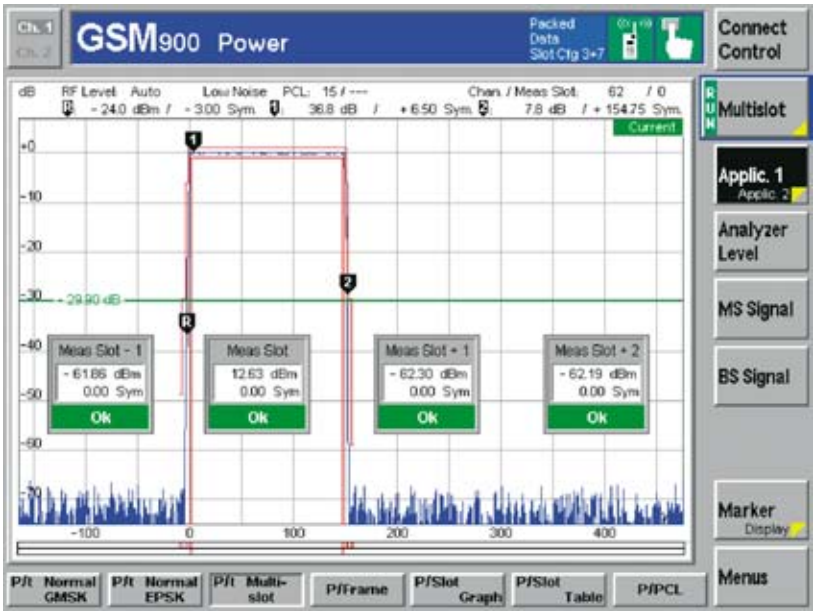
Modulation	GMSK, BxT = 0.3 8PSK
Frequency range	
GSM 400 band	460 MHz to 468 MHz / 488 MHz to 496 MHz
GSM850 band	869 MHz to 894 MHz
GSM900 band	921 MHz to 960 MHz
GSM1800 band	1805 MHz to 1880 MHz
GSM1900 band	1930 MHz to 1990 MHz
Attenuation of inband spurious emissions	>50 dB
Inherent phase error (GMSK)	<1°, rms <4°, peak
Inherent EVM (8PSK)	<2%, rms
Frequency settling time	<500 µs to res. phase of 4°
Output level range (GMSK)	
RF1	–130 dBm to –27 dBm
RF2	–130 dBm to –10 dBm
RF3OUT	–90 dBm to +13 dBm
Output level range (8PSK)	
RF1	–130 dBm to –31 dBm
RF2	–130 dBm to –14 dBm
RF3OUT	–90 dBm to +9 dBm
Output level resolution	0.1 dB

Output level uncertainty

	+23°C to +35°C	+5°C to +45°C
RF1, RF2		
>–117 dBm	<0.5 dB	<0.7 dB
RF3OUT		
–90 dBm to +10 dBm (GMSK) –90 dBm to +6 dBm (8PSK)	<0.7 dB	<0.9 dB

RF analyzer

Frequency range	
GSM 400 band	450 MHz to 458 MHz / 478 MHz to 486 MHz
GSM850 band	824 MHz to 849 MHz
GSM900 band	876 MHz to 915 MHz
GSM1800 band	1710 MHz to 1785 MHz
GSM1900 band	1850 MHz to 1910 MHz
Measurement bandwidth	
in measurement menus	500 kHz



The Power-versus-Time Multislot application can graphically display up to 4 adjacent timeslots, automatically detects GMSK- and 8PSK-modulated signals and activates the associated templates in real-time. A new zoom function allows full-screen display of each slot.

Reduced signalling synchronized mode

Extremely fast adjustment and testing of RF parameters during GPRS mobile phone production is ensured by deactivating the GPRS protocol stack. Without using the higher protocol layer (RLC/MAC layer), the CMU 200 synchronizes the mobile (camping), the data channel (PDCH) is then set up directly.

The GPRS and EGPRS data coders are already available to determine Bit Error Rates (BER) and Data Block Error Rates (DBLER).

GSM highlights of CMU200

Benchmark-breaking IEEE-bus speed due to

- Parallel measurements
- Secondary addressing
- Optimized processing power

High flexibility for R&D

- Assignment on up to 8 DL slots (TS 0 to 7)
- Tx/Rx on any transmit slot
- Individual level generation on any used DL slot

GMSK/8PSK Measurements

- Phase/frequency error, EVM, magnitude error, origin offset, I/Q imbalance for I/Q modulator tuning
- Power vs time
- On up to 4 UL slots
- normal/access
- Peak power/average, power vs frame, power vs slot
- General spectrum measurements
- Timing error
- BER/DBLER, RBER/FER, FastBER
- Power vs PCL (on 3 or 7 channels)

Power meter (frequency-selective)

Level range

RF1	
continuous power[1]	–40 dBm to +47 dBm (50 W)
Peak Envelope Power[2] (PEP)	+53 dBm (200 W)
RF2	
continuous power	–54 dBm to +33 dBm (2 W)
Peak Envelope Power[2] (PEP)	+39 dBm (8 W)
RF4IN (continuous power and PEP)	–80 dBm to 0 dBm

Level uncertainty

RF1, RF2, RF4IN	
in temperature range +23 °C to +35 °C	<0.5 dB
in temperature range +5 °C to +45 °C	<0.7 dB

Level resolution 0.1 dB (0.01 dB via remote control)

Modulation analysis

Level range (PEP)

RF1 [2]	–6 dBm to +53 dBm
RF2 [2]	–20 dBm to +39 dBm
RF4IN	–60 dBm to 0 dBm

Inherent phase error (GMSK) <0.6°, rms
<2°, peak

Inherent EVM (8PSK) <1,0 %, rms

Frequency measurement uncertainty ≤10 Hz + drift of time base

Burst power measurement

Reference level for full dynamic range (GMSK, low noise mode)

RF1 [2]	+10 dBm to +53 dBm
RF2 [2]	–4 dBm to +39 dBm
RF4IN	–22 dBm to 0 dBm
Dynamic range (GMSK)	>72 dB (BW=500 kHz, rms)

Reference level for full dynamic range (8PSK, low noise mode)

RF1 [2]	+6 dBm to +49 dBm
RF2 [2]	–8 dBm to +35 dBm
RF4IN	–26 dBm to –4 dBm
Dynamic range	>69 dB (BW = 500 kHz, rms)

Relative measurement uncertainty

Result > –40 dB	<0.1 dB
–60 dB ≤result≤–40 dB	<0.5 dB

Resolution 0.1 dB in active part of burst

[1] *50 W from +5 °C to +30 °C, linear degradation down to 25 W at 45 °C.*
[2] *Mean value of power vs time must be equal or less than allowed continuous power.*

TDMA in CMU200

The need for higher data rates is the trend in our information-oriented society in the new millennium. The enhancement of mobile phones takes this need into account on the way to the next generation of wireless communication. Need to test these future improvements?

CMU200 does it all. The TDMA part takes care of your requirements to cope with this fast progressing mobile technology. The CMU200 concept with its multistandard platform architecture provides for further extensions such as *Bluetooth* and cdma2000.

TDMA

The wide acceptance of TDMA (IS-136) is based on a very flexible and powerful technology as well as on its compatibility with AMPS, which is widespread and one of the major wireless communication standards. Derived from analog AMPS, the TDMA standard is now ready for a step-by-step evolution into the third generation of mobile technology. This fact shows the need for a test instrument that is flexible enough to cover all future needs as well as the current standards.

For TDMA (IS-136) signalling functionality, the CMU200 requires the versatile signalling unit (CMU-B21) as well as the software option CMU-K27 for the cellular band or CMU-K28 for the PCS band.

Due to the highly user-friendly menu concept, the CMU200 provides quick access to all measurements desired, optimizing handling and consequently efficiency.

Signalling mode

The CMU200 simulates a TDMA base-station RF interface including the signalling protocol so that a mobile can be tested with regard to different signalling parameters. All necessary network and base-station parameters can be set, such as control and traffic channel configuration, neighbouring channels setup etc. You can also generate a MAHO report.

Non-signalling mode

The non-signalling mode is for generating and analyzing TDMA (IS-136) signals within the frequency range from 10 MHz to 2.7 GHz. CMU200 provides TDMA-specific measurements such as:

- Power
- Modulation
- Spectrum
- Power versus time
- BER

TDMA (IS-136) development

With its great versatility the CMU 200 is the most suitable tool for the development of mobile phones. Four configurable RF connectors are provided to enable flexible signal generation and analysis. The power meter can evaluate signals within a range from –80 dBm to+ 47 dBm, whereas the generator outputs signals from –130 dBm to +13 dBm. The clearly structured and user-friendly menu design together with the clear-cut screen layout provides quick access to all features and ensures trouble-free monitoring of the device under test.

Quality assurance

Due to its high measurement repeatability and accuracy, the CMU200 is the right choice to ensure a consistently high quality standard from production. TDMA-specific measurements such as BER, Error Vector Magnitude (EVM) and EVM10, where only the first 10 symbols are taken into account, provide an excellent test platform to guarantee the production of high-quality devices.

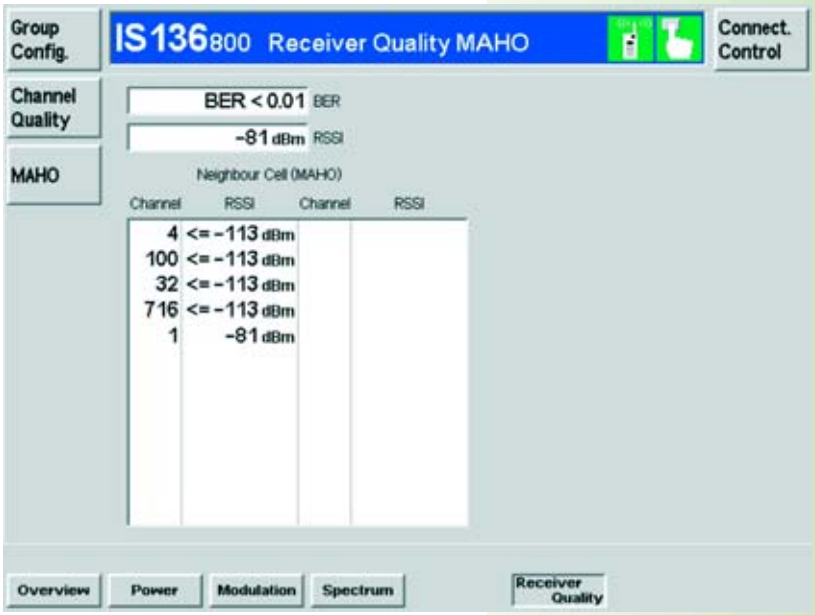
Production of mobile phones

The production of mobile phones requires time-efficient and cost-effective means that ensure both high throughput and state-of-the-art accuracy. Thanks to the unique IEC/IEEE-bus concept of the CMU200, these two goals can be easily achieved in your production line. The intelligent handling of the received GPIB commands optimizes the measurement speed for all TDMA-specific measurements. In practice, this will mean drastically enhanced test time and test yield.

Acoustic Measurements

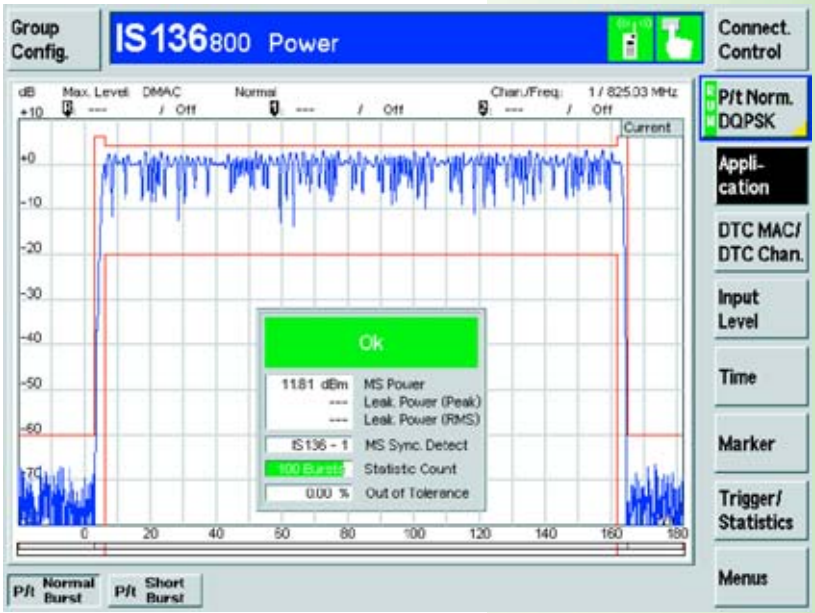
The newly implemented ACELP speech coder is able to encode and decode real audio signals and allows you to use the CMU200 also in real acoustic measurement applications. Equivalent to the GSM implementation of the CMU200 the TDMA speech coder provides analog inputs and outputs and a connector for an external handset. The speech coder requires the hardware option CMU-B52 and can also be combined with the internal Audio Analyzer/Generator option CMU-B41.

The mobile reports the received signal strength (RSSI) of the observed channels back to the CMU where the RSSI is displayed in the MAHO report list. It is possible to configure the neighbouring channels in the network setup. The reported BER can also be monitored



In the modulation menu it is possible to measure the phase error, frequency error and the error vector magnitude. The mesurements results are displayed graphically. Additional measurements such as amplitude droop and timing error are taken as well and displayed numerically in the same screen

In the power menu, the mobile output power of the short burst or the normal burst is displayed. CMU also enables leakage power measurements which inform on the mobile power output in unused time slots



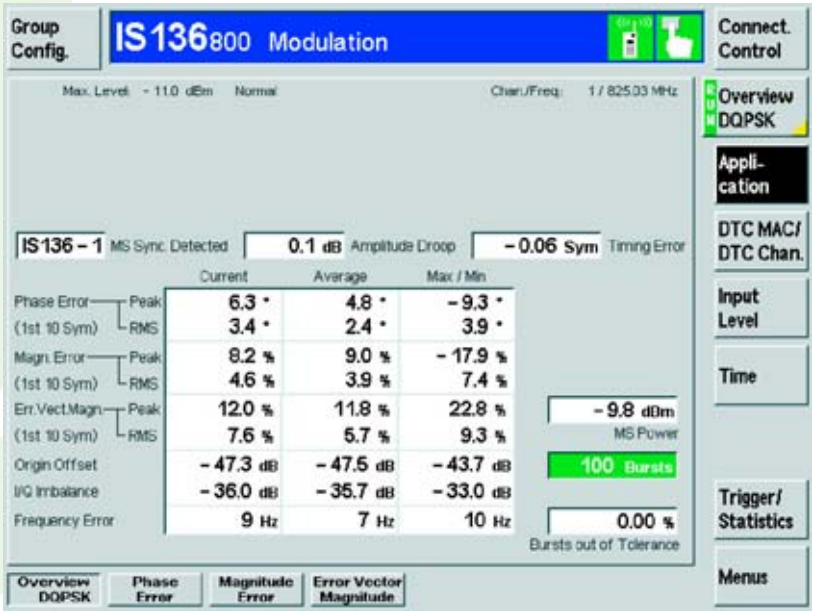
TDMA in CMU200

Handoffs

Handoffs are part of the IS-136 specification. Handoffs between PCS and cellular bands as well as from and to AMPS are defined and have to be tested. CMU200 supports handoffs from IS-136 800 MHz to 1900 MHz (inter-band handoff) and vice versa. Handoffs from 1900 MHz or 800 MHz to AMPS and back are also possible (inter-mode handoff) with CMU200.

Switching standards

The flexibility of CMU200 makes for quick and simple switching between two different standards. This is very important for IS-136, which is a dual-mode standard containing a digital (TDMA) and an analog mode (AMPS). The handoff between TDMA and AMPS can be achieved by simply pressing a button. This results in a very versatile test concept to improve the flexibility and throughput of your production line.



In the modulation overview menu, error vector magnitude (EVM), phase error and magnitude error are measured simultaneously and displayed in a numerical table It is possible to choose either EVM, where the whole burst is considered, or EVM10, where only the first ten symbols are taken into account

TDMA specifications – Mobile station test

RF generator

Frequency range signalling mode	
US Cellular	869 MHz to 894 MHz
PCS (US)	1930 MHz to 1990 MHz
Frequency range non-signalling mode	10 MHz to 2200 MHz
Frequency resolution	1 Hz
Frequency uncertainty	same as time base
Output level range	
RF1	–130 dBm to –32 dBm
RF2	–130 dBm to –15 dBm
RF3OUT	–90 dBm to +8 dBm
Output level resolution	0.1 dB
Output level uncertainty	see CMU200 base unit

Modulation
π/4 DQPSK or unmodulated (non-signalling mode)

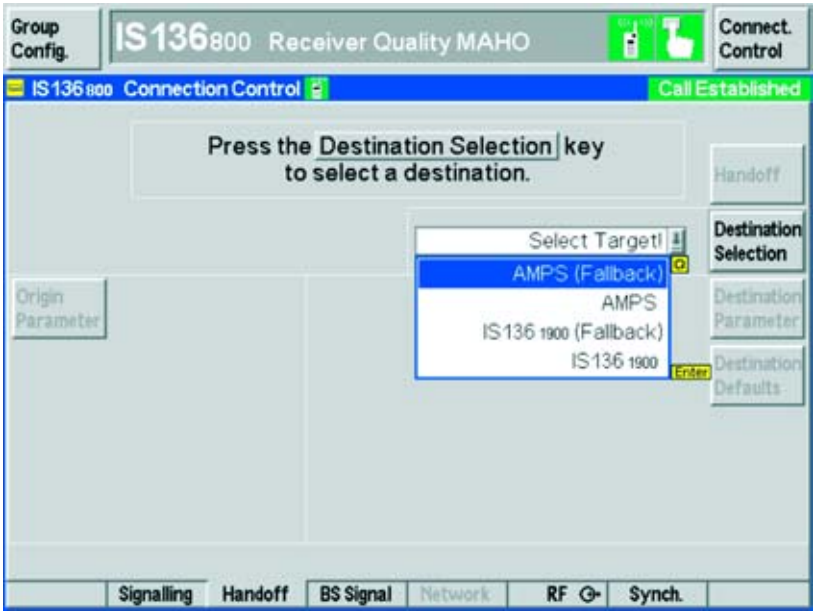
Uncertainty	<2.5% (EVM rms)
Carrier suppression	>40 dB

RF analyzer

Frequency range signalling mode	
US Cellular	824 MHz to 849 MHz
PCS (US)	1850 MHz to 1910 MHz
Frequency range non-signalling mode	10 MHz to 2200 MHz
Frequency resolution	1 Hz
Frequency uncertainty	same as time base

Modulation analyzer
824 MHz to 849 MHz and 1850 MHz to 1910 MHz

EVM, rms (residual)	<2%
EVM, peak (residual)	<4%
I/Q offset (residual)	<–50 dB (0.3%)
I/Q imbalance (residual)	<–50 dB (0.3%)
Frequency measurement range	–2 kHz to +2 kHz
Frequency measurement error	≤5 Hz + drift of time base



Handoffs from cellular band (800 MHz) to PCS band (1900 MHz) can be tested as well as to and from AMPS. Before handing off to a new network the parameters for the target network can be set. This results in a large variety of different test scenarios

Power meter (frequency-selective)

Level uncertainty	see CMU200 base unit

Power versus time measurement

Reference level for full dynamic range (low noise mode)	
RF1	+4 dBm to +47 dBm
RF2	–10 dBm to +33 dBm
RF4IN	–28 dBm to –6 dBm
Dynamic range	>74 dB (BW=100 kHz, rms)
Relative measurement uncertainty	
Result >–40 dB	<0.1 dB
–60 dB≤ Result ≤–40 dB	<0.5 dB
Residual leakage power level	<–65 dBm
Adjacent channel power measurement	
Dynamic range	
1st adjacent channel	>45 dB
2nd and 3rd adjacent channel	>55 dB

TDMA highlights of CMU200

Basic features

- Call to / from mobile
- Handoff to AMPS
- Dual-band handoff

Signalling measurements

- MAHO report
- Power versus time
  - Short burst
  - Normal burst
- Modulation
  - Phase error
  - Magnitude error
  - EVM/EVM10
  - Overview of phase / magnitude and EVM simultaneously
- Spectrum
  - Adjacent channel power due to switching/due to modulation
- Overview
  - Signalling information

Non-signalling measurements

- Modulation
- Spectrum
- Power versus time
- BER

AMPS in CMU200

AMPS overview

Analog AMPS (advanced mobile phone system) is a standard system for analog cellular telephone service in the United States and is also used in other countries. It is based on the frequency spectrum allocation for cellular service by the Federal Communications Commission (FCC) in 1970. Introduced by AT&T in 1983, AMPS became the most widely deployed cellular system in the United States.

AMPS options

Although AMPS is a 1st generation analog standard, a great demand for mobile radio testers covering this standard will continue to exist in the future. Especially in the United States, dual-mode CDMA/AMPS and TDMA/AMPS phones are very common. By combining the digital standards with analog AMPS, the network operators offer their customers the advantages of the digital standards and ensure nearly 100% coverage in North America. As a consequence, Rohde&Schwarz is extending the range of CMU200 options by introducing analog AMPS in addition to the digital standards TDMA and CDMA. These options add analog AMPS functionality to the CMU200 base unit:

- CMU-B21 (versatile link handler)
- CMU-B41 (audio generator/analyzer)
- CMU-K29 (AMPS test software)

The hardware options CMU-B21 (versatile link handler) and CMU-B41 (audio generator/analyzer) are suited for other standards as well.

AMPS measurements and features

As for other standards, there are two categories of AMPS measurements:

- Transmitter tests for assessing the transmit part of a mobile
- Receiver tests for assessing the receive part of a mobile
- AF Level Search routine
- Sensitivity Search routine

The AF Level Search routine in the TX test menu allows the user to set the desired frequency deviation of the mobile transmitter at a keystroke, the level of the CMU200 modulation generator is automatically corrected.

The Sensitivity Search routine in the RX test menu automatically searches the receiver input level at which a selectable SINAD of the demodulated signal can still be attained. The following list provides an overview of the most important tests implemented in option CMU-K29.

Transmitter measurements

- Carrier power
- Carrier frequency error
- SAT frequency error/peak deviation
- ST frequency error/peak deviation
- Modulation noise and distortion
- Hum and noise
- Electrical audio frequency response
- Modulation distortion
- Residual AM

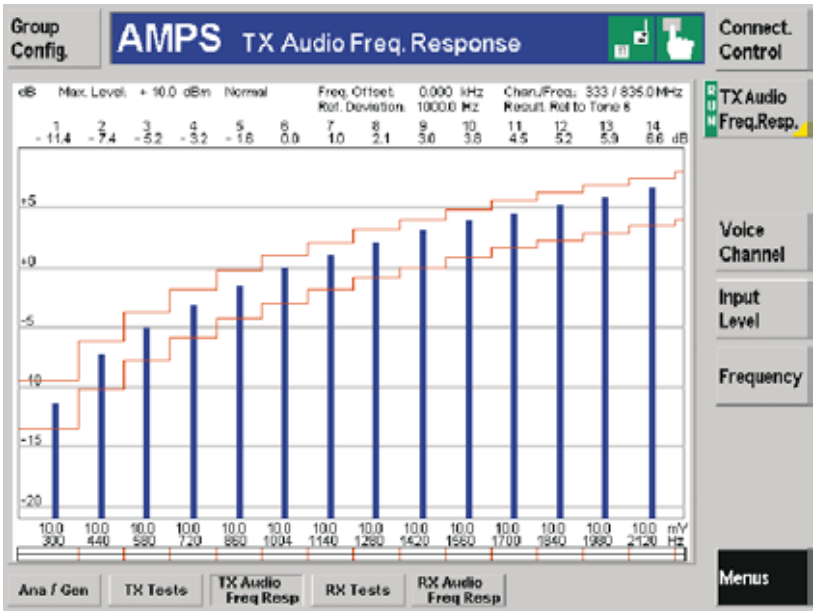
Receiver measurements

- Sensitivity
- Hum and noise
- SINAD
- Distortion
- AF voltage
- Electrical audio frequency response
- Residual AM
- Audio deviation

AMPS specifications – Mobile station test

RF Generator

Frequency range signalling mode	
US Cellular	869 MHz to 894 MHz
Frequency range non-signalling mode	10 MHz to 2200 MHz
Frequency resolution	1 Hz
Frequency uncertainty	same as time base
Output level range	
RF1	–130 dBm to –27 dBm
RF2	–130 dBm to –10 dBm
RF3OUT	–90 dBm to +13 dBm
Output level resolution	0.1 dB
Output level uncertainty	see CMU200 base unit (add 0.1 dB)
Modulation	
FM deviation range	100 Hz to 20 kHz
FM resolution	1 Hz
AF range	100 Hz to 15.999 kHz



TX audio frequency response measurement. The pre-emphasis characteristic of the mobile transmitter is verified by a single-shot measurement

All the filters required for the measurements are of course preconfigured in line with specifications, but their settings can be modified for individual measurements. The RX and TX electrical audio frequency response measurements in AMPS are usually defined as frequency sweep versus AF frequency range. The CMU 200 offers a much faster and more modern alternative. Using the TX and RX audio frequency response menus of CMU 200, the AF frequency response is measured simultaneously at 20 test points with user-programmable level and frequency and then checked against specified tolerances (see screenshot above).

FM distortion (SINAD; dev. 8 kHz, AF 1 kHz, BW 30 Hz to 15 kHz)	≥40 dB
Residual FM (rms, BW 300 Hz to 3 kHz)	≤10 Hz
Deviation uncertainty at 1kHz AF, 8kHz dev.(measurement bandwidth 30 Hz to 15 kHz)	<2 % of setting + residual FM
Deviation frequency response at 300 Hz to 15.999 kHz AF	≤1 dB

RF analyzer

Frequency range signalling mode	
US Cellular	824 MHz to 849 MHz
Frequency range non-signalling mode	10 MHz to 2200 MHz
Frequency resolution	1 Hz
Frequency uncertainty	same as time base

Power meter (frequency-selective)

Reference Level Range	
RF1	0 dBm to +53 dBm
RF2	–14 dBm to +39 dBm
RF4IN	–37 dBm to 0 dBm
Level uncertainty	see CMU 200 base unit
Level resolution	0.1 dB

FM measurement

Dynamic range	30 dB below reference level
RF bandwidth (2 x deviation + 4 x AF)	136 kHz
Deviation range	0 kHz to 47 kHz
Resolution	1 Hz
AF range	100 Hz to 18 kHz
Residual FM	
BW 300 Hz to 3 kHz, rms	≤5 Hz
BW 6 Hz to 20 kHz, rms	≤18 Hz
Uncertainty (BW 6 Hz to 20 kHz)	<1% of reading + residual FM
Carrier frequency error measurement range	–47 kHz to +47 kHz
Carrier frequency error measurement uncertainty	≤2 kHz + drift of time base

AF generator

see CMU 200 base unit (Audio option CMU-B41)

AF analyzer

see CMU 200 base unit (Audio option CMU-B41)

AMPS highlights of CMU200

Benefits of base unit

- Platform supporting CDMA, TDMA and AMPS within one box
- Wide frequency range allowing dual mode/dual band testing required for CDMA and TDMA
- See base unit section

AMPS features

- Powerful signalling capabilities
- Base station simulation
- Mobile or base station originated call connect/disconnect
- Short measurement time ensuring high throughput
- Combined measurements
- Benchmark-breaking IEEE-bus speed (see GSM highlights)
- Simple interactive operation, standardized MMI
- No specialized network knowledge required
- Various handoffs from CDMA/TDMA and to TDMA supported

cdmaOne in CMU200

CDMA overview

Code division multiple access (CDMA) – once a radically new concept in wireless communication – has meanwhile become a well established standard in the world of mobile communication. CDMA has proven its advantages and capabilities and has gained widespread international acceptance.

Instead of using frequencies or timeslots as traditional technologies like TDMA and AMPS do, CDMA uses mathematical codes to transmit and distinguish between multiple wireless conversations. Depending on the level of mobility, CDMA provides 8 to 10 times the capacity of AMPS and 4 to 5 times the capacity of TDMA systems. CDMA can efficiently utilize the spectrum and serve many subscribers without requiring extensive frequency planning.

History

Since the startup of the first commercial CDMA network in Hong Kong in September 1995 CDMA has established itself as a worldwide mobile radio standard. It has not only been successful in its country of origin, the USA, as well as in Korea and Japan, but all over the world. With its still booming growth rates CDMA today is – besides GSM – one of the most important digital 2nd generation mobile radio standards. CDMA is therefore also suited as the leading-edge technology on the way to 3rd generation mobile radio.

cdmaOne options

Taking the current development on the market into account, Rohde & Schwarz has extended the proven modular concept of the CMU200 with cdmaOne functionality. The following options make the CMU200 a compact radio communication tester for all TIA/EIA-95-based cdmaOne mobile phones:

- CMU-B81 (cdmaOne signalling unit)
- CMU-K81 (cdmaOne test software for cellular band)
- CMU-K82 (cdmaOne test software for PCS band)

CMU200 is also the first choice as a tester for cdmaOne – especially in harsh production environments – because of its outstanding measurement speed, ultra-high accuracy and unrivalled reliability which is also a result of the innovative ventilation concept. Thanks to the modular concept of CMU200, cdmaOne functionality plus GSM, TDMA (TIA/EIA-136), AMPS and other standards such as *Bluetooth* can be implemented in a single unit. Which other radio communication tester can boast such superior features?

cdmaOne functionality

In cdmaOne mode, the tests are based on the TIA/EIA-95A, TSB-74, and J-STD-008 cdmaOne airlink standards. In addition, the cdmaOne option supports also the standards ARIB-T53 and Korean PCS. The tester emulates a code division multiple access base station, makes a call to the mobile, and tests all essential parameters of a cdmaOne mobile station. The tester can measure the following key parameters among other tests:

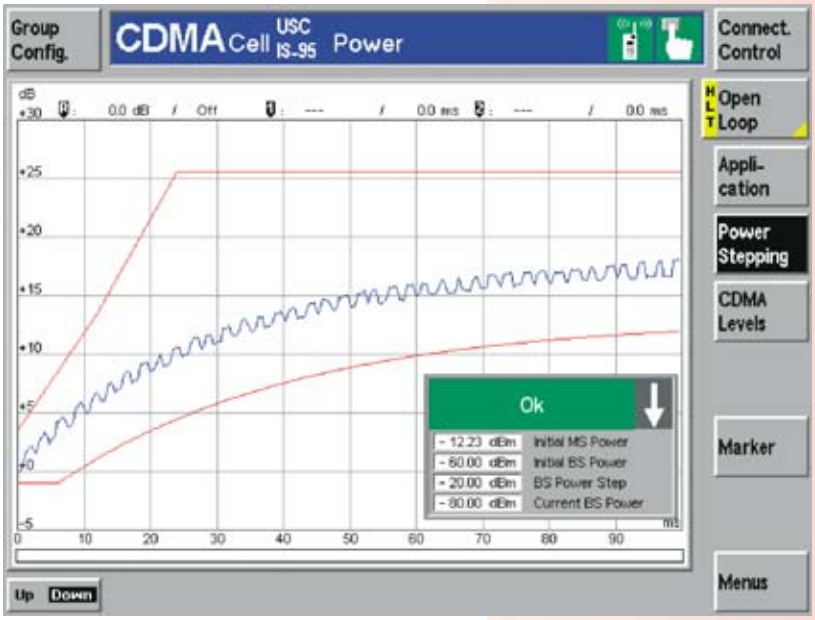
- Power measurements:
  - Open-loop time response
  - Gated output power
  - Minimum output power
  - Maximum output power
  - Side band suppression
- Receiver quality measurements:
  - Frame error rate (FER)
  - With additional AWGN generator to simulate noise caused by other cdmaOne calls at the same frequency
  - Predefined configurations for sensitivity and dynamic range
- Transmitter quality measurements:
  - Waveform quality
  - Error vector magnitude
  - Phase error
  - Magnitude error
  - Carrier feed through and I/Q imbalance
  - Frequency accuracy
- Handoffs:
  - RF channel
  - CDMA inter band
  - Handoff to AMPS
  - PN offset
  - Frame offset
- Non signalling Measurements:
  - Power
  - Waveform quality
  - Frequency error
  - Carrier feed through
  - I/Q imbalance

All measurements are implemented according to test specification IS-98C. Parameters and limits are predefined to meet the IS-98C test requirements. This allows easy pass/fail decisions without the need of reconfiguring the test setup.

Graphical representation of transmitter measurements like open loop time response, gated output power and modulation measurements are helpful tools especially in R&D environments.

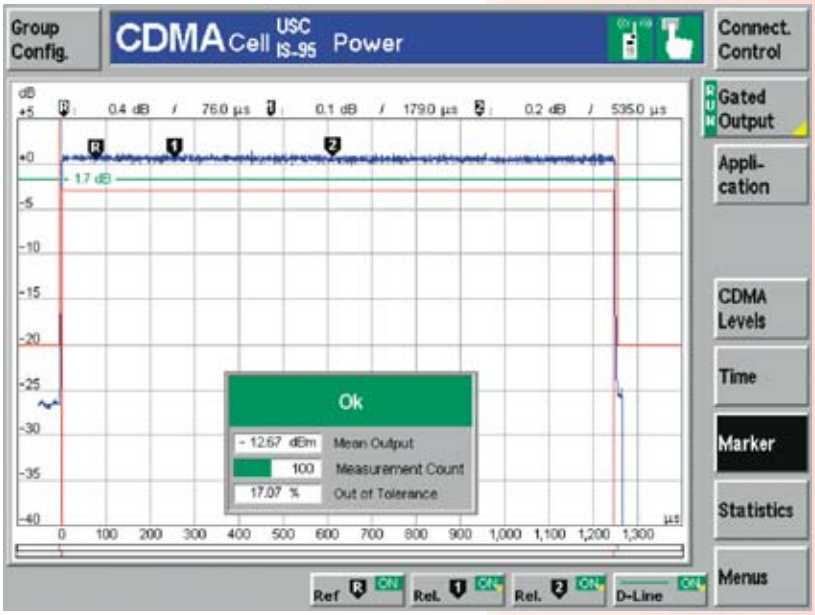
Open-loop time response

The open-loop power control test shows the response of the mobile station to an increase or decrease in base-station total power. The default increase or decrease for this test is 20 dB. Power stepping and cdmaOne levels are user-definable



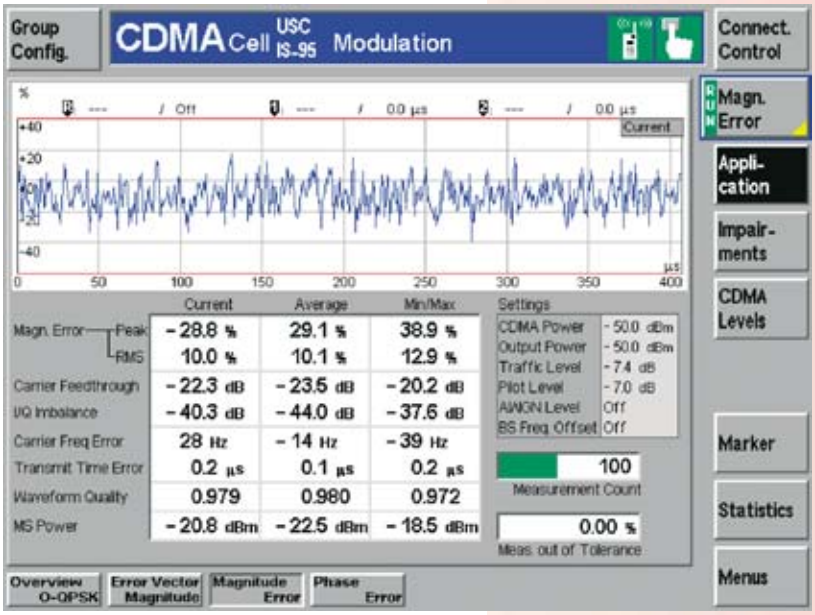
Gated output power

The gated output power can be displayed in several formats. Select FULL DISPLAY to show the total period of the IS-98 gated output template. The period of the full display is approx. 1500 µs. Select RISING EDGE (see figure) or FALLING EDGE to zoom in to display the 17 ms period of the rising or falling edge of the waveform. In each of these displays, a MARKER may be activated to display both power amplitude and relative time



Modulation measurements: magnitude error

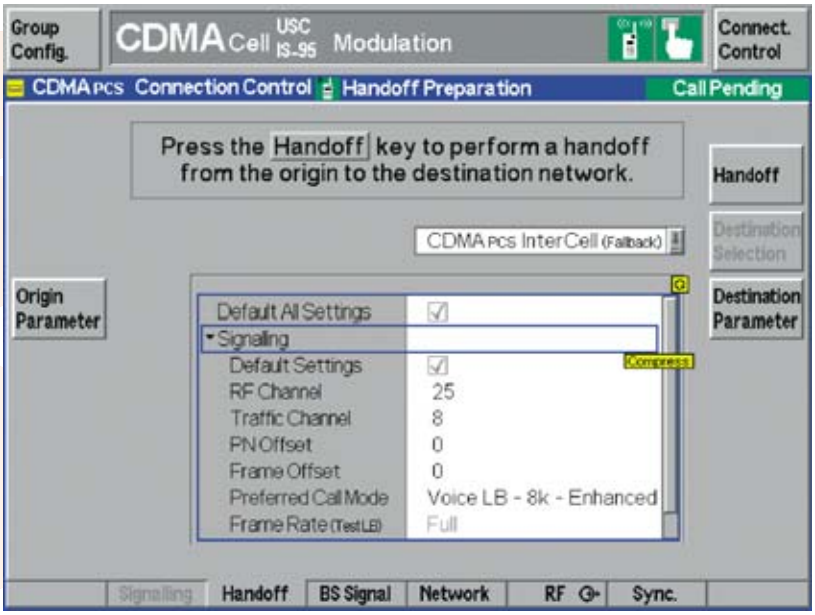
Modulation measurements serve for assessing the quality of the mobile's transmit part. In addition to phase error, error vector magnitude and magnitude error can be shown graphically at the push of a button. A clearly arranged table lists carrier feedthrough, IQ imbalance, frequency error and waveform quality with current measurement results, average and minimum/ maximum values



cdmaOne in CMU200

CDMA know-how

Rohde&Schwarz is not a newcomer in the field of CDMA, but has many years of experience. As early as 1996 Rohde&Schwarz and Tektronix launched a professional radio tester for CDMA mobiles. Worldwide this extremely successful tester sold thousands of units and has undergone permanent enhancement and adaptation to remain state-of-the-art. CMU200 builds on this success and is able to perform cdmaOne mobile station tests using thoroughly proven test and measurement methods, and also offers the possibility of enhancements for future technologies



CMU200 offers a separate menu for handoffs. In addition to handoff targets such as operating status or network to which CMU200 is to switch, the required target parameters as for example channel number etc can be configured. This enables handoff to AMPS as well as handoff to and from the voice loopback mode

TIA MEMBER

cdmaOne specifications – Mobile station test

Standards

cdmaOne standards	TIA/EIA-95, J-STD-008, ARIB T53, Korean, Chinese
cdmaOne test standards	TIA/EIA-98, J-STD-018

RF generator

Frequency range

Option CMU-K81	
US Cellular	869 MHz to 894 MHz
China Cellular	934 MHz to 969 MHz
Japan Cellular	832 MHz to 870 MHz
Option CMU-K82	
PCS (US)	1930 MHz to 1990 MHz
PCS (Korea)	1805 MHz to 1870 MHz

Frequency resolution channel spacing according to standard

Frequency uncertainty same as time base

Output level range (modulated signal)

RF1	–120 dBm to –33 dBm
RF2	–120 dBm to –16 dBm
RF3OUT	–80 dBm to +7 dBm

Output level resolution (modulated signal) 0.1 dB

Output level uncertainty

	+23°C to +35°C	+5°C to +45°C
RF1, RF2: ≥ –108 dBm	<0.5 dB	<0.7 dB
RF3OUT: –80 dBm to +4 dBm	<0.7 dB	<0.9 dB

Modulation

QPSK, multiple QPSK	1.2288 Mcps
AWGN	see AWGN generator
Carrier suppression	>35 dB
Waveform quality factor (ρ)	>0.99

AWGN generator

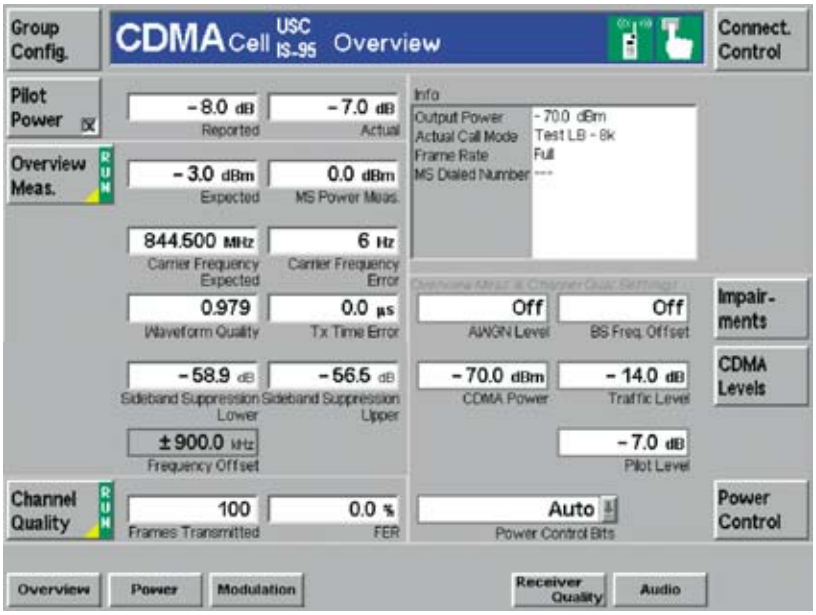
Selectable bandwidth	1.23 MHz or 1.8 MHz
Output level resolution	0.1 dB

RF analyzer

Frequency range

Option CMU-K81	
US Cellular	824 MHz to 849 MHz
China Cellular	889 MHz to 924 MHz
Japan Cellular	887 MHz to 925 MHz
Option CMU-K82	
PCS (US)	1850 MHz to 1910 MHz
PCS (Korea)	1715 MHz to 1780 MHz

Measurement filter according to standard (1.23 MHz bandwidth)



The overview menu shows the most important parameters in a clear form. These include BS settings as well as MS test results such as power, frequency error and waveform quality. The overview menu also gives access to other test modules (power control, modulation, receiver quality)

cdmaOne™

Frequency resolution	channel spacing according to standard
Level range (O-QPSK signal)	
RF1	–40 dBm to +47 dBm
RF2	–54 dBm to +33 dBm
RF4IN	–80 dBm to –6 dBm

Power meter (frequency-selective)

Level uncertainty	
RF1, RF2, RF4IN	
in temperature range +23°C to +35°C	<0.5 dB
in temperature range +5°C to +45°C	<0.7 dB
Level resolution	0.1 dB

Modulation analyzer

ρ uncertainty (for ρ 0.9 to 1)	<0.003
Frequency measurement range	–3 kHz to +3 kHz
Frequency measurement uncertainty	≤30 Hz + drift of timebase
Timing measurement uncertainty	<60 ns

cdmaOne highlights of CMU200

- Voice loopback and comprehensive testing of mobiles
- Powerful signalling capabilities
- Built-in AWGN generator for simulating noise generated by other cdmaOne calls
- Base station simulation
- Mobile or base station originated call connect/disconnect
- Short measurement time ensuring high throughput
- Combined measurements (RX/TX in parallel)
- Benchmark-breaking IEEE-bus speed (see GSM highlights)
- Simple interactive operation, standardized MMI
- No specialized network knowledge required
- Various handoffs supported (e.g. cdmaOne to analog AMPS)
- Dual-band/dual-mode testing
- Signalling and non-signalling mode

Supported CDMA standards

Frequency band	Airlink standard
US Cellular (800 MHz)	TIA/EIA-95
Japan Cellular	ARIB-T53/-95
China Cellular	TIA/EIA-95
US PCS (1900 MHz)	ANSI-J-STD008, UB-IS-95
Korea PCS (1800 MHz)	J-STD008, UB-IS-95

CDMA2000-1X im CMU

CDMA2000 overview

CDMA2000 arose from the further development of cdmaOne (TIA/EIA-95) and is an enormous step towards 3G. Besides higher data rates and considerably improved efficiency, CDMA2000 is particularly noteworthy for its downward compatibility to cdmaOne. Nine different configurations (radio configurations RC1 to RC9) in the forward link and six radio configurations in the reverse link define the different connections which are specified in the IS-2000 standard.

- RC1 and RC2 define cdmaOne connections for rate set 1 and rate set 2
- RC3 to RC5 in the forward link (or RC3 to RC4 in the reverse link) define CDMA2000 connections for spreading rate 1 (CDMA2000-1X)
- RC6 to RC9 in the forward link (or RC5 to RC6 in the reverse link) are CDMA2000 connections for spreading rate 3 (CDMA2000-3X) only.

Compared to cdmaOne, CDMA2000-1X doubles the capacity for pure voice transmission and provides a maximum packet data rate of 307 kps on a single 1.25 MHz carrier. CDMA2000-1X is a recognized IMT-2000 3G standard, already successfully established in Korea – and will soon be implemented in Japan, the USA, Canada, Mexico and Brazil. Its application in Eastern Europe is planned as well.

CMU CDMA2000-1X options:

The CDMA2000 standards will be implemented in conjunction with our proven cooperation partner Tektronix. By supporting the CDMA2000 standard, Rohde&Schwarz consequently enhances the functionality of the CMU200 multimode platform.

The central component of the CDMA2000-1X option is the signalling Unit CMU-B83, which is a prerequisite for enhancing the CDMA2000-1X functionality in the CMU200. The CMU-B83 is designed for maximum conformity to the standard. The CMU-B83, of course, does not only support pure CDMA2000-1X high-speed data links, but also enables the links of the previous TIA/EIA-95A/B standards.

All tests, which could be performed with the cdmaOne option in conjunction with the CMU-B81, are also available in the new CDMA2000 option. The CMU-U83 upgrade option is a cost-efficient upgrade solution from Rohde&Schwarz for customers who have already acquired the cdmaOne option in the CMU200.

CDMA2000-1X is used in diverse frequency ranges. The standard currently prescribes ten different band classes all of which are supported by the CMU200 with its universal hardware concept.

The following options are available for the CDMA2000-1X:

- CMU-B83: CDMA2000 signalling unit (essential)
- CMU-U83: cost-efficient hardware upgrade from CMU-B81 to CMU-B83
- CMU-U65: 3G DDC (additional DSP for the digital board, essential)
- CMU-K83: CDMA2000-1X software for the 450 MHz band (band class 5)
- CMU-K84: CDMA2000-1X software for cellular bands
- CMU-K85: CDMA2000-1X software for PCS bands
- CMU-K86: CDMA2000-1X software for IMT2000 band (band class 6)

The universal hardware and software concept of the CMU200 represents the optimum solution for the future development and challenges of the CDMA standard over the next few years.

CDMA2000-1X functionality

The similarities with cdmaOne (same physical conditions and downward compatibility), makes the CDMA2000-1X T&M concept very similar to that of cdmaOne. There are, however, major differences as to the protocols.

The CMU200 supports connections in all radio configurations defined for the CDMA2000-1X, i.e. TIA/EIA-95 combinations as well as the usual CDMA2000-1X high-speed connections.

Code Domain Power is a new and highly important measurement for mobile phones in CDMA2000. Since several code channels are now transmitted simultaneously in the reverse link, it is necessary to check whether the power distribution of the different channels complies with the test specification (TIA/EIA-IS-98-D) for CDMA2000. The measurement technology in the CMU200 is based on the ProbeDSP™ technology, which permits high-speed measurement of the code domain power. The emphasis is on fast measurement technology and clear and concise representation.

Of course, the CMU200 also supports the requirements placed on the gpsOne test application; the CMU200 meets the high demands for frequency and phase accuracy.

The CDMA2000-1X implementation in the CMU200 is based on the TIA/EIA IS-2000 Rev. 0 standard; the measurements comply with the TIA/EIA IS-98-D standard.

The CMU200 currently supports the service options 2, 9, (loop-back service options) and 1, 3, 17, 0x8000 (speech service options).

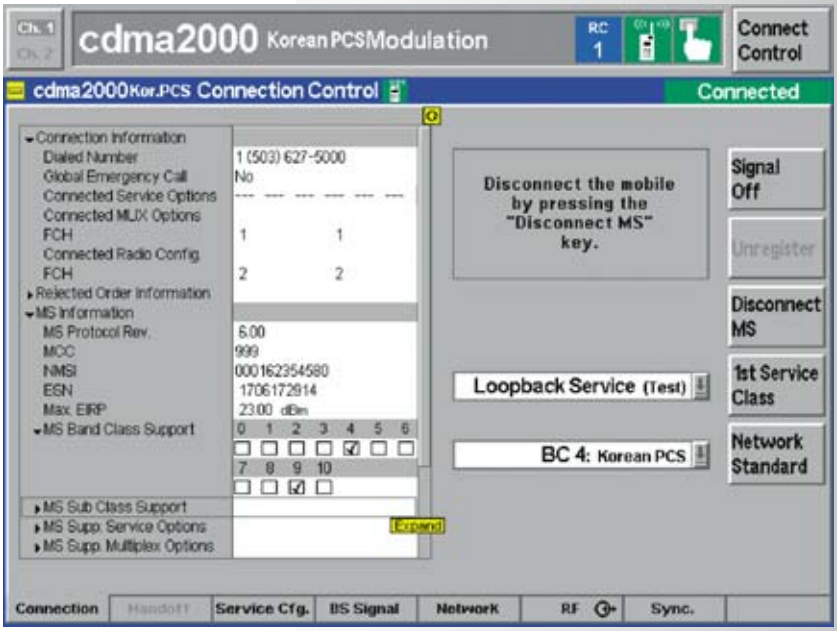
All relevant base station parameters and connection settings can be configured in user-friendly menus.

As with all mobile radio networks supported by the CMU 200, two different measurement modes are basically available:

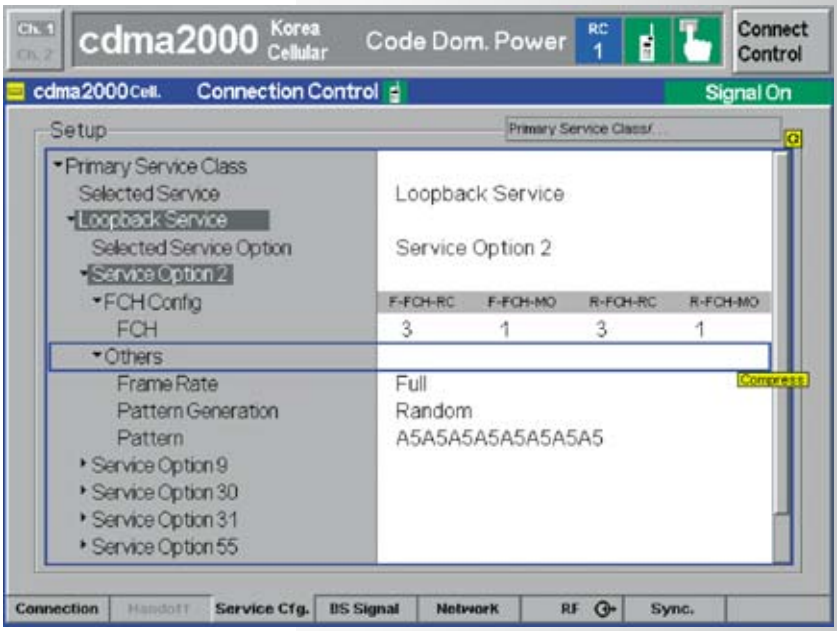
On the one hand, there are tests in the "non-signalling-mode", which permit an analysis of the mobile without registration in the base station and without actual call setup. For this purpose, the CMU generates a base station signal with all the physical channels required, which are user-configurable. This measurement mode complies in particular with the demands for high measurement speed in production lines.

On the other hand, there are tests with complete signalling.

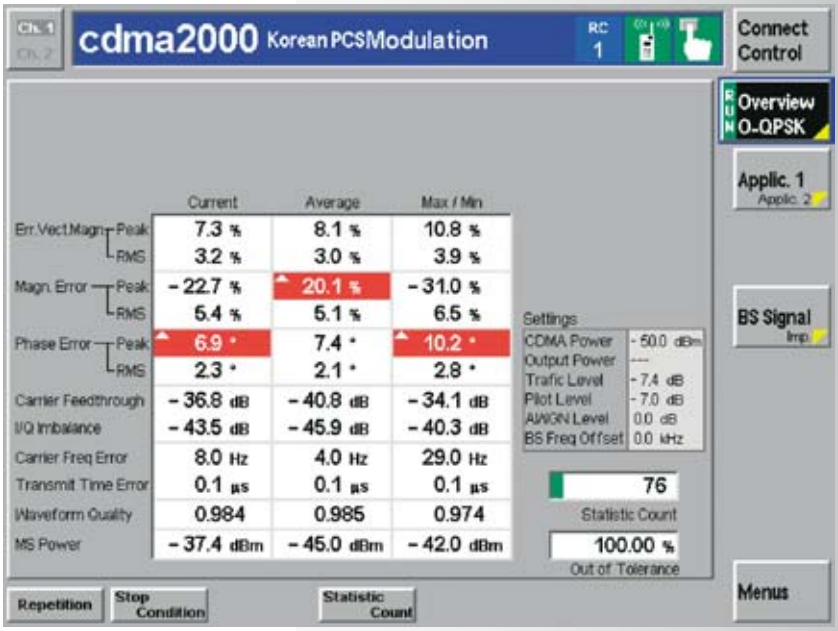
CDMA2000 Connection Control



CDMA2000 Connection Control - Service Configuration



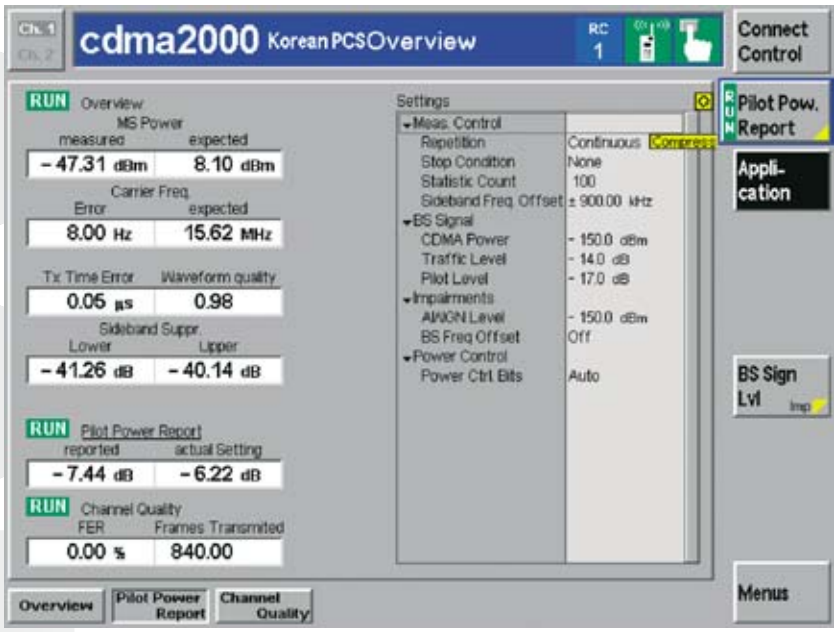
CDMA2000 Modulation Measurements



Signalling mode

The following describes the range of functions in detail:

- Power measurements
- Minimum/maximum output power
- Gated output power
- Receiver quality measurements
- Frame error rate (FER)
  Dynamic range, sensitivity and other user-settable test environments
- Modulation (both RC1/2 and RC3/4)
- Error vector magnitude (EVM), magnitude error, phase error, waveform quality, carrier feedthrough, frequency error
- Code domain power, peak code domain error power, channel power
- Implicit handoffs (RF channel, Walsh code, PN offset, frame offset)
- Interband handoff
- Handoff to AMPS
- Sideband suppression



All relevant TX parameters such as power, frequency error, waveform quality (both for RC1/2 and RC3/4) as well as sideband suppression, reported pilot power and frame error rate (FER)

Non-Signalling

- High-speed power measurement
- Frequency error
- Waveform quality (both RC1/2 and RC3/4)
- Carrier feedthrough
- Transmit time error
- Sideband suppression

CDMA2000 specifications – Mobile Station Test

Standards

CDMA2000 standards:	TIA/EIA IS-2000 Rev. 0
CDMA2000 test standards:	TIA/EIA IS-98-D

RF generator

Frequency range

Option CMU-K83:	
NMT-450 (band class 5)	421.675 MHz to 494.480 MHz
Option CMU-K84:	
US/Korean cellular (band class 0)	869.025 MHz to 893.985 MHz
TACS band (band class 2)	917.0125 MHz to 959.9875 MHz
JTACS band (band class 3)	832.0125 MHz to 869.9875 MHz
North American 700 MHz cellular band (band class 7)	746.000 MHz to 764.000 MHz
900 MHz band (band class 9)	925.000 MHz to 958.750 MHz
Secondary 800 MHz Band (band class 10)	851.000 MHz to 939.975 MHz
Option CMU-K85:	
North American PCS (band class 1)	1930 MHz to 1990 MHz
Korean PCS (band class 4)	1840 MHz to 1870 MHz
1800 MHz Band (band class 8)	1805.000 MHz to 1879.950 MHz
Option CMU-K86:	
IMT-2000 (band class 6)	2110.000 MHz to 2169.950 MHz
Frequency resolution	Channel spacing according to standard
Frequency uncertainty	same as time base

Output level range (modulated signal)

RF1	–120 dBm to –33 dBm
RF2	–120 dBm to –16 dBm
RF3OUT	–80 dBm to +7 dBm

Output level resolution (modulated signal) 0.1 dB

Output level uncertainty

	+23°C to +35°C	+5°C to +45°C
RF1, RF2: ≥–108 dBm	<0.5 dB	<0.7 dB
RF3OUT: –80 dBm to +4 dBm	<0.7 dB	<0.9dB

Modulation

Dual BPSK, multiple QPSK	1.2288 Mcps
AWGN	see AWGN Generator
Carrier suppression	>35 dB
Waveform quality factor (Rho)	>0.99
Code channel level uncertainty (relative to the total CDMA power)	
F-PICH, F-PCH, F-FCH, F-SCH1, F-SCH2	0.1 dB typ.
all other channels	0.25 dB typ.
Code channel resolution	0.1 dB

AWGN Generator

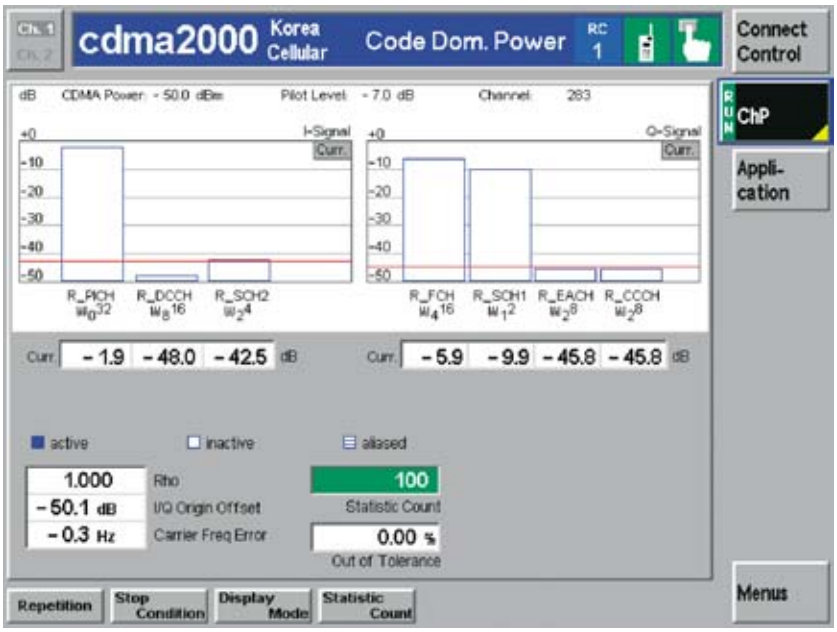
Bandwidth	>1.8 MHz
Output level resolution	0.1 dB
Output level uncertainty	0.2 dB typ.

Output level range

Relative to total CDMA output power	–20 dB to +4 dB

Supported Service Options

Loopback Service Options	SO 2, 9
Speech Service Options	SO 1, 3, 17, 0x8000



The channel power measurement displays the power in the channels used by the reverse link, separated into I and Q signal

CDMA2000 Highlights of CMU200

- Voice loopback and coprehensive testing of mobiles
- Full support of RC1/RC2 (cdmaOne measurements)
- Support of all band classes specified in IS-2000
- Innovative measurement of code domain power, code domain peak error power, channel power
- Parallel Rx/Tx measurements ensure high throughput in production environments
- Graphical representation of measurement results best suited for R&D labs
- Readout and display of many mobile specific parameters (ESN, Slot-cycle-index, etc)
- Extremly fast measurments
- Non-signalling and signalling mode
- Various handoffs supported (e.g. handoff to AMPS, interband handoff)

RF Analyzer

Frequency range

Option CMU-K83:	
NMT-450 (Bandclass 5)	411.675 MHz to 483.480 MHz
Option CMU-K84:	
US/Korean cellular (band class 0)	824.025 MHz to 848.985 MHz
TACS band (band class 2)	872.0125 MHz to 914.9875 MHz
JTACS band (band class 3)	887.0125 MHz to 924.9875 MHz
North American 700 MHz cellular band (band class 7)	776.000 MHz to 794.000 MHz
900 MHz band (band class 9)	880.000 MHz to 913.750 MHz
Secondary 800 MHz band (band class 10)	806.000 MHz to 900.975 MHz
Option CMU-K85:	
North American PCS (band class 1)	1850 MHz to 1910 MHz z
Korean PCS (band class 4)	1750 MHz to 1780 MHz
1800 MHz band (band class 8)	1710.000 MHz to 1784.950 MHz
Option CMU-K86:	
IMT-2000 (band class 6)	1920.000 MHz to 1979.950 MHz

Measurement filter according to standard (1.23 MHz bandwidth)

Frequency resolution channel spacing according to standard

Level range (HPSK, O-QPSK signal)

RF1	–43 dBm to +44 dBm
RF2	–57 dBm to +30 dBm
RF4IN	–83 dBm to –9 dBm

Power meter (frequency-selective)

Level uncertainty

RF1, RF2, RF4IN	
in temperature range +23° to +35°C	<0.5 dB
in temperature range +5° to +45°C	<0.7 dB

Level resolution 0.1 dB

Modulation analyzer

RC1, RC2 (O-QPSK):
Waveform quality, error vector magnitude, magnitude error, phase error

Rho uncertainty (for Rho 0.9 to 1)	<0.003
Frequency measurement range	–3 kHz to +3 kHz
Frequency measurement uncertainty	<30 Hz + drift of time base

RC3, RC4 (HPSK):
Waveform quality, error vector magnitude, magnitude error, phase error, code domain power, peak code domain error power, channel power

Rho uncertainty (for Rho 0.9 to 1)	<0.003
Frequency measurement range	–3 kHz to +3 kHz
Frequency measurement uncertainty	<10 Hz + drift of time base
Relative measurement uncertainty result > –33 dB	<0.1dB

Bluetooth™ measurements in CMU200

General

The CMU200 with the *Bluetooth* option can set up a *Bluetooth* connection to a Device Under Test (DUT) via the RF interface. The CMU200 switches the DUT into test mode and performs a number of basic RF measurements (TX and RX). According to the *Bluetooth* Test Mode Specification the DUT has to be locally enabled for the test mode operation. All measurements can be performed in hopping-, reduced hopping- or non-hopping-mode. The CMU200 supports measurements using DH1, DH3 and DH5 packets.

The coupling between the CMU200 and the DUT can be either via a cable or a coupler, depending on the implementation of the DUT.

Applications

The Universal Radio Communication Tester CMU200 with the *Bluetooth* option is the ideal instrument for production, development and maintenance of any kind of devices with integrated *Bluetooth* wireless technology.

The CMU200 can also be equipped with additional options for cellular standards like GSM, AMPS, TDMA or CDMA. Therefore the CMU200 is an ideal tester for mobile phone production, as it offers measurements in line with *Bluetooth* wireless technology and cellular standards in one instrument. With a further extension, which is already in development, the CMU200 will be able to run *Bluetooth* measurements and cellular measurements simultaneously. This means the total test time for a mobile phone will not be increased by the *Bluetooth* tests because the two types of tests can take place at the same time.

Parallel operation for high measurement speed

Due to the high measurement speed and large memory capacity of the CMU, transmitter and receiver measurements can be carried out in parallel. When measurements are performed during frequency

hopping, a great test depth is rapidly attained. Only a few seconds are required between call setup, transmitter and receiver measurements and call detach.

Many convenient measurement functions

The CMU offers a great number of statistical monitoring and measurement functions. It is possible, for instance, to define individual tolerances for each measured value and to stop a measurement sequence after a certain number of measurements or when a tolerance has been exceeded. Besides the common traces for power and modulation versus time, averaged minimum or maximum traces can also be displayed over a userdefined number of packages.

Compliance with existing Bluetooth standards

The CMU200 is compliant with the *Bluetooth* core specifications Ver. 1.0 B and 1.1. The *Bluetooth* Test Mode (Core Spec. Part I:1) is implemented with all commands needed to perform the TX/RX measurements.

The *Bluetooth* RF Test Specification Ver. 0.9 describes RF test cases for the *Bluetooth* qualification process. Rohde&Schwarz offers the Test System TS8960 for *Bluetooth* qualification tests, which is fully compliant with the RF Test Specification. Although the CMU200 was not designed for qualification tests, the RF test specification was taken as a guideline for the implementation of the CMU200´s *Bluetooth* measurements.

Signalling

Setting up a *Bluetooth* connection

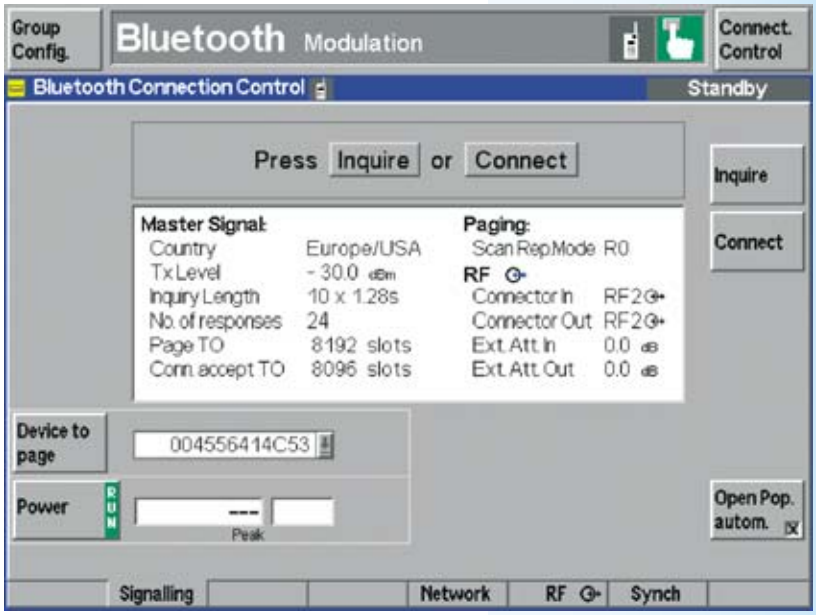
The CMU200 acts as the master of a *Bluetooth* piconet, the DUT as a slave. The CMU200 is able to perform the inquiry procedure for the identification of all *Bluetooth* devices within range of the CMU200. All devices found are listed on the display and one of them can be selected for the paging procedure. The CMU200 then establishes the connection to the DUT and switches it into test mode operation.

The inquiry procedure can be skipped, if the *Bluetooth* device address of the DUT is already known. In this case a shorter setup time for the connection can be achieved. This is important for production tests of *Bluetooth* devices to increase the maximum throughput of a production line.

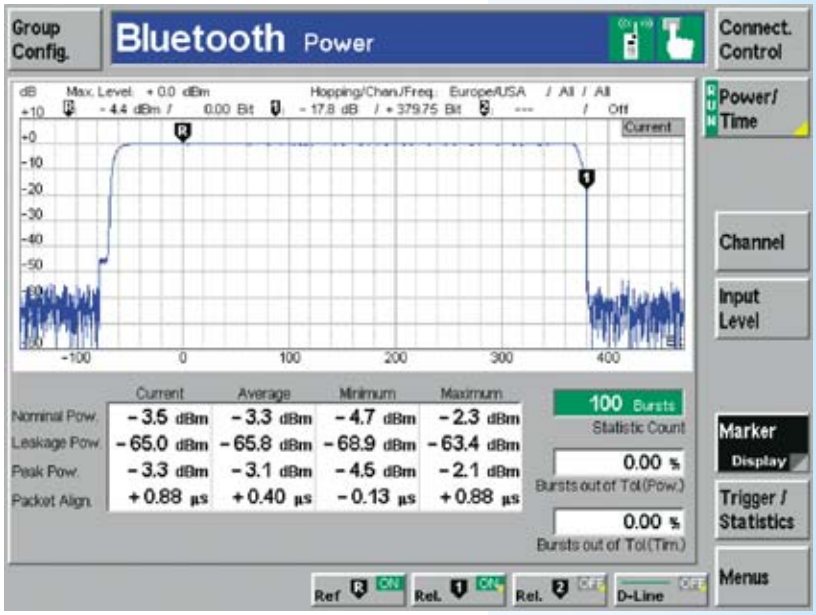
Signalling information from the DUT

The CMU200 is able to display a variety of information which is received from the DUT (eg device name, version numbers, service class, supported features).

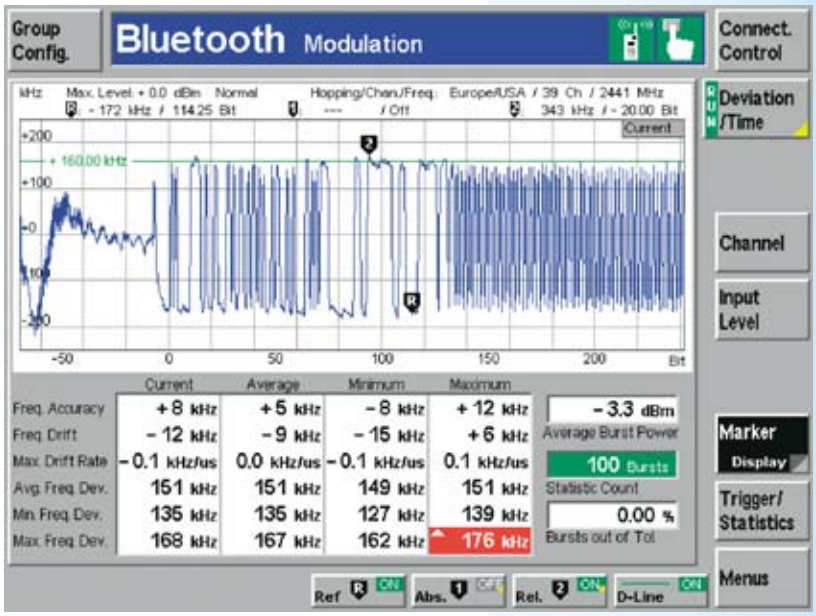
The connection control menu allows to inquire addresses of all Bluetooth devices in range. The "Device to page" softkey then selects the DUT for the measurements tests. Alternatively the input of a known address is possible



The power menu shows the results in graphical and scalar form. Statistical functions as well as convenient markers aid further evaluation. The timing measurement complements the numerical power results



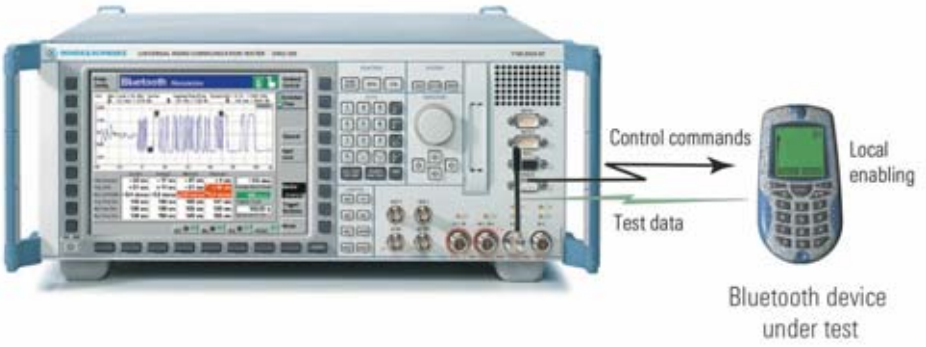
The graphical display of the modulation results may be spread between 1/1 and 1/8 of a burst for in-depth analysis. The "Max. Freq. Dev." and "Min Freq. Dev." results allow the highest and lowest values for 10 bit long fractions of a payload to be evaluated individually



Bluetooth wireless technology in CMU200

TX measurements

The current measurement values for each parameter are displayed on the CMU200 screen. Additionally average, maximum and minimum values are displayed as a result of a statistical evaluation of a settable number of *Bluetooth* packets (bursts).



The device under test can be connected to the CMU200 via a RF coupler (antenna) or a cable

Power measurements

Measurement parameters:

Measurement parameters:

- Nominal power (measured as the part of the burst starting at the detected 1st bit of the preamble (bit 0) to the last bit of the burst)
- Peak power (shows the highest powerlevel within a burst)
- Leakage power (measured within defined areas before and after the burst)

Timing measurements

Measurement parameter:

- Packet alignment (distance between ideal master receiver slot and detected bit 0 of the received burst)

This measurement is displayed on the "Power" screen.

Modulation measurements

Measurement parameters:

- Frequency accuracy (difference between measured frequency and intended transmitted frequency, measured in the preamble at the beginning of a packet)
- Frequency drift (difference between the frequency at the start of the packet and the frequency in the payload)
- Maximum drift rate (maximum drift rate anywhere within the packet payload)
- Average, maximum and minimum frequency deviation (calculated over the packet payload)

RX measurements

For RX measurements, the built-in signal generator generates a selectable bit sequence, which is looped back in the DUT and demodulated and processed by the CMU200 again. The TX level of the CMU200 can be adjusted for this measurement. The BER application supports defining up to five test programs. Each program can independently set settings such as control parameters, limits, repetition or statistical cycles.

Bluetooth specifications

Standards	Bluetooth Specifications Version 1.0 b and 1.1

RF generator

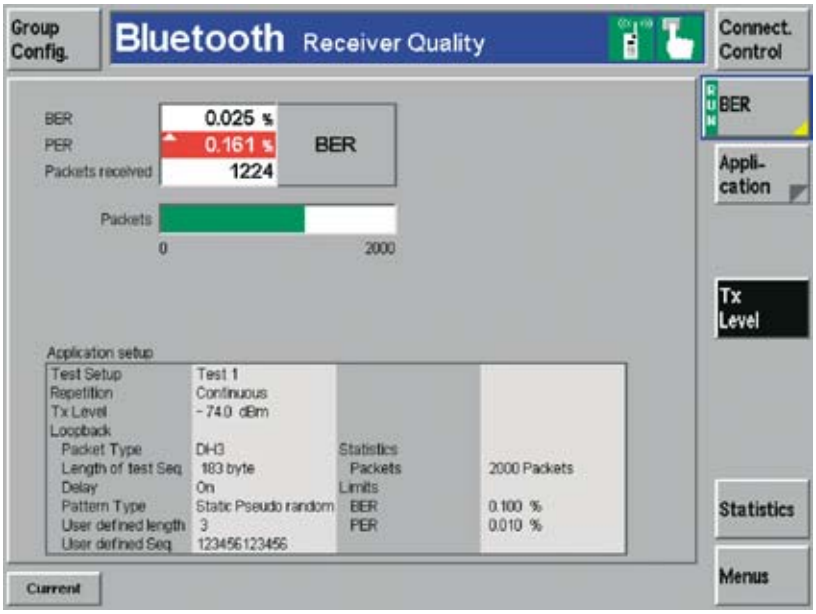
Frequency range	
Europe (except Spain and France), USA and Japan	2.4000 GHz to 2.4835 GHz
France	2.4465 GHz to 2.4835 GHz
Spain	2.4450 GHz to 2.475 GHz
Frequency resolution	channel spacing 1 MHz according to standard
Frequency hopping	all modes according to standard
Output level range (modulated signal)	
RF1	–106 dBm to –33 dBm
RF2	–106 dBm to –12 dBm
RF3OUT	–90 dBm to +5 dBm
Output level resolution	0.1 dB
Output level uncertainty	
RF1	
in temperature range +23°C to +35°C	<0.9 dB
in temperature range +5°C to +45°C	<1.6 dB
RF2	
in temperature range +23°C to +35°C	<0.9 dB
in temperature range +5°C to +45°C	<1.6 dB
RF3OUT	
in temperature range +23°C to +35°C	<1.1 dB
in temperature range +5°C to +45°C	<1.6 dB
Modulation	
GFSK	
(AC coupling cut off frequency 100Hz)	1 Mbps, B*T=0.5
Modulation index (11110000 pattern	
in temperature range +23°C to +35°C)	0.304 to 0.336 plus residual FM (see base unit)

Bluetooth wireless technology highlights of CMU200

- *Bluetooth* test mode signalling
- High measurement accuracy and speed
- Parallel TX and RX measurement of the RF interface in loopback mode
- Output of *Bluetooth* specific clock signal
- IF signal output
- Graphical and scalar result output

Supported Standards

- *Bluetooth* Specification Version 1.0 b and 1.1



The receiver quality measurement includes output of BER and PER values. Supports three modes, single shot, continuous and search of a target BER value by automatic variation of CMU200 output level. Up to 5 different best scenarios can be configured.

Sensitivity

Measurement parameters

- BER (percentage of bit errors that have occurred within the current statistical cycle)
- PER (percentage of packet errors that have occurred within the current statistical cycle, where an errored packet is a packet with a header which cannot be corrected)

BLUETOOTH is a trademark owned by Bluetooth SIG, Inc., USA and licensed to Rohde & Schwarz

RF analyzer

Frequency range	
Europe (except Spain and France), USA and Japan	2.4000 GHz to 2.4835 GHz
France	2.4465 GHz to 2.4835 GHz
Spain	2.4450 GHz to 2.475 GHz
Frequency resolution	channel spacing 1 MHz according to standard
Frequency hopping	all modes according to standard

Power meter (frequency selective) and power versus time

Level Resolution	0.1 dB
Reference level for full dynamic range (GFSK signal)	
RF1	0 dBm to +41 dBm
RF2	–14 dBm to +33 dBm
RF4IN	–32 dBm to 0 dBm
Level uncertainty from full scale down to –25 dB	
RF1, RF2	
in temperature range +23°C to +35°C	<0.7 dB
in temperature range +5°C to +45°C	<1.0 dB
RF4IN	
in temperature range +23°C to +35°C	<0.9 dB
in temperature range +5°C to +45°C	<1.1 dB
Dynamic range	>55 dB (BW= 3 MHz, rms)

Modulation analyzer (BW= 3 MHz)

Level range (GFSK signal)	
RF1, RF2, RF4IN	from full–scale setting down to –25 dB
Frequency offset error in preamble	≤2 kHz
Frequency deviation error in payload (for deviation ≤200 kHz)	
for 11110000 pattern	≤2 %
for 10101010 pattern	≤4 %
Total measurement range for frequency offset and frequency deviation	–250 kHz to +250 kHz

Timing measurement

Range	±20 µs
Uncertainty	≤0.25 µs

WCDMA in CMU200

The need for higher data rates is the trend in our information-oriented society in the new millennium. The enhancement of mobile phones takes this need into account on the way to the next generation of wireless communication. How to cover these future challenges? Driven by ideas of the first and second generation (SIM, global roaming, military CDMA technology, data services), WCDMA will take all of these fundamentals to unprecedented levels and add new applications and higher data security. Derived from Asian, American and European ideas, "3G" is getting ready to be the mobile solution for future needs as well as the current applications.

WCDMA

Depending on the level of mobility, WCDMA provides several times the capacity of 2nd generation CDMA or TDMA systems.

Thanks to the modular concept of CMU200, WCDMA functionality plus e.g. GSM, TDMA (TIA/EIA-136), AMPS and other wireless standards such as Bluetooth, can be implemented in a single unit at the same time.

WCDMA FDD functionality

The tests are based on the 3GPP/FDD, release 99 WCDMA radio link standards version June 2001. The CMU200 can easily be upgraded to different functionality steps by means of hardware and software options for non-signalling Tx/Rx measurements and signalling measurements. All measurements are following the 3GPP specification TS 34.121. This is especially interesting due to the variety of different filter bandwidth and shapes for ACLR, SEM, MIN power, MAX power, etc that are to be used according to the specification. Due to the highly user-friendly menu concept, the CMU200 provides quick access to all measurements desired and optimizes handling and consequently efficiency.

Non-signalling mode

The non-signalling mode is for generating and analyzing WCDMA (3GPP/FDD) signals within the frequency range from of the CMU200 base unit. CMU200 provides WCDMA-specific TX measurements on signals with up to 6 DPDCHs such as

- ACLR (Adjacent Channel Leakage Power Ratio): Two measurement modes, Filter (Bargraph) and FFT (cont. spectrum) method: Absolute or relative readout
- OBW (Occupied Bandwidth)
- SEM (Spectrum Emission Mask)
- CDP (Code Domain Power): CDP vs all codes, CDP vs DCH channels, RHO vs all codes, RHO vs DCH channels. All measurements in relative or absolute readout, splitted into I and Q parts
- Modulation (for 3GPP or general QPSK): EVM (Error Vector Magnitude), Magnitude Error, Phase Error, Frequency Error, I/Q Offset, I/Q Imbalance, Peak Code Domain Error, RHO (Waveform Quality)
- Power: MAX, MIN, OFF (UE test mode)
- Autoranging for received UE signal

The non-signalling mode allows tests of all essential RF parameters of the connected UE (User Equipment). The measurements work in unsynchronized mode. No time consuming call setup is done to evaluate UE performance using these measurements.

RX measurements

A synchronization (but still no call setup) is needed for the RX evaluation and some additional TX measurements, such as

- Inner Loop Power Control with TPC commands: TPC stepping measurement (UE receives TPC commands from CMU200 generator)
- Receiver Quality: BER, BLER, (with UE-assisted evaluation, no RF loopback)

The generated channels and functions available are

- P-CPICH/P-SCH/S-SCH/P-CCPCH/ DPCCH/DPDCH
- TPC profiles

In conjunction with the Rohde&Schwarz Baseband Fading Simulator ABFS and the planned option CMU-B17, conditions of fading may be simulated and evaluated with CMU200.

FDD signalling mode (planned)

The CMU200 simulates a WCDMA base-station RF interface including the signalling protocol so that a mobile can be tested with regard to different signalling parameters. All necessary network and Node B (base station) parameters such as control and data channel configurations can be set. This mode will be supported in a next step. In addition to the non-signalling tests it provides features such as

- Power: MAX, MIN, OFF (UE signalling mode)
- Power control: ON/OFF time mask, open loop power control, inner loop power control (3GPP mode)
- Receiver Quality: BER, BLER, (with RF loopback)
- Call setup and release / paging

◆ Test mode connection

Signalling test allows tests in an environment closer to a real live network. However in a production context they might not be absolutely neccessary.

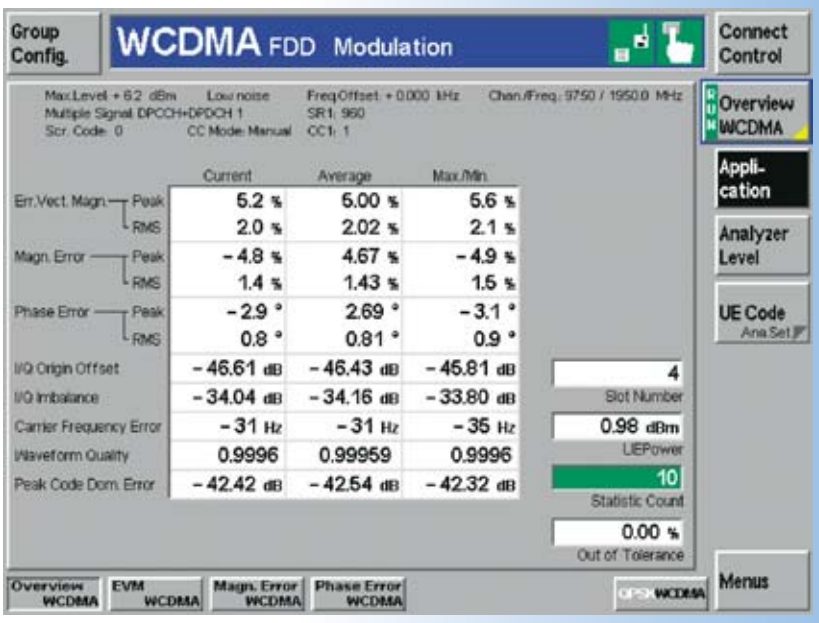
WCDMA development

With its great versatility the CMU200 is also a suitable tool for the development of mobile phones. Four configurable RF connectors are provided to enable flexible signal levels. The clearly structured and user-friendly menu design together with the clear-cut screen layout provides quick access to all features and ensures trouble-free monitoring of the device under test. The tester can be switched between 3GPP and general QPSK modes to increase the usability with DUTs under development.

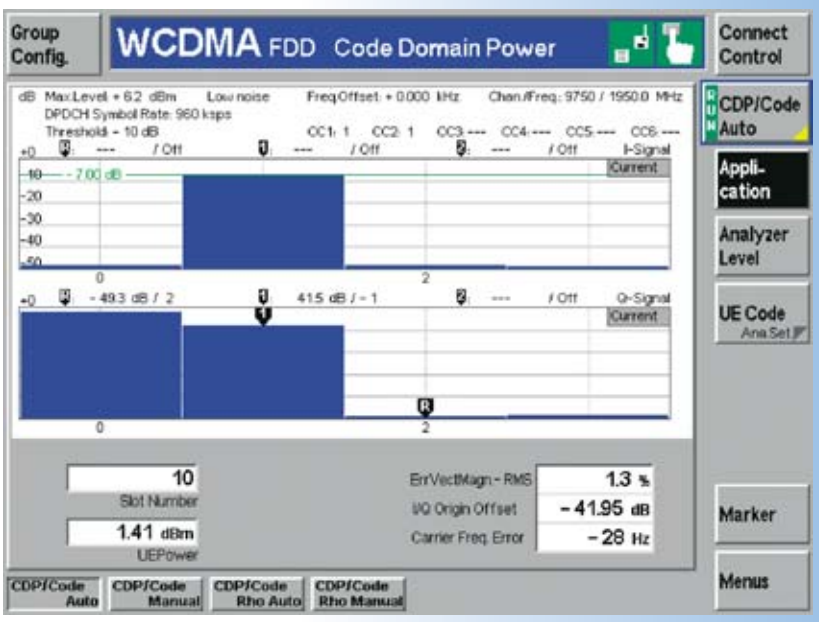
Quality assurance

Due to its high measurement repeatability and accuracy, the CMU200 is the right choice to ensure a consistently high quality standard of all your deliveries. WCDMA-specific measurements such as BER, EVM , and full implementation of complimentary (i.e. ACLR- and OBW-) measurements provide an excellent test platform to guarantee

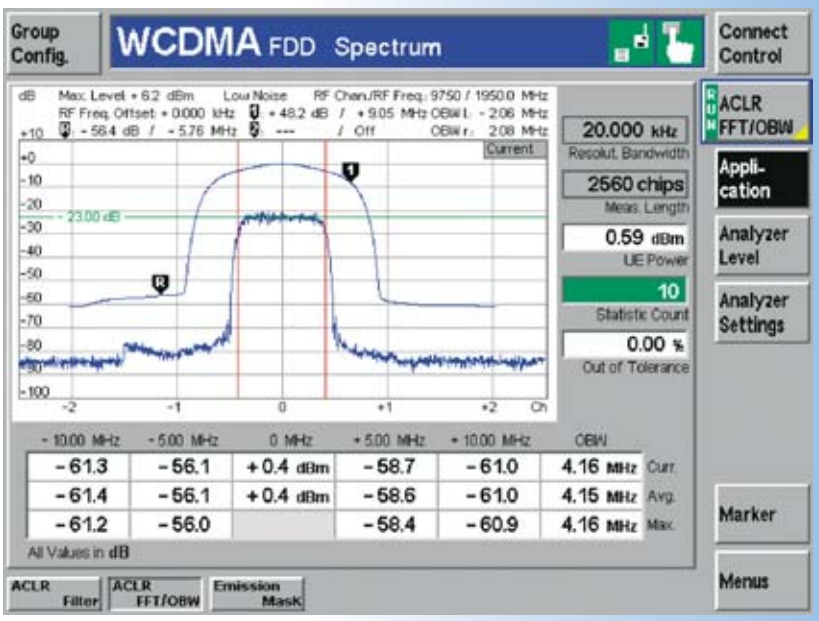
The overview menu provides fast comprehensive information on the UE´s RF performance. The hotkeys at the bottom of the screen give immediate access to specific and detailed measurements



The screenshot shown here is just one of the 4 comprehensive ways to display the UE Code Domain Power in non-signalling mode



The ACLR menu shows all adjacent channel related information in graphical as well as in scalar numerical form. Since the ACLR-FFT and OBW measurement methods are closely related, results for Occupied Bandwidth are displayed simultaneously. The scalar display except center channel (0MHz) may be switched to absolute readout as well

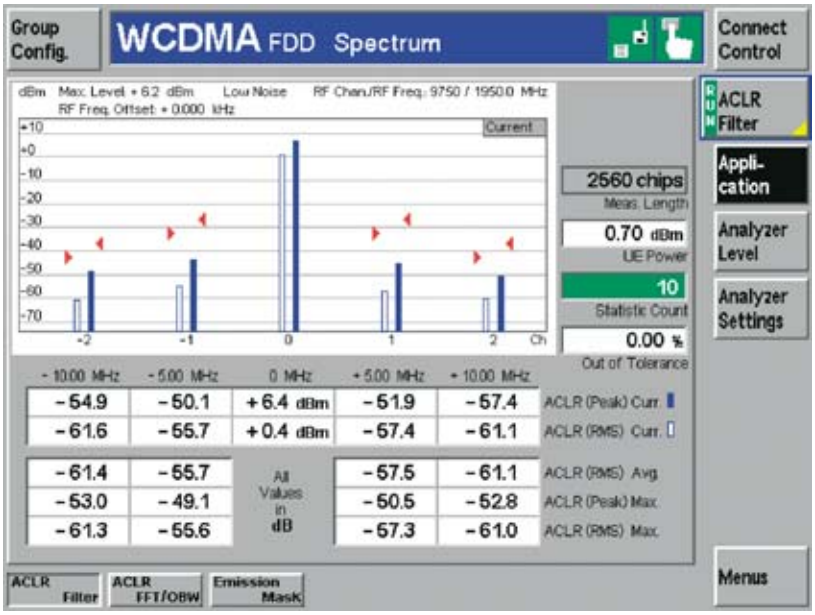


WCDMA in CMU200

the production of high-quality devices.

Production of mobile phones

The production of mobile phones requires time-efficient and cost-effective means that ensure both high throughput and state-of-the-art accuracy. Thanks to the unique IEC/IEEE-bus concept of the CMU 200, these two goals can be easily achieved in your production line. The intelligent handling of the received GPIB commands thoroughly optimizes the measurement speed for WCDMA-specific measurements. In practice, this will mean reduced test time and enhanced test yield.



ACLR measurements are available using two differing measurement methods and corresponding displays. In this screenshot, the ACLR is measured using the filter method to obtain results for 5 channels. The scalar display except center channel (0MHz) may be switched to absolute readout as well

Switching standards

The flexibility of CMU 200 makes for quick and simple switching between different standards. This is very important for e.g. TIA-136 (TDMA) and TIA-95 (CDMA) use as many 3GPP UEs for markets with networks of these second generation standards are going to be dual-mode even without a handover being defined. Switching between WCDMA and other

WCDMA specifications – Mobile station (UE) test

Standard	3GPP-FDD
Symbol rate	3.84 MHz
Synchronization output 2	BNC connector REFOUT2
Frequency	30.72 MHz

RF Generator

Channels	P-CPICH, P-SCH, S-SCH, P-CCPCH, DPCH
Channel levels	–30 dB to 0 dB relative to CPICH
Reference measurement channel RMC	12.2 kbps, 64 kbps, 144kbps, 384 kbps (3GPP TS34.121)
Frequency range	2110 MHz to 2170 MHz
Resolution	0.1 Hz

Output level range[1]

RF1	–120 dBm to –40 dBm
RF2	–120 dBm to –23 dBm
RF3OUT	–80 dBm to 0 dBm

Output level uncertainty

	+23°C to +35°C	+5°C to +45°C
RF1, RF2: ≥–110 dBm	<0.6 dB	<1.0 dB
RF3:≥–80 dBm	<0.9 dB	<1.0 dB

Signal quality

Error Vector Magnitude (EVM)	<8 %[2]

RF Analyzer (TX Measurements)

Frequency range	1920 MHz to 1980 MHz
Resolution	1 Hz

Reference level for full dynamic range

RF1	
Continuous power[3]	0 dBm to +47 dBm
Peak envelope power (PEP)[4]	0 dBm to +53 dBm
RF2	
Continuous power	–14 dBm to +33 dBm
Peak envelope power (PEP)[4]	–14 dBm to +39 dBm
RF4IN	
Continuous power and PEP	–37 dBm to +0 dBm

Modulation analysis [5]

Measurement filter	receiver filter according to standard 3.84 MHz, RRC, a=0.22
Analysis modes	QPSK, WCDMA uplink

Error Vector Magnitude (EVM)

Measurement range	up to 25 %
Inherent EVM, rms	<2.5 %[6]
Resolution	0.1 %

Frequency error

Measurement range [7]	±3 kHz
Uncertainty	<10 Hz + drift of time base
Resolution	1 Hz

IQ offset

Inherent IQ offset	<–55 dB
Resolution	0.01 dB

IQ imbalance

Inherent IQ imbalance	<–30 dB
Resolution	0.01 dB

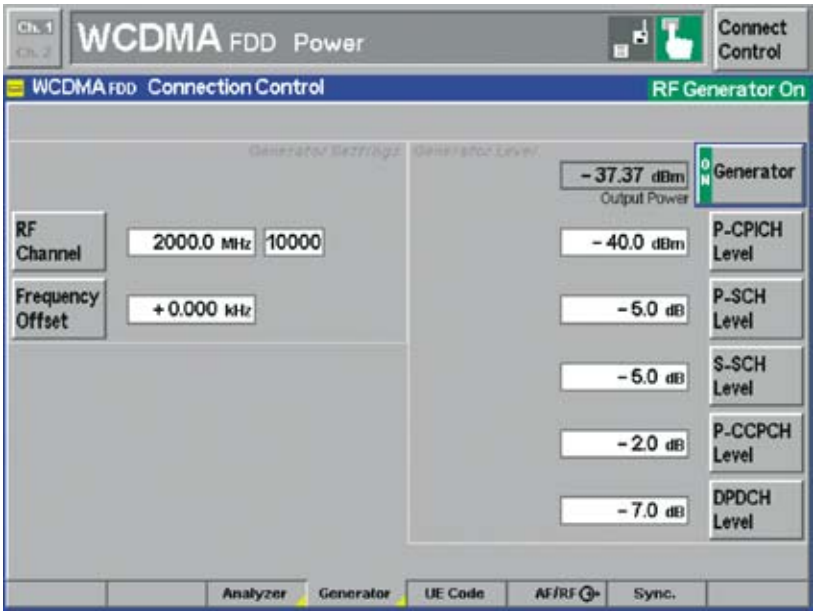
Waveform quality

Measurement range	0.9 to 1.0
Uncertainty	<0.002
Resolution	0.0001

Peak Code Domain Error (PCDE)

Uncertainty	<0.5 dB
Resolution	0.01 dB

1) *For crest factor ≤13 dB.*
2) *For reference measurement channel 384 ksps (TS34.121 C3.4).*
3) *50 W in temperature range +5 °C to +30 °C, linear degradation down to 25 W at 45 °C.*
4) *Mean value of power vs. time must be equal or less than allowed continuous power.*
5) *The specified data is valid for "Low Noise Mode" operation.*
6) *with CMU-Z6 typ<1.5%*
7) *At 12.2 kbps Reference measurement channel.*



This screenshot shows the independent generator settings for the various channels

WCDMA-related features

- Shortest measurement time ensuring high throughput
- Benchmark-breaking IEEE-bus speed (see highlights of base unit)
- Combined measurements, many different measurement modes
- Multi-band/multi-mode testing
- Powerful signalling capabilities part of a clear upgrade path
- Mobile- or base-station originated call connect/disconnect will be available in a next functionality step
- Simple interactive operation, standardized MMI
- No specialized network knowledge required

Supported WCDMA standards

Frequency band	Radio link standard
2000 MHz and 2200 MHz paired spectrum	3GPP-FDD

standards can be achieved by a simple remote command or by pressing a button. It allows a very versatile production test layout and improves the flexibility and throughput of your multimode UE application.

Spectrum Measurements [7][8]

Measurement filter	receiver filter according to standard 3.84 MHz, RRC, a=0.22
ACLR(FFT)	
Resolution bandwidth	20 kHz
Frequency offsets	
First adjacent channel	±5 MHz
Second adjacent channel	±10 MHz
Dynamic range	
First adjacent channel	>54 dB
Second adjacent channel	>62 dB
Resolution	0.1 dB
ACLR (Filter)	
Frequency offsets	
First adjacent channel	±5 MHz
Second adjacent channel	±10 MHz
Dynamic range[9]	
First adjacent channel	>54 dB
Second adjacent channel	>62 dB
Resolution	0.1 dB
Occupied bandwidth	
Range	1 MHz to 6 MHz
Uncertainty	<100 kHz
Resolution	20 kHz
Spectrum emission mask	
Measurement filter	
± 2.515 MHz to ± 3.485 MHz	30 kHz gaussian filter
± 4.0 MHz to ± 12.0 MHz	1 MHz gaussian filter
Dynamic range	
± 2.515 MHz to ± 3.485 MHz	tbd
± 4.0 MHz to ± 7.5 MHz	tbd
± 7.5 MHz to ± 8.5 MHz	tbd
± 8.5 MHz to ± 12.0 MHz	tbd
Resolution	0.1 dB

[8] *The specified data is valid for "High Dynamic Mode" operation.*
[9] *Valid for instruments since 3/2000.*

Power Measurements [5]

Maximum power	wide band filter
Minimum/Off power	receiver filter acc. to standard 3.84 MHz, RRC, a=0.22

Level range

	RF1	RF2	RF4IN
Continuous power	–52 dBm to +47 dBm[3]	–66 dBm to +33 dBm	10–89 dBm to 0 dBm[A][A]
Peak envelope power (PEP)	–42 dBm to +53 dBm[4]	–56 dBm to +39 dBm[4]	–79 dBm to 0 dBm

[A] *Upper limit is depending on crest factor*

Level uncertainty

	+23°C to +35°C	+5°C to +45°C
RF1		
–10 dBm to +47 dBm, rms	<0.5 dB	<0.7dB
–52 dBm to –10 dBm, rms	<0.7 dB	<0.9 dB
RF2		
–24 dBm to +33 dBm, rms	<0.9 dB	<1.0 dB
–66 dBm to –24 dBm, rms		
RF4IN		
–24 dBm to 0 dBm, rms	<0.5 dB	–
–89 dBm to –24 dBm, rms	<0.7 dB	–
–57 dBm to 0 dBm, rms	–	<0.7 dB
–89 dBm to –57 dBm, rms	–	<0.9 dB

Level resolution	0.01 dB
Code domain power	
Measurement filter	receiver filter according to standard 3.84 MHz, RRC, a=0.22
Level range	
RF1	–8 dBm to +47 dBm
RF2	–22 dBm to +33 dBm
RF4IN	–45 dBm to 0 dBm
Level resolution	0.01 dB

Base unit specifications

Please see standard-specific data on the previous pages for more details and improved accuracy

Timebase TCXO

Max. frequency drift	
in temperature range +5 °C to +45 °C	±1 x 10^{-6}
Max. aging	±1 x 10^{-6}/year

Timebase OCXO – option CMU-B11

Max. frequency drift	
in temperature range +5 °C to+45 °C	±1 x 10^{-7}
Max. aging	±2 x 10^{-7}/year, ±5 x 10^{-9}/day after 30 days of operation
Warmup time (at +25 °C)	approx. 5 min

Timebase OCXO – option CMU-B12

Max. frequency drift	
in temperature range +5 °C to +45 °C	±5 x 10^{-9}, referred to +25 °C
with instrument orientation referred to turn-off frequency after 2 h warmup time following a 24 h off time at +25 °C	±3 x 10^{-9} ±5 x 10^{-9}
Max. aging	±3.5 x 10^{-8}/year, ±5 x 10^{-10}/day after 30 days of operation
Warmup time (at +25 °C)	approx. 10 min

Reference frequency inputs/outputs

Synchronization input	BNC connector REFIN
Frequency	
Sinewave	1 MHz to 52 MHz, step 1 kHz
Squarewave (TTL level)	10 kHz to 52 MHz, step 1 kHz
Max. frequency variation	±5 x 10^{-6}
Input voltage range	0.5 V to 2 V, rms
Impedance	50 Ω
Synchronization output 1	BNC connector REFOUT1
Frequency	10 MHz from internal reference or frequency at synchronization input
Output voltage	>1.4 V, peak-peak
Impedance	50 Ω
Synchronization output 2	BNC connector REFOUT2
Frequency	net-specific frequencies in range 100 kHz to 40 MHz
Output voltage (f ≤13 MHz)	>1.0 V, peak-peak
Impedance	50 Ω

RF generator

Frequency range	100 kHz to 2700 MHz
Frequency resolution	0.1 Hz
Frequency uncertainty	same as timebase + resolution
Frequency settling time	<400 µs to Δf <1kHz

Output level range

RF1	
100 kHz to 2200 MHz	–130 dBm to –27 dBm
2200 MHz to 2700 MHz	–130 dBm to –33 dBm
RF2	
100 kHz to 2200 MHz	–130 dBm to –10 dBm
2200 MHz to 2700 MHz	–130 dBm to –16 dBm
RF3OUT	
100 kHz to 2200 MHz	–90 dBm to +13 dBm
2200 MHz to 2700 MHz	–90 dBm to +5 dBm

Output level uncertainty

	≥–106 dBm	>–117 dBm	–117 to –130 dBm
RF1, RF2			
in temperature range +23 °C to +35 °C			
10 MHz to 450 MHz	<0.6 dB		
450 MHz to 2200 MHz	<0.6 dB	<0.6 dB[2]	<1.5 dB[1][2]
2200 MHz to 2700 MHz	<0.8 dB	<0.8 dB[2]	<1.5 dB[1][2]
in temperature range +5 °C to +45 °C			
10 MHz to 450 MHz	<1.0 dB		
450 MHz to 2200 MHz	<1.0 dB	<1.0 dB[2]	<1.5 dB[1][2]
2200 MHz to 2700 MHz	<1.5 dB	<1.5 dB[2]	<1.5 dB[1][2]

	+23 °C to +35 °C	+5 °C to +45 °C
RF3OUT		
10 MHz to 450 MHz: –80 dBm to +10 dBm	<0.8 dB	<1.0 dB
450 MHz to 2200 MHz: –90 dBm to +10 dBm	<0.8 dB	<1.0 dB
2200 MHz to 2700 MHz: –90 dBm to +5 dBm	<1.0 dB	<1.5 dB

Output level settling time <4 µs

Output level resolution 0.1 dB

Generator RF level repeatability

(RF1, RF2, RF3OUT, typical values after 1h warm-up)

Output ≥–80 dBm	<0.01 dB
Output <–80 dBm	<0.1 dB

VSWR

RF1	
10 MHz to 2000 MHz	<1.2
2000 MHz to 2200 MHz	<1.3
2200 MHz to 2700 MHz	<1.6
RF2	
10 MHz to 2200 MHz	<1.2
2200 MHz to 2700 MHz	<1.6
RF3OUT	
10 MHz to 2200 MHz	<1.5
2200 MHz to 2700 MHz	<1.7

Attenuation of harmonics (f_0 = 10 MHz to 2200 MHz, up to 7 GHz)

RF1, RF2	>30 dB
RF3OUT (P≤ +10 dBm)	>20 dB

Attenuation of nonharmonics

10 MHz to 2200 MHz at >5 kHz from carrier	>40 dB

Phase noise (single sideband, f < 2.2 GHz)

Carrier offset	
20 kHz to 250 kHz	<–100 dBc(1 Hz)
≥250 kHz	<–110 dBc(1 Hz)

Residual FM

30 Hz to 15 kHz	<50 Hz (rms), <200 Hz (peak)
CCITT	<5 Hz (rms)

Residual AM

CCITT	<0.02% (rms)

IQ modulation

Data for frequency offset range 0 kHz to ±135 kHz	
Carrier suppression	>40 dB

RF analyzer

VSWR

RF1	
10 MHz to 2000 MHz	<1.2
2000 MHz to 2200 MHz	<1.3
2200 MHz to 2700 MHz	<1.6
RF2	
10 MHz to 2200 MHz	<1.2
2200 MHz to 2700 MHz	<1.6
RF4IN	
10 MHz to 2200 MHz	<1.5
2200 MHz to 2700 MHz	<1.6

Power meter (wideband)

Frequency range 100 kHz to 2700 MHz

Level range

RF1	
continuous power[3]	
100 kHz to 2200 MHz	+6 dBm to +47 dBm (50 W)
2200 MHz to 2700 MHz	+10 dBm to +47 dBm (50 W)
Peak envelope power [4] (PEP)	+53 dBm (200 W)
RF2	
continuous power	
100 kHz to 2200 MHz	–8 dBm to +33 dBm (2 W)
2200 MHz to 2700 MHz	–4 dBm to +33 dBm (2 W)
Peak envelope power [4] (PEP)	+39 dBm (8 W)
RF4IN (continuous power and PEP)	
100 kHz to 2200 MHz	–33 dBm to 0 dBm
2200 MHz to 2700 MHz	–29 dBm to 0 dBm

[1] *Valid for RF1 only.*

[2] *Not valid at frequencies of netclock harmonics*

[3] *50 W in temperature range +5 °C to +30 °C, linear degradation down to 25 W at 45 °C.*

[4] *Mean value of power vs time must be equal or less than allowed continuous power.*

Level uncertainty

RF1	+10 dBm to +20 dBm	+20 dBm to +47 dBm
50 MHz to 2700 MHz	<1.0 dB[6]	<0.5 dB[5] [6]
RF2	–4 dBm to +6 dBm	+6 dBm to +33 dBm
50 MHz to 2700 MHz	<1.0 dB[6]	<0.5 dB[6]
RF4IN	–29 dBm to –19dBm	–19 dBm to 0 dBm
50 MHz to 2700 MHz	<1.5 dB	<0.8 dB

Level resolution 0.1 dB (0.01 dB via remote control)

Power meter (frequency-selective)

Frequency range 10 MHz to 2700 MHz
Frequency resolution 0.1 Hz
Resolution bandwidths 10 Hz to 1 MHz in 1/2/3/5 steps

Level range

RF1	
continuous power[3]	
10 MHz to 2200 MHz	–40 dBm to +47 dBm (50 W)
2200 MHz to 2700 MHz	–34 dBm to +47 dBm (50 W)
Peak envelope power [4] (PEP)	+53 dBm (200 W)
RF2	
continuous power	
10 MHz to 2200 MHz	–54 dBm to +33 dBm (2 W)
2200 MHz to 2700 MHz	–48 dBm to +33 dBm (2 W)
Peak envelope power [4] (PEP)	+39 dBm (8 W)
RF4IN (continuous power and PEP)	
10 MHz to 2200 MHz	–80 dBm to 0 dBm
2200 MHz to 2700 MHz	–74 dBm to 0 dBm

Level uncertainty

RF1, RF2	
in temperature range +23 °C to +35 °C	
50 MHz to 2200 MHz	<0.5 dB
2200 MHz to 2700 MHz	<0.7 dB
in temperature range +5 °C to +45 °C	
50 MHz to 2200 MHz	<1.0 dB
2200 MHz to 2700 MHz	<1.0 dB
RF4IN	
in temperature range +23 °C to +35 °C	
50 MHz to 2200 MHz	<0.7 dB
2200 MHz to 2700 MHz	<0.9 dB
in temperature range +5 °C to +45 °C	
50 MHz to 2200 MHz	<1.0 dB
2200 MHz to 2700 MHz	<1.1 dB

Level resolution 0.1 dB (0.01 dB via remote control)

RF level measurement repeatability
(RF1, RF2, RF4IN, typical values after 1h warm-up)

Input ≥ –40 dBm	<0.01 dB
Input < –40 dBm	<0.03 dB

Demodulation (data of hardware paths)

Phase noise (single sideband, f <2.2 GHz)
Carrier offset

20 kHz to 250 kHz	<–100 dBc(1 Hz)
250 kHz to 400 kHz	<–110 dBc(1 Hz)
≥400 kHz	<–118 dBc(1 Hz)

Residual FM

30 Hz to 15 kHz	<50 Hz (rms), <200 Hz (peak)
CCITT	<5 Hz (rms)

Residual AM

CCITT	<0.02% (rms)

Spectrum analyzer

Frequency range 10 MHz to 2.7 GHz
Span zero span to full span
Frequency resolution 0.1 Hz
Resolution bandwidths 10 Hz to 1 MHz in 1/2/3/5 steps
Sweep time ≥100 ms, depending on RBW
Display 560 dots, horizontal
Marker up to 3, absolute/relative
Display line 1
Display scale 10/20/30/50/80/100 dB

Level range

RF1	
continuous power[3]	up to +47 dBm (50 W)
Peak envelope power[4] (PEP)	up to +53 dBm (200 W)
RF2	
continuous power	up to +33 dBm (2 W)
Peak envelope power[4] (PEP)	up to +39 dBm (8 W)
RF4IN (continuous power and PEP)	up to 0 dBm

Level uncertainty

	+23°C to +35°C	+5°C to +45°C
RF1, RF2		
50 MHz to 2200 MHz	<0.5 dB	<1.0 dB
2200 MHz to 2700 MHz	<0.7 dB	<1.0 dB
RF4IN		
50 MHz to 2200 MHz	<0.7 dB	<1.0 dB
2200 MHz to 2700 MHz	<0.9 dB	<1.1 dB

Reference level for full dynamic range (low noise mode)
Logarithmic level display

RF1	+10 dBm to +47 dBm
RF2	–4 dBm to +33 dBm
RF4IN	–22 dBm to 0 dBm

Displayed average noise level (RBW 1 kHz, low noise mode)

RF1/RF2/RF4IN	
10 MHz to 2200 MHz	<–100 dBc
2200 MHz to 2700 MHz	<–95 dBc

Inherent spurious response <–50 dB
Low distortion mode, 20 MHz to 2200 MHz, except 1816.115 MHz

Inherent harmonics
(f_0 = 50 MHz to 2200 MHz, up to 7 GHz)

RF1, RF2	<–30 dB
RF4IN	<–20 dB

Audio option CMU-B41

AF generator

Output impedance <4 Ω
Maximum output current 20 mA peak

AF sine generator

Frequency range	20 Hz to 20 kHz
Frequency uncertainty	same as time base + half resolution
Frequency resolution	0.1 Hz
Output level range	10 µV to 5 V
Output level resolution	
at level <10 mV	10 µV
at level ≥10 mV	0.1%
Output level uncertainty	
at level ≥1 mV and frequency ≤10 kHz	≤1.5% + resolution

THD+N[7]
at level ≥100 mV into load ≥600 Ω ≤0.05%

THD[7]
at level ≥100 mV into load ≥600 Ω ≤0.025%

AF analyzer

Input impedance 1MΩ | | 100 pF

AF voltmeter

Frequency range	50 Hz to 20 kHz
Level Range	50 µV to 30 V
Level Resolution	
at level <1 mV	1 µV
at level ≥1 mV	0.1%
Level uncertainty	
at 1 mV ≤level≤ 2 V	<1.0% + resolution
at 2 V <level≤20 V	<2.0% + resolution

THD+N meter
Measurement bandwidth 21 kHz

Frequency range	100 Hz to 10 kHz
Level Range	10 mV to 30 V
Resolution	0.01% THD+N
Inherent distortion	
at 100 mV ≤ level≤ 20 V	<0.05% THD+N
Uncertainty	
at 100 mV ≤ level≤ 2 V	<1% + inherent distortion
at 2 V <level≤20 V	<2% + inherent distortion

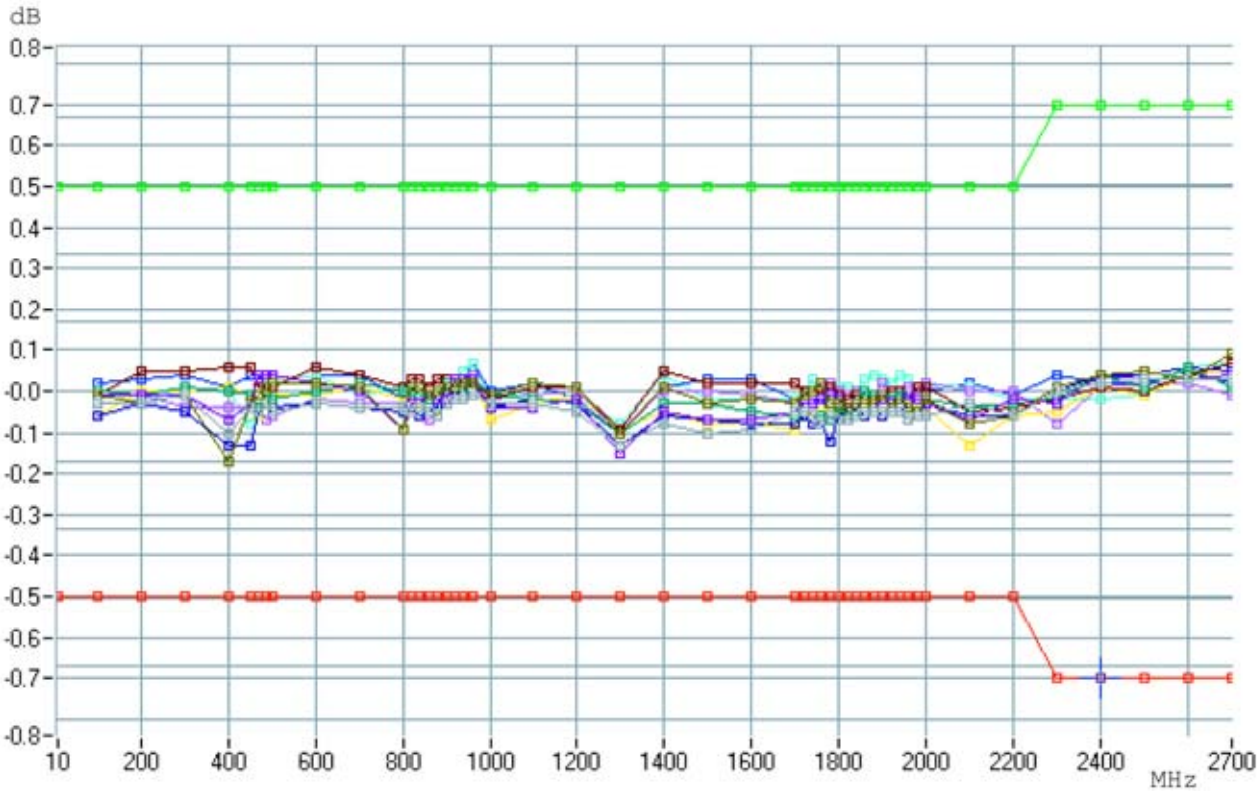
[5] *Calibrated for P>33 dBm only in frequency range 800 MHz to 2000 MHz.*
[6] *Temperature range +5°C to +23 °C or +35 °C to +45 °C and f>2200 MHz: add 0.2 dB.*
[7] *Measurement bandwidth: 21.9 kHz*

General data

Rated temperature range	+5 °C to +45 °C
Storage temperature range	–25 °C to +60 °C
Humidity	+40 °C, 80% rh, non-condensing; complies with IEC 68-2-3
Display	21 cm TFT color display (8.4")
Resolution	640 x 480 pixels (VGA resolution)
Pixel failure rate	<2 x 10^{-5}
Electromagnetic compatibility	meets requirements of EMC Directive 89/336/EEC (EN50081-1 and EN50082-2)
Mechanical resistance (non operating mode)	
Vibration, sinusoidal	meets IEC68-2-6, IEC1010-1, EN61010-1, MIL-T-28800 D class 5, 5 Hz to 150 Hz, max. 2 g at 55 Hz, 55 Hz to 150 Hz, 0.5 g const.
Vibration, random	meets DIN IEC 68-2-36, DIN 40046 T24 10 Hz to 300 Hz, acceleration 1.2 g rms
Shock	meets DIN IEC 68-2-27, MIL-STD-810D 40 g shock spectrum
Electrical safety	IEC1010-1, DIN EN61010-1, UL3111-1, CSA22.2 No. 1010-1
Power supply	100 V to 240 V ± 10% (AC), 50 Hz to 400 Hz –5% to +10% power factor correction, EN61000-3-2 power consumption, max. 500 VA, base unit typical 130 W with options typical 180 W
Dimensions (W x H x D)	465 mm x 193 mm x 517 mm (19"; 4 height units)
Weight	
Base unit	14 kg
With typical options	18 kg

Inputs and outputs (rear panel)

IF3 RX CH1	Z_{out} = 50 Ω, BNC female, max level –2 dBm, 10.7 MHz
Remote control interfaces	
IEC/IEEE-bus	IEC 625-2 (IEEE 488.2) 24-pin Amphenol connector
Serial interface COM1, COM2	RS-232-C (COM), 9 pin sub-D connector
Printer interface LPT	parallel (Centronics compatible), 25 pin sub-D connector
Keyboard	PS/2 **connector**
Exernal monitor (VGA)	15 pin sub-D connector



Rohde&Schwarz specifications are a conservative view of what a product has to offer. As an example, this diagram presents the accuracy of the CMU200 frequency selective power measurement. This is shown here for 10 randomly chosen instruments at 25°C and 0 dBm on RF2 without taking additional measurement uncertainty rom the test system itself into account. The tolerances marked above and below (green and red line) indicate the data stated in this data sheet´s general data section.

Models and options

Instruments, options and ordering information

Type/Option	Description	GSM	TDMA	AMPS	cdmaOne	Bluetooth	WCDMA	CDMA2000	Order number
CMU200	Base unit with following accessories: power cord, operating manual, service manual instrument	✓	✓	✓	✓	✓	✓	✓	1100.0008.02
CMU-B11[1]	Reference OCXO, aging 2 x 10^{-7}/year. Ensures high absolute accuracy, minimum temperature-dependent drift and especially high long-term stability. Used for measurements with exact frequency stability requirements	☺	☺	☺	☺	☺	☺	☺	1100.5000.02
CMU-B12[1]	High-stability OCXO, aging 3.5 x 10^{-8}/year. Oven crystal with highest long-term stability. Ensures compliance with tolerances specified by GSM. Used for highly demanding frequency stability requirements to GSM 11.20	☺	☺	☺	☺	☺	☺	☺	1100.5100.02
CMU-B17	I/Q IF Interface	☺	☺	☺	–	☺	☺	☺	1100.6906.02
CMU-B21	Versatile signalling unit. Provides multistandard signalling hardware	✓	✓	✓	–	✓	–	–	1100.5200.02
CMU-B41	Audio generator and analyzer. Includes audio frequency (AF) generator, voltmeter, distortion meter	☺	☺	✓	–	–	–	–	1100.5300.02
CMU-B52[2]	Internal versatile multimode speech coder/decoder. This option converts digital speech signals into analog signals and vice versa. The option allows separate uplink and downlink audio application measurements on mobile phones.	☺	☺	–	–	–	–	–	1100.5400.02
CMU-B53[2]	Bluetooth extension, factory installation only	–	–	–	–	✓	–	–	1100.5700.02
CMU-B66	Versatile base band board	–	–	–	–	–	✓	–	1149.9509.02
CMU-B81	cdmaOne signalling unit	–	–	–	✓	–	–	–	1100.6506.02
CMU-B83	CDMA2000 (1x) signalling unit	–	–	–	–	–	–	✓	1150.0301.02
CMU-B99	RF1 level range identical to RF2	☺	☺	☺	–	–	–	☺	1150.1250.02
CMU-U53[2]	Bluetooth upgrade kit for CMU	–	–	–	–	✓[7]	–	–	1100.7302.02
CMU-U61	Modification kit: floppy disk drive 3½" instead of PCMCIA	☺	☺	☺	☺	☺	☺	☺	1100.5500.02
CMU-U65	3G Measurement DSP	–	–	–	–	–	✓	–	1100.7402.02
CMU-U66	Upgrade kit versatile base band board	–	–	–	–	–	✓[14]	–	1149.9609.02
CMU-U83	Upgrade kit to CMU-B83 in exchange with CMU-B81	–	–	–	–	–	–	✓[14]	1150.0401.02
CMU-U99	Modification kit RF1 level range identical to RF2	☺	☺	☺	–	–	–	☺	1150.1350.02
CMU-K20[2]	GSM400 mobile station signalling/non-signalling test	✓[8]	–	–	–	–	–	–	1115.5900.02
CMU-K21[2]	GSM900, R-GSM and E-GSM mobile station signalling/non-signalling test	✓[8]	–	–	–	–	–	–	1115.6007.02
CMU-K22[2]	GSM1800 (DCS) mobile station signalling/non-signalling test	✓[8]	–	–	–	–	–	–	1115.6107.02
CMU-K23[2]	GSM1900 (PCS) mobile station signalling/non-signalling test	✓[8]	–	–	–	–	–	–	1115.6207.02
CMU-K24[2]	GSM850 mobile station signalling/non-signalling test	✓[8]	–	–	–	–	–	–	1115.6307.02
CMU-K27[2]	IS-136/Cellular (800 MHz band) mobile station signalling/non-signalling test	–	✓[8]	–	–	–	–	–	1115.6607.02
CMU-K28[2]	IS-136/PCS (1900 MHz band) mobile station signalling/non- signalling test	–	✓[8]	–	–	–	–	–	1115.6707.02
CMU-K29[3]	AMPS mobile station signalling/non-signalling test	–	–	✓	–	–	–	–	1115.6807.02
CMU-K42[12]	GPRS software extension for all GSM software packages	✓	–	–	–	–	–	–	1115.4691.02
CMU-K53[2][5]	Bluetooth test software	–	–	–	–	✓	–	–	1115.5000.02
CMU-K65[9]	WCDMA (3GPP/FDD, UL) User Equipment Tx-Test, non-signalling	–	–	–	–	–	✓	–	1115.4891.02
CMU-K66[9][10]	WCDMA (3GPP/FDD, DL) Generator software	–	–	–	–	–	✓	–	1115.5100.02
CMU-K81[4]	cdmaOne cellular (800 MHz band) mobile station signalling/non-signalling test	–	–	–	✓[8]	–	–	–	1115.5500.02
CMU-K82[4]	cdmaOne PCS (1700/1900 MHz band) mobile station signalling/non-signalling test	–	–	–	✓[8]	–	–	–	1115.5600.02
CMU-K83[11][4]	CDMA2000 (1x) (450 MHz band) mobile station signalling/non-signalling test	–	–	–	–	–	–	✓[8]	1150.3500.02
CMU-K84[11][4]	CDMA2000 (1x) (cellular band) mobile station signalling/non-signalling test	–	–	–	–	–	–	✓[8]	1150.3600.02
CMU-K85[11][4]	CDMA2000 (1x) (PCS band) mobile station signalling/non-signalling test	–	–	–	–	–	–	✓[8]	1150.3700.02
CMU-K86[11][4]	CDMA2000 (1x) (IMT2000 band) mobile station signalling/non-signalling test	–	–	–	–	–	–	✓[8]	1150.3800.02
BW2-C1	Corner cover 1 (2 pieces required)	☺	☺	☺	☺	☺	☺	☺	1096.2593.00
BW2-C2	Corner cover 2 (2 pieces required)	☺	☺	☺	☺	☺	☺	☺	1096.2602.00
CMU-DCV	Documentation of calibration values	☺	☺	☺	☺	☺	☺	☺	0240.2193.08
CRT-Z2	GSM/GPRS test SIM for loopback mode, required for BER and other applications	☺	–	–	–	–	–	–	1039.9005.02
CMU-Z1	30 MByte memory card for use with PCMCIA interface	☺	☺	☺	☺	☺	☺	☺	1100.7490.02
CMU-Z6	Enhancement of wideband modulation	–	–	–	–	–	☺	–	1150.0001.02
PSM-B9	PCMCIA 500 MByte hard disk	☺	☺	☺	☺	☺	☺	☺	1064.5700.02
ZZA-411	19" rack adapter	☺	☺	☺	☺	☺	☺	☺	1096.3283.00

Comments on table:

✓ mandatory; ☺ optional; – not applicable

[1] *CMU-B11 or CMU-B12 possible. One of two OCXOs should be installed to ensure high frequency accuracy or external frequency reference may be used, if available.*

[2] *CMU-B21 necessary.*

[3] *CMU-B21 and CMU-B41 necessary*

[4] *CMU-B81 necessary.*

[5] *CMU-B53 necessary.*

[6] *CMU-K53 necessary.*

[7] *For upgrade only if factory installation is not applicable. Includes CMU-B53 and CMU-K53.*

[8] *Depending on the required frequency band.*

[9] *CMU-U65 necessary.*

[10] *CMU-U66 or CMU-B66 necessary.*

[11] *CMU-B83 or CMU-U83 necessary.*

[12] *at least on of CMU-K20...K24 necessary.*

[13] *Factory installation only.*

[14] *For upgrade only if factory installation is not applicable.*

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ROHDE&SCHWARZ

ROHDE&SCHWARZ GmbH & Co. KG · Mühldorfstraße 15 · 81671 München · Germany · P.O.B. 80 14 69 · 81614 München · Germany · Telephone +49 89 4129-0
www.rohde-schwarz.com · Customer Support: Tel. +49 1805124242, Fax +49 89 4129-13777, E-mail: CustomerSupport@rohde-schwarz.com

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