Universal Protocol Tester CRTU-G

The reference for GSM

- Simulation of a GSM cell with two independent channels
- Platform for validated 3GPP 51.010 test cases
- Programming interface for user-defined tests
- Detailed analysis of messages at various protocol layers
- Fit for future mobile radio standards
- Compact single-box, single-supplier solution with MS Windows 2000 operating system
- Upgradable to WCDMA

ROHDE&SCHWARZ

CRTU-G for GSM

Rohde&Schwarz milestones in digital testing

1990 CMTA94 – First test set for GSM transmitter and receiver testing

1991 CRTS02/04 – Signalling tester for GSM mobile and base stations

1992 FTA – Sole supplier of GSM900 system simulator for conformance testing of mobiles

1993 ITA – Sole supplier of GSM900 interim conformance test system, upgradable to GSM1800

1994 CMD55/57 – World's first compact digital radiocommunication tester for GSM mobile and base stations

1996 CRTP – Approved as stand-alone tester for conformance testing of phase II GSM900/1800 mobiles

1997 TS8915 – Supplier of first conformance test system for GSM1900

1997 CRTC – Approved as stand-alone tester for conformance testing of phase II GSM900/1800/1900 mobiles

1997 CMD65 – World's first compact digital radiocommunication tester for GSM900/1800/1900 and DECT

1999 CMU – THE tester for current and future mobile radio networks

2001 CRTU-G – The reference for the GSM protocol

Fields of application

Development of GSM mobiles

The CRTU-G simulates a GSM base station and records all messages sent to and received from a mobile station. This allows detailed analysis of the protocol stack in the mobile station. Protocol stack functions can also be modified by the user. So it is possible to simulate network errors, for instance, and analyze a mobile station's response. Parts of the protocol stack can be bypassed by appropriate programming. In this way, even protocol stacks implemented only partly in the mobile station can be tested.

Conformance testing of GSM mobiles

The conformance test of GSM mobiles is based on the test cases defined by 3GPP in specification 51.010. A large number of these test cases have been validated for Rohde & Schwarz by independent test houses and are available for the CRTU-G. Easy-to-use tools, automated testing and detailed log files speed up conformance testing and error elimination. Log files can be analyzed on a separate PC for the most efficient use of the CRTU-G.

Additional conformance tests in line with user's own standards, e.g. network operators, can be implemented with the aid of user-defined tests.

Development of GSM chip sets

In the development of GSM chip sets, detailed analysis of customized test cases is as important as the requirement for several interfaces with the device under test, since an RF connection is not possible in all phases of development. The DUT can be contacted via analog IQ and IF signals (option CRTU-B7).

Main features

Simulation of a GSM cell with two independent channels

The two channels of the CRTU-G can be configured independently of each other and usually simulate a single GSM cell. They can also be configured for different frequency bands or used at the same time as a traffic channel.

CRTU – the platform for future mobile radio standards

The CRTU-G is the first member of the Rohde&Schwarz protocol tester family implemented on the basis of the CRTU platform. The platform architecture ensures easy enhancement of the CRTU to cover future mobile radio standards.

Up to four GSM timeslots per RF channel for GPRS

With the optional GPRS operational software, the CRTU-G uses only one physical channel for four timeslots. GSM class 12 mobiles can thus be tested by a single CRTU-G.

EDGE and software-controlled modulators/demodulators

The modulators and demodulators are software-driven and able to generate and receive GMSK and 8PSK signals as used in EDGE systems. The modulation formats are easily modified by software upgrades or further formats added as required.

Tools

The tools supplied with the tester considerably facilitate routine work. For more efficient use of the tester, the tests can be pre- and postprocessed offline on a standard Windows PC, using optionally the tools described below.

- Configuration editor

This editor is used to generate basic information. The hardware configuration of the tester, DUT or SIM card is entered via various masks and available as basic information during the test.

- Sequencer

A defined sequence of tests has to be executed especially for the conformance test. The sequencer is an environment for defining and running these sequences. It is also used as a navigator for other tools.

- Message viewer

The message viewer clearly displays the message log file recorded during a test. GSM messages can be filtered or analyzed at various protocol layers. The message database contained in the operational software usually allows the GSM information fields to be displayed in plain text.

Multiple opening of the message viewer allows several log files to be compared.

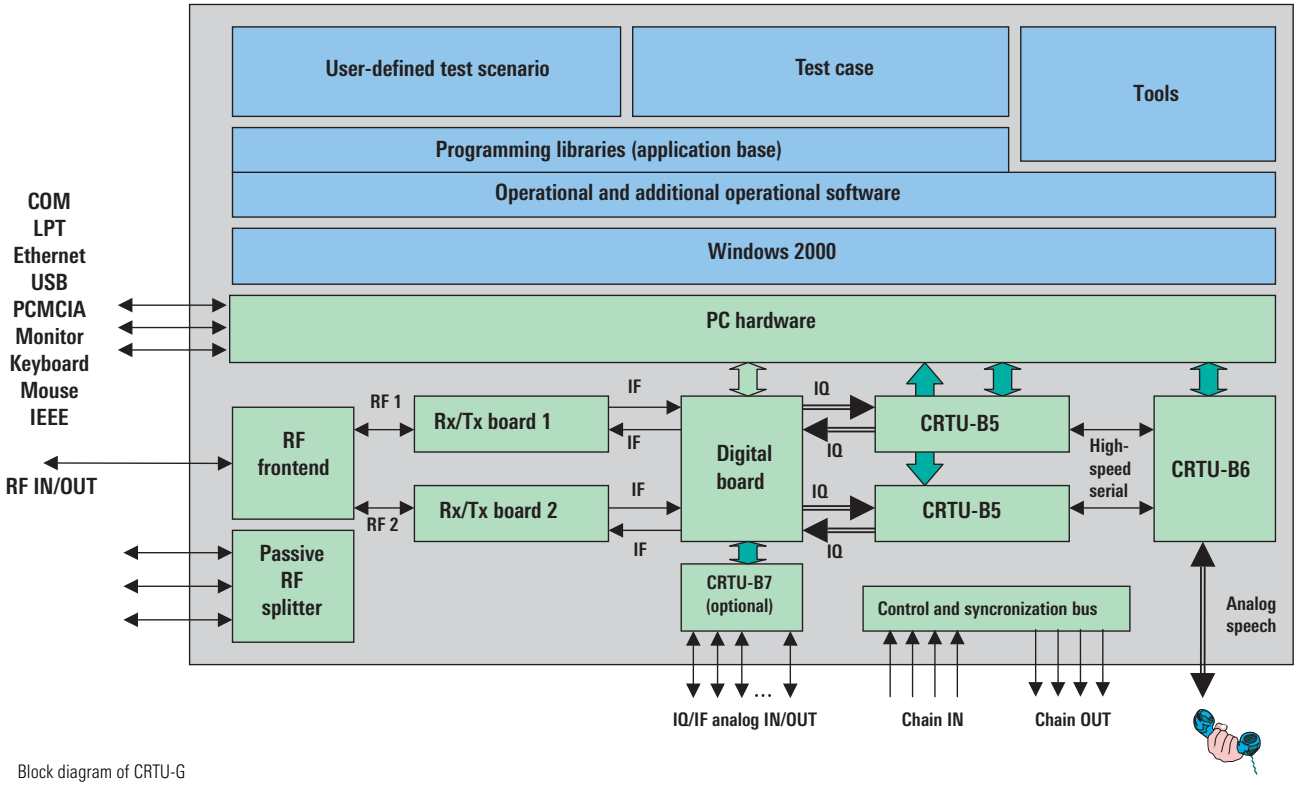
- Message composer

API functions are used in a test program to send or receive GSM messages. The message composer supports the programmer in easily composing the messages.

CRTU-G highlights

- Compact solution
  - Single box
  - Hardware, software and service from a single source
- Fit for the future
  - Upgradable to new standards
- Customized solution can be further enhanced
  - Individual software configuration
- Cuts development costs
  - Base station simulation in the lab
  - Immediately executable tests for fast results
  - Shorter development times

Like with the message viewer, the contents of GSM messages are displayed in plain text.



Block diagram of CRTU-G

- Hardware diagnostics

The diagnostic tool confirms to the user proper functioning of the hardware modules in the CRTU-G. Any faults that may occur are quickly located.

Predefined ETSI test cases available

Rohde&Schwarz provides a large number of test cases to 3GPP 51.010 validated by independent test houses for conformance tests. The tests can be run automatically to increase throughput. All test cases are supplied as source code, can be viewed and used as a template for user-defined tests.

Programming interface for user-defined tests

Various C libraries are used to create user-defined tests. Program examples and the 3GPP test cases supplied in source code can be modified for customized tests. Programs are generated in MS Visual C++ with debugging tools. Detailed documentation as well as functions at various abstraction levels facilitate programming of user-defined tests.

Enhancement to multicell systems

The CRTU-G is prepared for cascading up to four units. This makes it possible to perform measurements requiring more than two (and up to eight) RF channels.

High broadband RF accuracy

The CRTU-G features an accuracy of <1 dB in a wide frequency range from 10 MHz to 2.7 GHz. Tests such as "Handover", "Cell selection" or "AMR" requiring high level accuracy can thus be performed. The frequency range covers all present and future GSM bands.

GSM Phase 2+ Operational Software CR02P2P

The operational Software CR02P2P contains the protocol stack and the channel/speech coders required to simulate a GSM base station. The protocol stack function can be modified in the test program to simulate faulty behaviour of the base station for instance. The individual entities of the protocol stack can be addressed separately.
The operational software is continuously updated in line with modifications to 3GPP specifications. It comprises customary services and functions (not test cases), and optional services and functions can be installed. Detailed information on optional products can be found on Rohde&Schwarz's website.

The tester comes with:

- Speech HR/FR/EFR
- GMSK, 8PSK channel coder for EDGE
- Supplementary services
- ASCI
- Cell handover and multiband handover
- Ciphering
- BER measurements
- EGSM, RGSM

The following software options can be added:

- GPRS including EDGE incremental redundancy, link adaptation
- AMR
- Circuit-switched single-slot data transfer NTDS (RLP)

Platform for validated 3GPP 51.010 test cases

The validated test cases to 3GPP standard required for the conformance test of GSM mobile phones are available as an option and can easily be started with the tools supplied.

MS Windows 2000 operating system

The GSM operational software is based on the MS Windows 2000 operating system, allowing the user to work in a familiar, user-friendly environment. Integration in a network and operation of additional standard PC peripherals, measuring instruments and PC software thus becomes very easy.

Controlling further measuring instruments – multimode tests

The CRTU-G can assume controller functions in test systems comprising several measuring instruments. Control of further instruments via IEEE, COM or Ethernet can be incorporated in test programs.

In combination with the CMU200, handover scenarios to different standards such as IS-136 or CDMA are possible.

Analog IQ/IF interface

The optional IQ/IF Interface Card CRTU-B7 allows connection to the DUT via analog IQ signals and an IF interface instead of the RF signal. Even with incomplete or faulty RF components, analysis can thus be carried out in baseband mode.

Control and synchronization bus

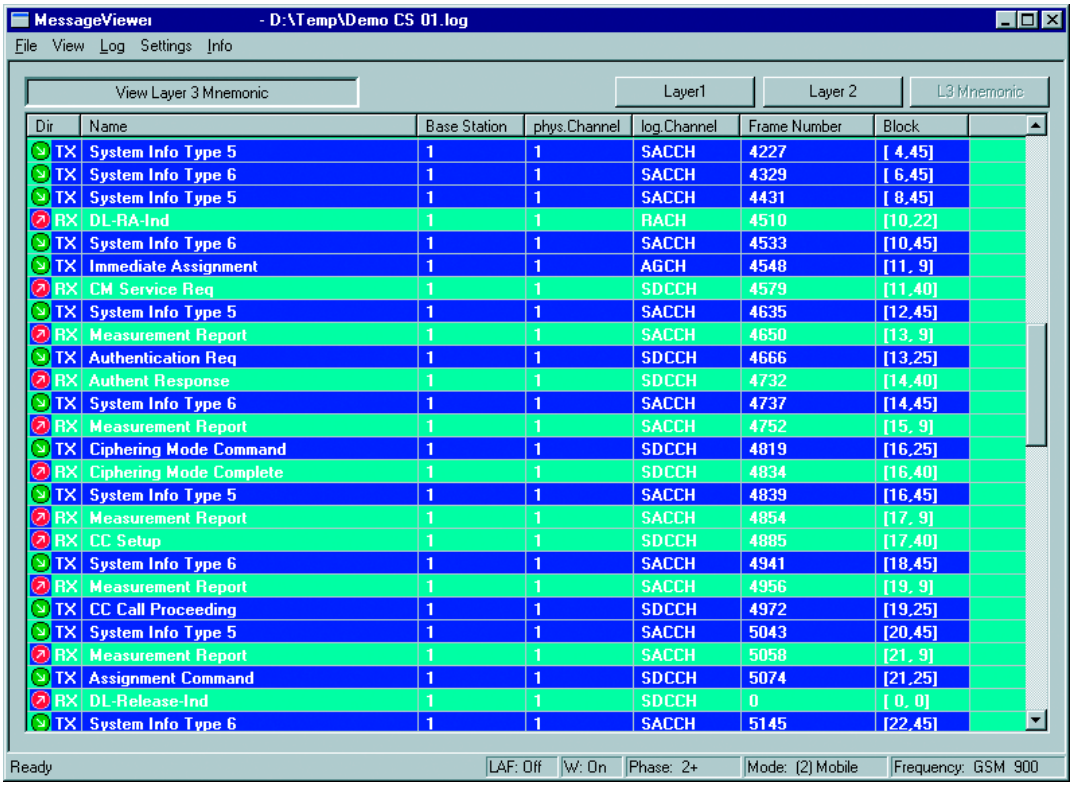
Configurable trigger, clock and data signals available at the output allow synchronization to further measuring instruments or to the DUT. Especially RF measurements that have to be performed in synchronism with signalling can thus easily be implemented.

Multicell/multichannel systems

Up to four CRTU-G testers can be interconnected for tests requiring more than two channels. Multichannel systems capable of handling even complex test scenarios are thus easily configured. All channels are fully synchronized. RF signal routing and transmitter power control are already integrated in the testers so that no extra hardware is required. All testers are controlled via a single test application.

Tests under fading conditions using Baseband Fading Simulator ABFS

Using the optional IQ/IF interface card, a baseband fading simulator (e.g. ABFS from Rohde&Schwarz) can be inserted into the signal path to perform fading tests on the DUT. Use of the CRTU-G frontend ensures high level accuracy.



Message viewer

High broadband RF accuracy

The RF frontend features extremely high level accuracy and resolution over a wide frequency range. This component is very successfully used in Rohde&Schwarz production testers where reproducibility and speed are of vital importance.

Standard PC interfaces and software installation

The CRTU-G is fitted with the current standard PC interfaces allowing convenient connection to further peripherals such as a printer or network. The software can be installed from the CD-ROM drive supplied with the tester or via the network connector.

Easy and fast calibration

The modular design and the use of components from the Rohde&Schwarz Mobile Radio Production Tester CMU 200 ensure reliable and fast calibration and maintenance of the tester.

Single-box, single-supplier solution

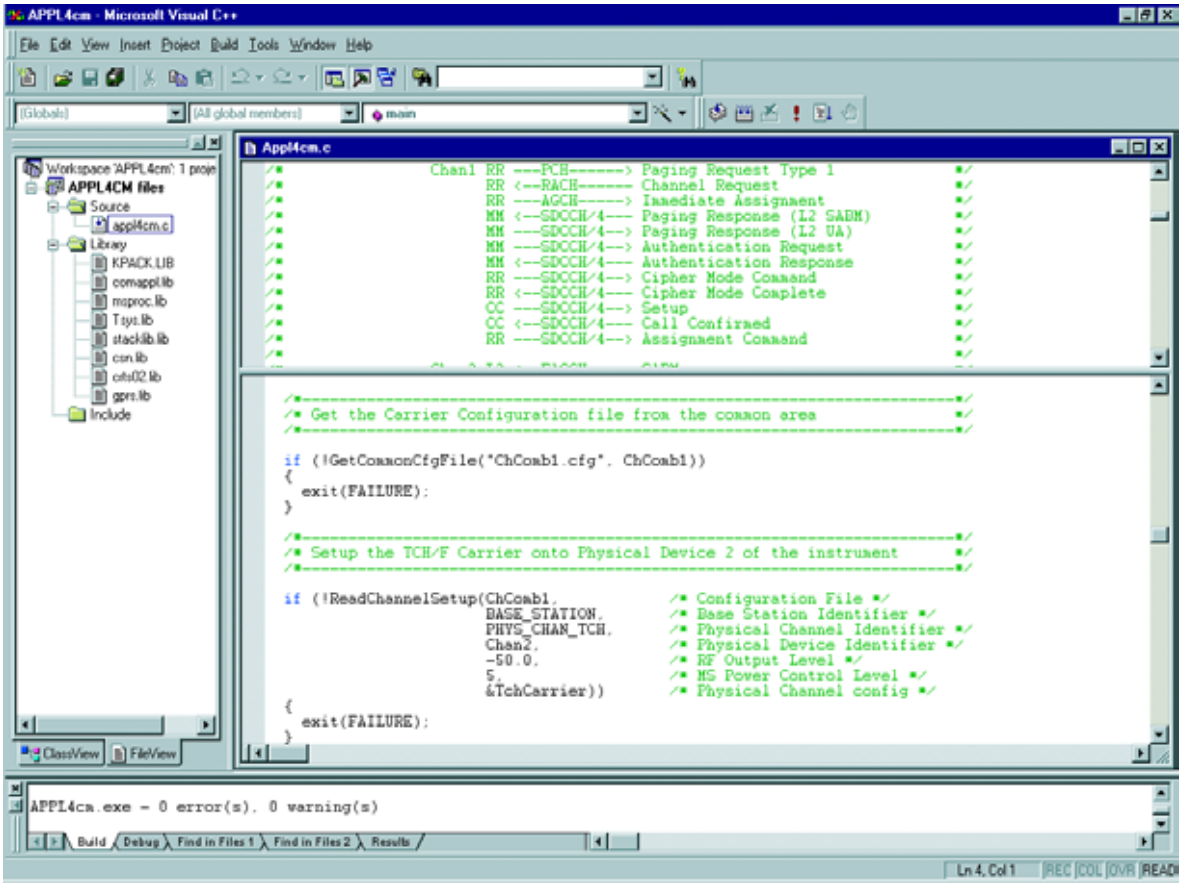
The CRTU-G from Rohde&Schwarz is a complete solution with hardware, software and the associated calibration and maintenance services from a single source.

Upgrade service

Are you sure your software is up-to-date?

The GSM specifications forming the basis of the GSM operational software and of the test cases are subject to continuous updating. To ensure that you are always up-to-date, Rohde&Schwarz is offering a software upgrade service for the CRTU-G GSM software.
So you can be sure of always using the latest software version.

Current information on all protocol test products is available under www.protocol-testing.rohde-schwarz.com.



MS Visual C++ user API

Specifications

Inband GSM specifications

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 –33 dBm
RF2	–130 dBm to –16 dBm
RF3OUT	–90 dBm to + 5 dBm
Output level range (8PSK)	
RF1	–130 dBm to –37 dBm
RF2	–130 dBm to –20 dBm
RF3OUT	–90 dBm to +1 dBm
Output level uncertainty inband	
RF1, RF2 at >–117 dBm	
in temperature range +23°C to +35°C	<0.7 dB
in temperature range +5°C to +45°C	<0.9 dB
RF3OUT	
–90 dBm to +5 dBm (GMSK)	
–90 dBm to +1 dBm (8PSK)	
in temperature range +23°C to +35°C	<0.9 dB
in temperature range +5°C to +45°C	<1.1 dB

RF receiver

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
Inherent phase error (GMSK)	<0.6°, rms <2°, peak
Inherent EVM (8PSK)	<1.0 %, rms
Reference level for full dynamic range	
GMSK	
RF1	+10 dBm to +53 dBm, max. continuous input power 50 W [1]
RF2	–4 dBm to +39 dBm max. continuous input power 2 W
RF4IN	–22 dBm to 0 dBm
8PSK	
RF1	+6 dBm to +49 dBm max. continuous input power 50 W [1]
RF2	–8 dBm to +35 dBm max. continuous input power 2 W
RF4IN	–26 dBm to –4 dBm

[1] 50W in temperature range +5°C to +30°C, linear degradation down to 25 W at +45°C.

Base unit specifications

Timebase OCXO

Max. frequency drift	
in temperature range +5°C to +45°C	$\pm 5 \times 10^{-9}$ referred to +25°C
with instrument orientation	$\pm 3 \times 10^{-9}$
referred to turn-off frequency after 2 h warmup time following a 24 h off time at +25°C	$\pm 5 \times 10^{-9}$
Max. aging	$\pm 3.5 \times 10^{-8}$/year, $\pm 5 \times 10^{-10}$/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	$\pm 5 \times 10^{-6}$
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 uncertainty

RF1, RF2 in temperature range +23°C to +35°C

	≥–106 dBm	>–117 dBm	–117 to –130 dBm
10 MHz to 450 MHz	<0.8 dB		
450 MHz to 2200 MHz	<0.8 dB	<0.8 dB	<1.7 dB
2200 MHz to 2700 MHz	<1.0 dB	<1.0 dB	<1.7 dB

in temperature range +5°C to +45°C

	≥–106 dBm	>–117 dBm	–117 to –130 dBm
10 MHz to 450 MHz	<1.2 dB		
450 MHz to 2200 MHz	<1.2 dB	<1.2 dB	<1.7 dB
2200 MHz to 2700 MHz	<1.7 dB	<1.7 dB	<1.7 dB

RF3OUT in temperature range +23°C to +35°C	
10 MHz to 450 MHz: –80 dBm to +10 dBm	<1.0 dB
450 MHz to 2200 MHz: –90 dBm to +10 dBm	<1.0 dB
2200 MHz to 2700 MHz: –90 dBm to +5 dBm	<1.2 dB
RF3OUT in temperature range +5°C to +45°C	
10 MHz to 450 MHz:–80 dBm to +10 dBm	<1.2 dB
450 MHz to 2200 MHz: –90 dBm to +10 dBm	<1.2 dB
2200 MHz to 2700 MHz: –90 dBm to +5 dBm	<1.7 dB
Output level settling time	<4 µs
Output level resolution	0.1 dB

Generator RF level repeatability
(RF1, RF2, RF3OUT, typical values after 1 h warmup)

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 receiver

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

Phase noise (single sideband, f <2.2 GHz)

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

Residual FM

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

Residual AM

CCITT	<0.02% (rms)

Power splitter

Insertion loss

SC/S1, SC/S2	
400 MHz to 2200 MHz	<7 dB
2200 MHz to 2700 MHz	<8 dB

VSWR

SC	
400 MHz to 2200 MHz	<1.3
2200 MHz to 2700 MHz	<1.6
S1,S2	
400 MHz to 2700 MHz	<1.5

Isolation

S1/S2	
400 MHz to 2200 MHz	>17 dB
2200 MHz to 2700 MHz	>10 dB

Max. continuous power

SC	4 W
S1/S2	21 dBm

Audio

Input connector AUX1 (BNC)

Full range input level	0.079 V (rms)
Input impedance	100 kΩ

Output connector AUX2 (BNC)

Full range output level	0.79 V (rms)
Output impedance	<2 Ω

Inputs and outputs (rear panel)

IEC/IEEE–bus remote control interface according to IEC 625-2 (IEEE 488.2)	
Connector	24-pin Amphenol
Serial interface COM1, COM2	RS-232-C (COM), 9-pin sub-D connector
Printer interface LPT	parallel (Centronics-compatible)
Mouse/Keyboard connector	PS/2
Connector for ext. monitor (VGA)	15-pin sub-D connector
USB	double connector
Ethernet	RJ45

Trigger/clock signals

Input (BNC) connectors: Trig In A, Trig In B	
Nominal input level	TTL
Input impedance	1 kΩ
Output (BNC) connectors: Trig Out A, Trig Out B, SLOT CLK, BIT CLK	
Nominal output level	TTL
Output impedance	50 Ω

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 colour display (8.4")

Resolution	640 x 480 pixels (VGA resolution)
Pixel failure rate	$<2 \times 10^{-5}$

Electromagnetic compatibility

meets requirements of European 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
Power supply	100 V to 240 V ±10% (AC), 500 VA, 50 Hz to 400 Hz –5% to +10% power factor correction, EN61000-3-2
Power consumption	200 W

Dimensions

W x H x D	465 mm x 193 mm x 517 mm (19"; 4 height units)
Weight	20 kg

Ordering Information

Test equipment for Protocol verification of GSM Mobiles	CRTU-G	1140.0009.82
2-channel IQ/IF interface card for CRTU-G	CRTU-B7	1139.0009.02

For information about software options, please contact the nearest Rohde&Schwarz office

Equipment Supplied with CRTU-G

CRTU-RU	Radio Unit
CRTU-B5	Link handler (2 pieces)
CRTU-B6	MAC/speech board
CRT-Z2	Test SIM phase 2+

VGA monitor, keyboard, mouse, USB/SCSI host adapter, CD-ROM drive, hardlock

CR02P2P	Operational software

Certified Environmental System ISO 14001 REG. NO 1954

Certified Quality System ISO 9001 DQS REG. NO 1954

ETSI MEMBER

...making the right connections.

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