Digital Radiocommunication Test Sets CRTP 02/CRTC 02

for GSM 900, DCS 1800 and DCS 1900 Mobile Stations

CRTP02 and CRTC02 are extremely powerful test sets, providing all simulation and analysis capabilities from measurement of GSM 900, DCS 1800 and DCS 1900 specific RF parameters through to detailed checking for errors in the signalling protocol.

The Radiocommunication Test Set CRTP 02 simulates a base station (BTS, cell) with two independent radio channels in the GSM or DCS 1800 band. The CRTC02 covers in addition the DCS 1900 standard in the US PCS frequency band.

With CRTP02 and CTRC02 almost every GSM feature which is relevant for the communication between mobile and network can be tested. Besides the standard speech service the instruments optionally support

- Short Message Service
- Supplementary Services
- Transparent Data Services
- Non-Transparent Data Services (RLP)
- Ciphering A5-1 and A5-2
- GSM Phase II

Due to its flexible structure the instrument can follow easily the evolution of the GSM standard by software upgrades.

ROHDE&SCHWARZ

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Milestones in GSM testing

Rohde&Schwarz expertise in GSM testing goes back to the late 1980s. As the leading manufacturer of testers for analog mobile radios R&S launched the market's first GSM compact tester CMTA 94. The instrument was designed to meet the early needs of the GSM radio engineers and was soon followed by the GSM Radiocommunication Test Set CRTS 02, which offered, in addition, in-depth signalling test capabilities.

The CRTS 02 has set the standard in GSM testing. It became the key element of the Interim Type Approval System, parts of its hardware and software went into the Full Type Approval System. These systems are used for qualifying every GSM mobile on the market by test houses.

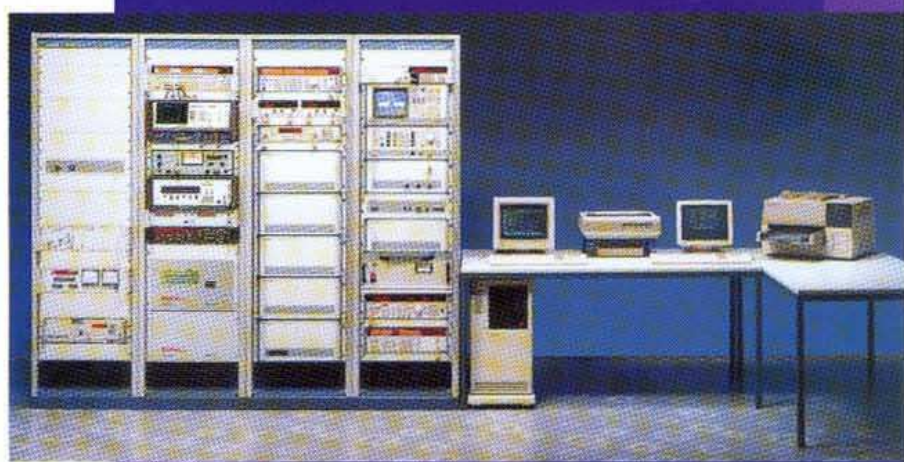
Its successor, Digital Radiocommunication Test Set CRTP02, extended the frequency range to DCS 1800 and became the heart of the DCS 1800 Type Approval System.

Many tests originally developed for systems using CRTS/CRTP have been made available to customers and have lead to the situation that almost every manufacturer or operator worldwide uses CRTS 02 or CRTP 02 for development and/or verification of mobile stations.

In early 1995 Rohde & Schwarz launched the CRTC02 which now covers in addition the US DCS 1900 frequency range. At the same time, R&S began shipping completed GSM phase 2 test case packages. Through all the years Rohde&Schwarz has provided upward and backward compatibility by offering hardware and software options: A phase 2 test will still run on CRTS 02 shipped years ago.

That is the R&S way of safeguarding the customer's investment in test equipment.

CMTA 94 was the first GSM compact tester on the market allowing precision RF measurements on base and mobile stations



Type approval of GSM mobiles, using very comprehensive RF and audio tests, is performed exclusively by the Rohde & Schwarz System Simulator

CRTS has set the standard for detailed and flexible protocol testing of GSM mobile stations

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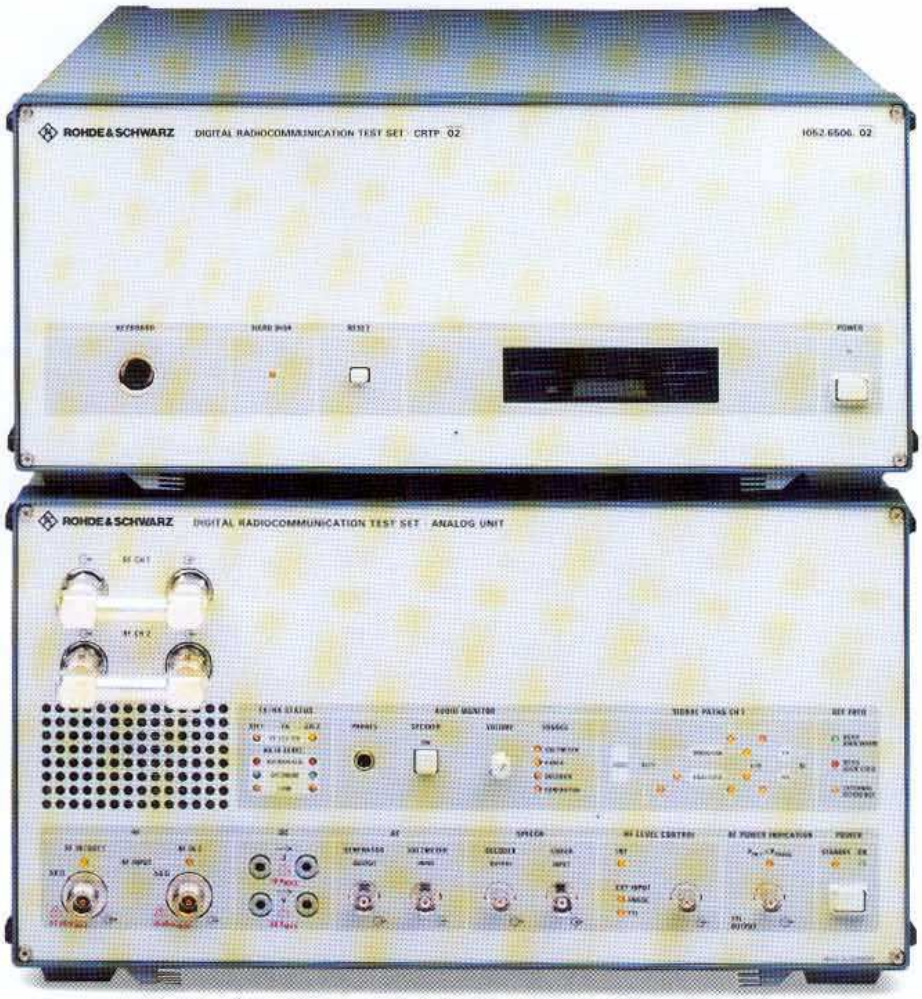

Digital Radiocommunication Test Set CRTP02

The CRTP02 has set the standard in GSM testing. Due to the high flexibility and an extensive list of features, this instrument or parts of it have been used to built the kernel of the GSM 900 and DCS 1800 type approval systems. All the know-how and experience obtained during the design and the use of these systems reflect back into the CRTP/C software and allows measurements with results traceable to the type approval procedure.

Applications

Development

- Measurements on GMSK-modulated RF signals and receiver testing
- Testing of all signalling functions and validation of data transmission protocols and timing
- Simple generation of customized test procedures

Type-approval preparation and quality assurance

Testing of conformance with GSM Recommendation 11.10. phase I and phase II with respect to

- channel coding
- datalink protocols
- network signalling and
- GSM-specific RF parameters

Chip design

Thanks to built-in TTL input/output of bits and an optional I/Q interface at baseband the instruments are ideal for use in development and validation of integrated circuits and modules.

Operation

The CRTP02 and the CRTC02 may be operated in three different ways:

- via convenient menus
- by running ready-to-use test cases selected from a pick list
- by running user-programmed tests

Menu interface

The convenient, menu-guided user interface permits simple and fast call-up of test routines and RF measurements.

Test routines

- synchronization of mobile
- location update of mobile
- incoming/outgoing call setup
- power level control of mobile
- bit error in loop-back mode
- channel change
- call clearing by mobile
- call clearing by network
- SACCH measurements
- speech loop-back

RF measurements

- phase error
- frequency error
- power level
- power characteristics versus time

Test routines and measurements are clearly indicated on the screen and activated by simple selection. Test results are displayed in graphical and numerical form.

Ready-to-use programs

About 20 of ready-to-use test programs complying with GSM Rec. 11.10, GSM 900 and DCS 1800/1900 are delivered with the instrument's basic operating software. Numerous additional test programs are available as software options.

By means of a test environment manager, the programs may be selected from a list using the cursor and subsequently started.

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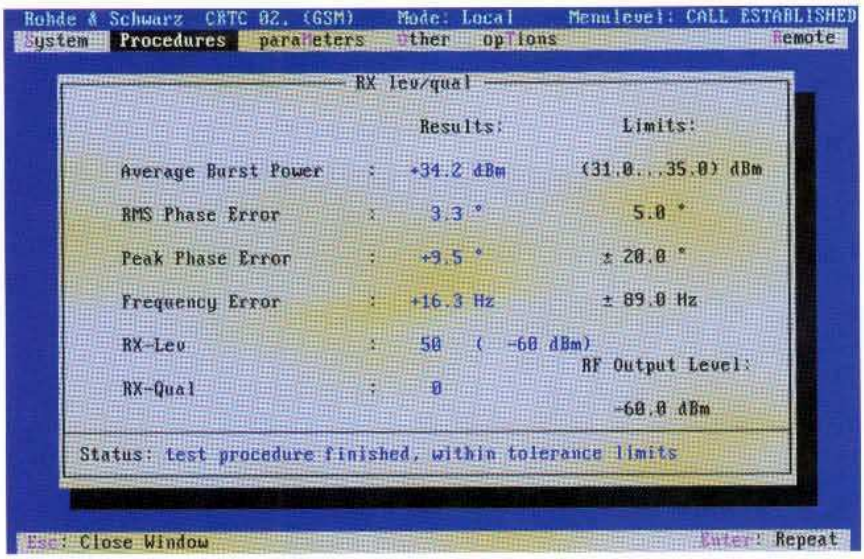


Menu-driven RF measurements

The test programs automatically generate a pass/fail result which in many cases is accompanied by an error message. The complete signalling sequence is stored in the log memory of the instrument, permitting a detailed analysis of messages from layer 1 to layer 3. The ready-to-use test programs are written in C and supplied in source code.

User programming

Experienced C programmers are able to modify the test programs, for instance to locate error sources in the mobile. All required tools such as software compiler and message editor are supplied with the system. In order to simplify the writing of customer programs, a number of clearly arranged program examples for frequently occurring functions such as location update, mobile originated/terminated call as well as for measurements of bit error rate, phase frequency error and power time template are delivered as part of the instrument.

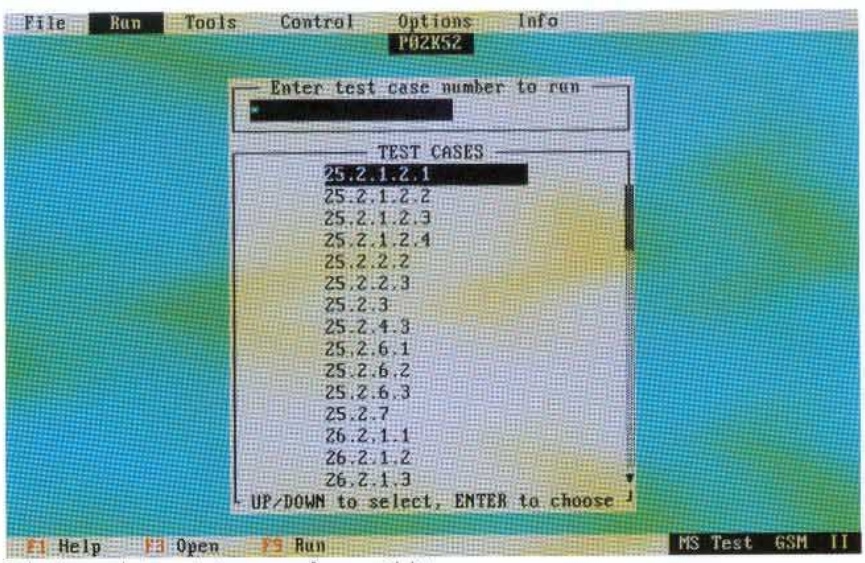
Signalling

The instrument performs all channel coding and layer 2 signalling functions automatically in real-time. The detailed signalling sequence is determined by the user-written or ready-to-use C program, defining which layer 3 messages have to be transmitted in which order.

The messages are generated by a special editor which can handle the coding rules of GSM 4.08. The same tool is also used to examine the log memory.

In order to test the layer 2 or RLP function the layer 2 functionality can be modified during the execution of a test. In particular, it is possible to ignore a certain number of layer 2 frames, wait for the arrival of a specific frame or modify the layer 2 status variable V(R), V(S) and V(A).

A built-in speech coder/decoder may be used to test voice transmission. Data traffic may be routed to the display or the COM interface of the instrument.



Selecting ready-to-use test programs from a pick list

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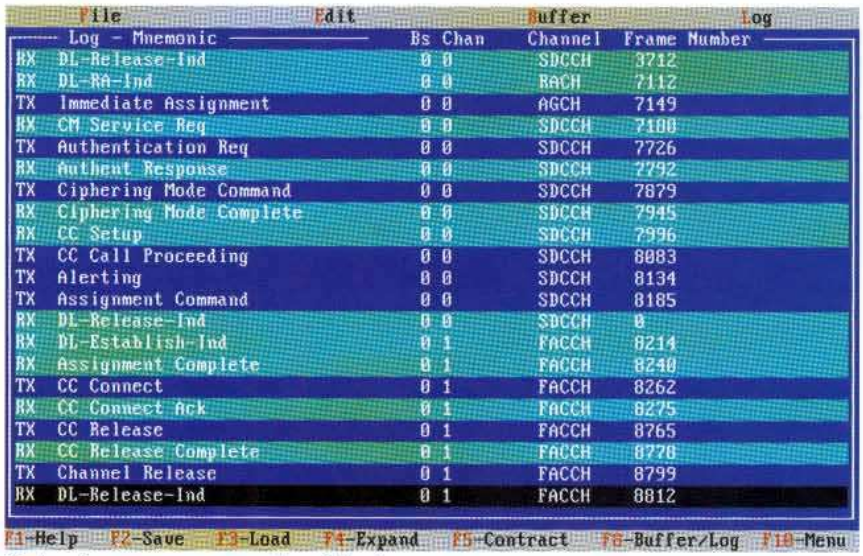
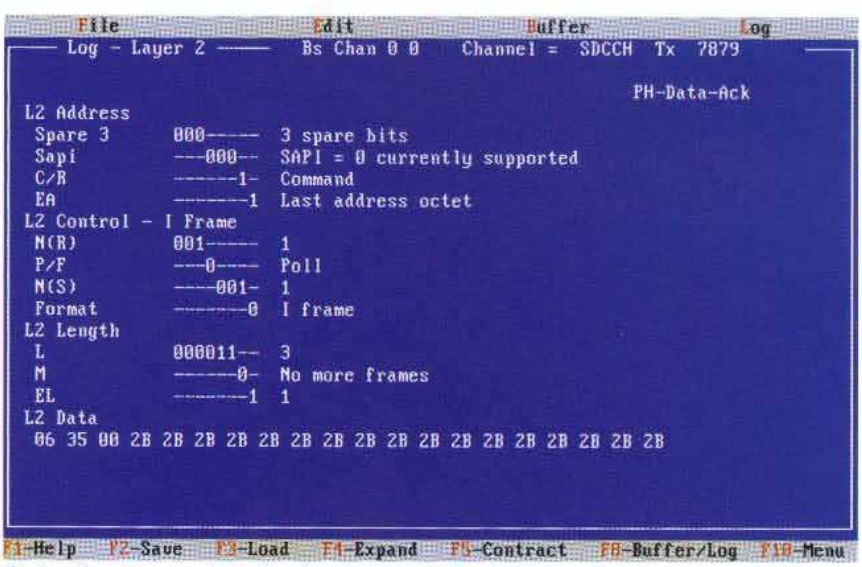


Display of message sequence at layer 3 level

Display of detailed content of a layer 3 messsage



Display of a message at layer 2 level

Protocol analysis

Every transmitted or received layer 3 or layer 2 message, or even the bits of a burst, are marked with a frame number, channel type and recorded in the log memory. The menu-controlled message editor operating in line with the coding rules of GSM 4.08 can be used to navigate through the log memory and to display the recorded sequence at the various layers in mnemonic form.

The user may look at the message sequence or in more detail at all the elements of a single layer 3 message. Besides the message type and a frame number the channel type is displayed. The BsChan column permits to distinguish between the two radio channels of the instrument.

At layer 2 level the header of the frame is displayed with explanatory text followed by the content of the layer 3 frame in hexadecimal presentation.

Filter functions allow suppression of those signalling channels which are of no interest for the current investigations.

The log may be saved on disk for later analysis or sent to a printer. For off-line analysis the content of the log and the message editor program can be easily transferred to an external PC.

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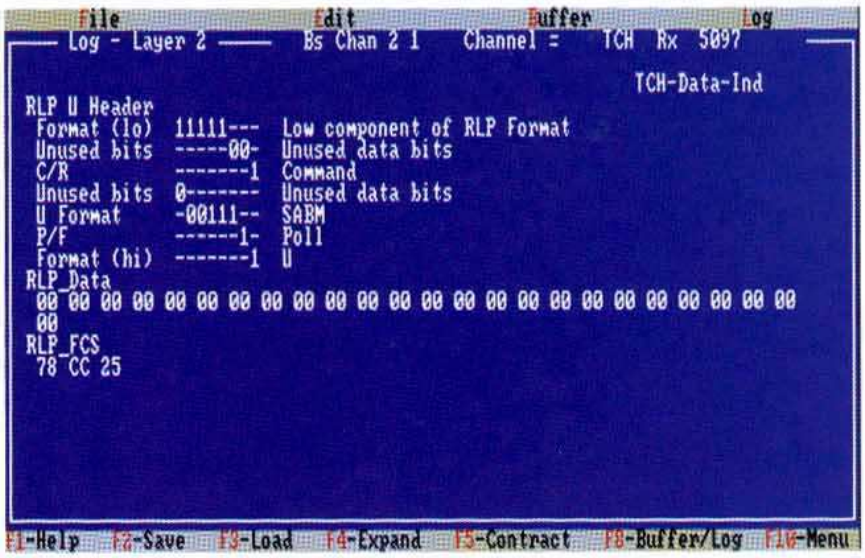
Data Services

The CRTP02 and CRTC02 support the testing of transparent and non-transparent data services. In the transparent, asynchronous case the instrument performs rate adaptation and checks for missing stopbits, wrong parity bits etc. The instrument is also able to generate data streams with over- and underspeed.

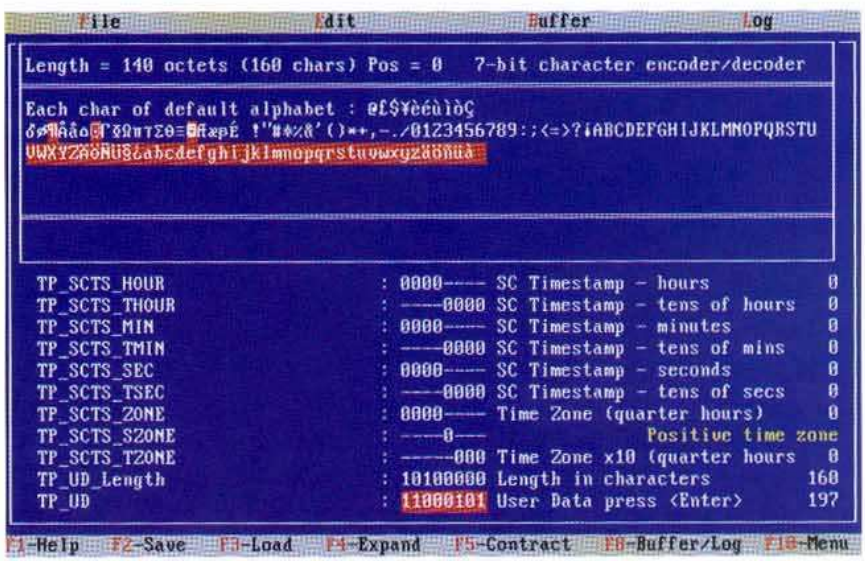
When testing the non-transparent radio link protocol, the tester performs the correct real-time protocol and CRC checking. In addition, the instrument can simulate incorrect sequences such as the loss of acknowledgements and wrong sequence numbers.



RLP frame at layer 2 level

Short Message Services

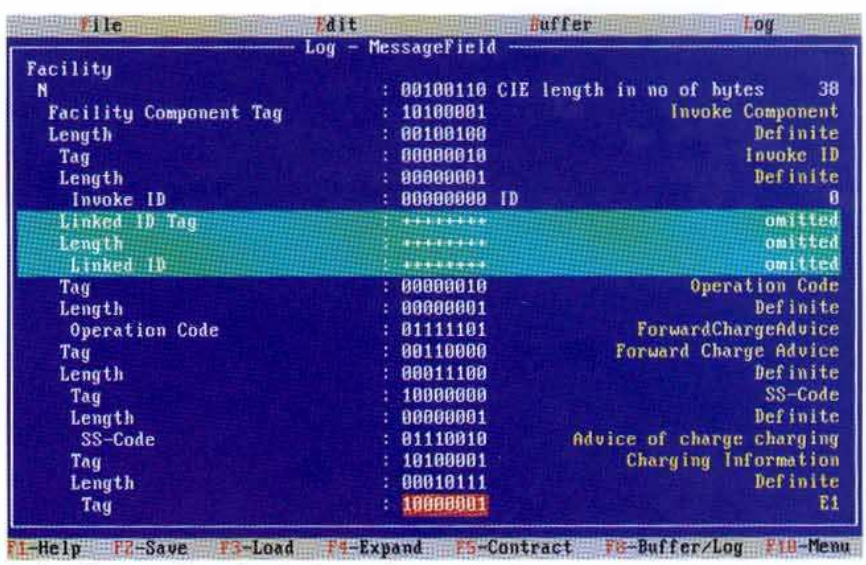
The instrument supports point-to-point and cell broadcast Short Message Service. The message editor displays the content of the transmitted message and the related signalling overhead. At layer 2 level the correct signalling at SAPI3 can be displayed in ASCII format. A set of ready-to-use test programs is available for both phase I and phase II.



Display of SMS layer 3 message

Supplementary Services

The instrument is able to test supplementary services such as call forwarding, call restriction and call charging by using a set of ready-to-use test programs.



Facility information element for charging supplementary services

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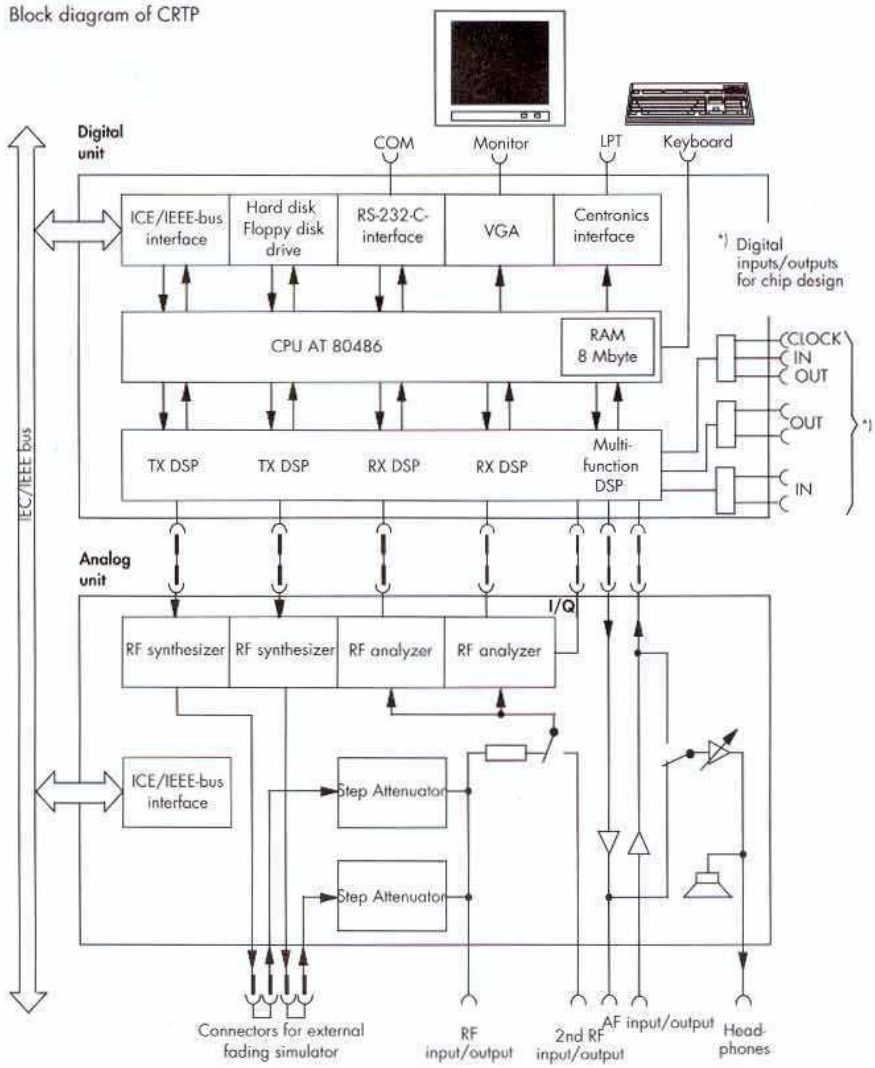
Block diagram of CRTP



Hardware

The Digital Radiocommunication Test Sets CRTP02 and CRTC02 consist of a digital unit, analog unit, colour monitor and keyboard.

Digital unit

A 80486 microprocessor forms the core of the digital unit. The high speed required for real-time signalling and fast measurement is obtained with the aid of five digital signal processors connected to the analog unit via fast interfaces. A 200-MByte hard disk with a short access time offers sufficient memory capacity for system software, user programs and measured data.

Analog unit

The analog unit comprises all necessary RF components. Extremely high signal quality and low measurement errors ensure that measured data of the mobile under test are not impaired by characteristics of the measuring instrument.

Each of the full-duplex channels is allocated a fast frequency-hopping synthesizer, a GMSK modulator, an output stage for level generation and a demodulator.

Several LEDs on the front panel indicate essential signal states and instrument setups in real time. At the transmitter end, fading simulators may be connected into the signal path.

Hardware Options

AF Measurements CRTP-B1

A wide range of audio measurements can be performed on the AF section of the mobile under test. The AF generator provides single or double tones. The following measurements are implemented:

- AF voltmeter with rms or peak weighting
- Continuously tunable distortion and SINAD meter
- AF frequency counter
- DC ammeter/voltmeter

I/Q Interface CRTP-B7

This option provides access to the interface between the modulator and the radio part of the instrument and enables the testing of mobiles at module level.

The digital section of a mobile can be examined in the baseband at an early stage when the RF module is not yet available.

Test SIM CRT-Z2

A special SIM card with known content enables the testing of authentication and ciphering.

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Software Options

GSM Phase I

CRTS-K48 (SMS + TDS)
This option consists of the message editor support for SMS, ready-to-use test programs for short message service and the basic software for transparent data services. The software works in all modes GSM 900, DCS 1800 and DCS 1900.

CRTS-K22, CRTS-K23, CRTS-K24 (Test Cases)
These three options together contain more than 150 ready-to-use test programs for GSM 900 in accordance with the GSM recommendation 11.10. The test programs follow the GSM evolution. For the detailed content and the actual version of GSM 11.10. please contact your local sales office.

CRTS-K38 (Supplementary Services)
This option consists of the message editor support for supplementary services and ready-to-use test programs. The software works in all modes GSM 900, DCS 1800 and DCS 1900.

CRTP-K22, CRTP-K23, CRTP-K24 (Test Cases)
These options are the DCS 1800 and DCS 1900 version of CRTS-K22 to CRTS-K24.

GSM Phase II

CR02PH2 (Operating Software)
This option is the phase II operating software for the CRTC02 and CRTP02.

CR48PH2 (SMS + TDS)
This option consists of the message editor support for short message service and the basic software for transparent data services. The software works in all three modes GSM 900, DCS 1800 and DCS 1900.

CRTP-K52, CRTP-K53, CRTP-K54 (Test Cases)
These three options together contain more than 150 ready-to-use test programs for GSM 900 in accordance with the GSM recommendation 11.10. phase II. The test programs follow the GSM evolution. For the detailed content and the actual version of GSM 11.10. please contact your local sales office.

CRTP-K58 (Supplementary Services)
This option consists of the message editor support for supplementary services GSM 900 phase II and a set of ready-to-use test programs.

CRTP-K59 (SMS)
This option is made up of a set of ready-to-use test programs for short message services GSM 900 phase II.

CRTP-K62, CRTP-K63, CRTP-K64
These three options are the DCS 1800 and DCS 1900 version of CRTP-K52 to CRTP-K54.

CRTP-K68
This is the DCS 1800 and DCS 1900 version of CRTP-K58.

CRTP-K69
This is the DCS 1800 and DCS 1900 version of CRTP-K59.

CRTS -K28 (NTDS/RLP)
adds non-transparent data services (radio link protocol) capability to the instrument. The option covers both GSM phase I and phase II.

CRTS -K1
adds A5-1 ciphering to the instrument.

CRTS-K2
adds A5-2 ciphering to the instrument.

CRTP-K55, CRTP-K65 (Handover)
This option contains a set of phase II handover tests for GSM 900 and DCS 1800/1900 mobiles.

Front panel of analog unit: LEDs indicate important signal states and instrument setups in realtime

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Specifications

Analog unit

Signal generator

Frequency range	GSM band 935.2 to 959.8 MHz DCS 1800 band 1710.2 to 1784.8 MHz DCS 1900 band 1930.2 to 1989.8 MHz
Spurious phase modulation	<1 ° rms, <4 ° peak
Frequency aging	$<2 \times 10^{-9}$/day (after 30 days operation)
Temperature variation	$<2 \times 10^{-9}$/°C
Maximum output level	13 dBm
Static attenuation setting	0 to 135 dB
Resolution	5 dB
Dynamic attenuation	0 to 35 dB (electronic)
Level error	<1.5 dB from –127 to +13 dBm, (with dynamic attenuation at 0 dB)
Modulation	GMSK, bit rate 270 833 bit/s acc. to GSM Rec. 05.04

Analyzer

Frequency range	GSM band 890.2 to 914.8 MHz DCS 1800 band 1805.2 to 1879.8 MHz DCS 1900 band 1850.2 to 1909.8 MHz
Reference level for full dynamic range	
GSM band	+13 to +47 dBm ($RF_{IN/OUT}$) –17 to +19 dBm (RF_{IN2}),
DCS 1800/DCS 1900 band	+9 to +36 dBm ($RF_{IN/OUT}$) –21 to + 6 dBm (RF_{IN2}),
Step size	3 dB
Level error	<2 dB
Spurious phase modulation	<1 ° rms, <4 ° peak
Sampler	two 12-bit A/D converters (for I and Q signals), sampled at 1.083 MHz (4 samples per bit)

Synchronization	10-MHz output, 52-MHz output, 10-MHz input/output

Inputs/outputs

for fading simulator	2 N-type connectors, 50 Ω (output level 8 to 13 dBm)
for $RF_{IN/OUT}$ and RF_{IN2}	N-type connectors, 50 Ω

Speech coder/decoder

Input voltage	20 mV to 2 V (R_{in} = 100 kΩ)
Output voltage	2 V (R_{out} <3 Ω)

Digital unit

Processor	80486 AT/8 MByte RAM
Disk drive	3 1/2", 1.44 MByte floppy 200-MByte hard disk
Graphics	VGA
Interfaces	parallel Centronics, RS-232-C
Channels supported	CO channel with FCCH + SCH + BCCH + CCCH + CBCH + SDCCH/4 + SACCH traffic channel (speech and data) with TCH + FACCH + SACCH, SDCCH/8 + SACCH

AF Measurement Unit (CRTP-B1)

AF generator

Signal source	single or dual tone
Frequency range	20 Hz to 20 kHz
Output level	10 µV to 5 V_{rms}
Output impedance	<3 Ω

AF voltmeter

Operating modes	rms, +peak, –peak
Frequency range	50 Hz to 5 kHz
Level range	0.1 mV to 30 V_{rms}
Weighting filter	CCITT filter, complying with CCITT 0.41

Distortion meter

Frequency range	20 Hz to 20 kHz
Measurement range	0 to 50 %

AF frequency counter

Frequency range	50 Hz to 5 kHz
Resolution	0.1 Hz/1 Hz
Input level	10 mV to 30 V (up to 20 kHz)

DC measurements

Voltage/currrent	0 to ±30 V/0 to ±10 A

I/Q Inputs/Outputs (CRTP-B7)

Input level/output level The option is required separately for each of the two channels of CRTC02/CRTP02	±1.5 V_{peak}/±1.5 V_{peak}

General data

Operating temperature range	0 to 45 °C
Environmental conditions	to IEC 359, class 1 (no condensation)
Storage temperature range	–40 to +70 °C
Power supply	110/220 V ±10 % 47 to 63 Hz (max. 500 VA) safety class 1 (acc. to IEC 348 and VDE 0411)
Dimensions (W x H x D), weight	
Analog unit	435 mm x 236 mm x 570 mm, 27 kg
Digital unit	435 mm x 192 mm x 570 mm, 18 kg

Ordering information

Digital Radiocommunication Test Set	CRTP02	1052.6506.02
Digital Radiocommunication Test Set	CRTC02	1081.6000.02
AF Measurement Unit	CRTP-B1	1052.9505.02
I/Q Inputs/Outputs (required twice)	CRTP-B7	1052.9257.02
Phase I Options		
GSM 900 Test Cases	CRTS-K22	1034.4286.02
GSM 900 Test Cases	CRTS-K23	1034.4305.02
GSM 900 Test Cases	CRTS-K24	1034.4328.02
DCS 1800/1900 Test Cases	CRTP-K22	1053.1050.02
DCS 1800/1900 Test Cases	CRTP-K23	1053.1108.02
DCS 1800/1900 Test Cases	CRTP-K24	1053.1150.02
Non-Transp. Data Services	CRTS-K28	1034.4405.02
Supplementary Services incl. 17 tests	CRTS-K38	1034.4457.02
Transp. Data Services/SMS	CRTS-K48	1034.4670.02
Phase II Options		
GSM Phase 2 Basic Software	CR02PH2	1053.0501.02
Transp. Data Services/SMS	CR48PH2	1057.8157.02
GSM 900 Test Cases	CRTP-K52	1053.1308.02
GSM 900 Test Cases	CRTP-K53	1053.1350.02
GSM 900 Test Cases	CRTP-K54	1053.1408.02
GSM 900 Handover Test Cases	CRTP-K55	1035.1450.02
GSM 900 Test Cases	CRTP-K58	1075.8105.02
GSM 900 Test Cases	CRTP-K59	1075.8357.02
DCS 1800/1900 Test Cases	CRTP-K62	1075.8505.02
DCS 1800/1900 Test Cases	CRTP-K63	1075.8557.02
DCS 1800/1900 Test Cases	CRTP-K64	1075.8605.02
DCS 1800/1900 Handover Test C.	CRTP-K65	1075.8657.02
DCS 1800/1900 Test Cases	CRTP-K68	1075.8705.02
DCS 1800/1900 Test Cases	CRTP-K69	1075.8757.02
Ciphering A5-1	CRTS-K1	1034.4228.02
Ciphering A5-2	CRTS-K2	1034.4105.02
Acessories		
GSM Test Sim	CRT-Z2	1039.9005.02

Note: DCS 1900 data are only applicable to CRTC02

Certified Quality System
ISO 9001
DQS REG. NO 1954-02

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Printed in Germany 895 (Pe dr)

PD 757.0058.22 · Printed on chlorine-free paper · Subject to change · Data without tolerances: order of magnitude only

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