ROHDE&SCHWARZ
Test and Measurement
Division

Operating Manual

DIGITAL
RADIOCOMMUNICATION
TESTER

CMD 54/57

1050.9008.54/.57

Printed in the Federal
Republic of Germany

Cable for local controller coupling in the case of hardware handshake

The connection of the CMD to a controller is effected with a so-called zero modem cable. In the case of this cable, the data, control and report lines must be crossed. The following wiring diagram applies to a controller with 9-pin or 25-pin configuration.

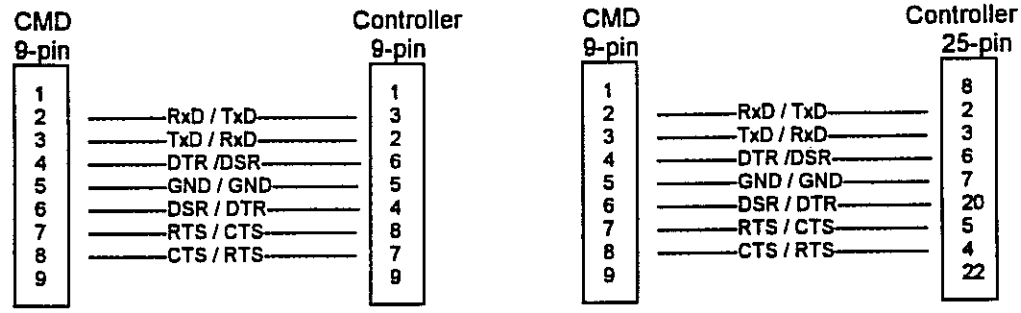


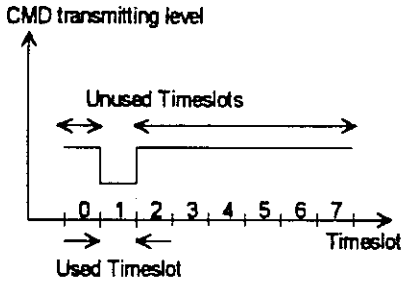
Fig. A3-4 Wiring of the data, control and report lines for hardware handshake

Additional information

① **BER test configuration**
You can now assign new measurement parameters to the selected softkey. Enter the desired number of frames to be sent. The number of samples and the approximate measuring time are displayed automatically.
The softkey "STOP COND." allows you to enter an abort criterium. Thus the test can be stopped immediately when a tolerance value is exceeded; this permits to reduce the test time to a minimum.

Used Timeslot
The absolute transmitting level is assigned to the used timeslot for the test.

Unused Timeslot
This softkey is used to set a uniform level for the remaining timeslots. It is relative and refers to the level of the used timeslot.



Step 12

② **Continuous BER measurement**

This measuring method is very useful for adjustments. The transmitting level of the CMD can be varied both in the used timeslot and in the unused timeslot (see above) using the rotary knob, and the respective measurement result can be read off immediately. The receiver sensitivities can be measured with great accuracy in this way.

The "AVERAGE" softkey permits to enter the number of frames over which the measurement is to be averaged.

The "RESTART" softkey causes the measurement and averaging to be restarted.

The displayed keys can be used to return to the measurement menu or to the given BER measurements.

ROHDE&SCHWARZ
Test and Measurement
Division

Operating Manual

DIGITAL RADIOCOMMUNICATION TESTER

CMD 54/57

1050.9008.54/.57

Printed in the Federal
Republic of Germany

ROHDE&SCHWARZ

EC Certificate of Conformity

(to EMC Directive 89/336/EEC)

CE

This is to certify that

Digital Radiocommunication Tester
CMD 54/57
1050.9008.54/.57

(equipment, type, designation)

complies with the provisions of the Directive of the Council of the European Communities on the approximation of the laws of the Member States relating to electromagnetic compatibility (EMC Directive 89/336/EEC).

This declaration of conformity of the European Communities is the result of an examination carried out by the Quality Assurance Department of **ROHDE & SCHWARZ** in accordance with European Standards EN 50081-1 and EN 50082-1, as laid down in Article 10 of the Directive.

ROHDE & SCHWARZ
GmbH & Co. KG

ROHDE & SCHWARZ

ROHDE & SCHWARZ GmbH & Co. KG
Postfachadresse: Postfach 801469 · D-81614 München
Hausadresse: Mühldorfstraße 15 · D-81671 München
Telefon: (München 089) 4129-0, International: (4989) 4129-0
Telefax: (München 089) 4129-2164 · Telex: 523703-0 (rs d)

Zweigniederlassungen — Subsidiaries in Germany

Zweigniederlassung Berlin Ernst-Reuter-Platz 10 **D-10587 Berlin**	Tel. (030) 340002-0 Telefax (030) 34130 17
Zweigniederlassung Büro Bonn Josef-Wirmer-Straße 1–3 **D-53123 Bonn**	Tel. (0228) 259195 Telefax (0228) 255087
Zweigniederlassung Dresden Fetscherstraße 72 **D-01307 Dresden**	Tel. (0351) 44592-0 Telefax (0351) 44592-15
Zweigniederlassung Hamburg Stellshooper Allee 47 **D-22309 Hamburg**	Tel. (040) 632900-0 Telefax (040) 630787 0
Zweigniederlassung Karlsruhe Am Sandfeld 9 **D-76149 Karlsruhe**	Tel. (0721) 97821-0 Telefax (0721) 97821-41
Zweigniederlassung Köln Graf-Zeppelin-Straße 18 **D-51147 Köln**	Tel. (02203) 807-0 Telefax (02203) 80750
Zweigniederlassung München Mühldorfstraße 15 **D-81671 München**	Tel. (089) 41 8695-0 Telefax (089) 40 47 64
Zweigniederlassung Neu-Isenburg Siemensstraße 20 **D-63263 Neu-Isenburg**	Tel. (06102) 2007-0 Telefax (06102) 800040
Zweigniederlassung Telekommunikation Siemensstraße 20 **D-63263 Neu-Isenburg**	Tel. (06102) 2007-0 Telefax (06102) 200712
Zweigniederlassung Nürnberg Münchener Straße 342 **D-90471 Nürnberg**	Tel. (0911) 86747 Telefax (0911) 869931

ROHDE & SCHWARZ GmbH & Co. KG Werk Köln Graf-Zeppelin-Straße 18 **D-51147 Köln**	Tel. (02203) 49-0 Telefax (02203) 49-308 Telex 8874525 (rsk d)
ROHDE & SCHWARZ GmbH & Co. KG Werk Teisnach Kaikenrieder Straße 27 **D-94244 Teisnach**	Tel. (09923) 28-0 Telefax (09923) 28-174
ROHDE & SCHWARZ MESSGERÄTEBAU GmbH Riedbachstraße 58 **D-87700 Memmingen**	Tel. (08331) 108-0 Telefax (08331) 108-124 Telex 54512 (rsmb d)
ROHDE & SCHWARZ Engineering and Sales GmbH Tassiloplatz 7 **D-81541 München**	Tel. (089) 480004-0 Telefax (089) 480004-44

R & S International

		Telephone Telefax Telex
Argentinia	Precisión Electrónica SRL Esmeralda 582, Piso 4, Of. 11 **1007 Buenos Aires**	(1) 3944615 (1) 7437285 –
Australia	ROHDE & SCHWARZ (Australia) Pty. Ltd 63 Parramatta Road **Silverwater**, N.S.W. 2141	(2) 7480155 (2) 7481836 26372 (rand sa)
Austria	ROHDE & SCHWARZ-ÖSTERREICH Ges.m.b.H. Sonnleithnergasse 20 **A-1100 Wien**	(1) 6026141 (1) 6026141-14 133933 (rsoe a)
Bangladesh	Business International Ltd. 146/A, New Bailey Rd., P.O.B. 727 **Dhaka-2**	(2) 408633 (2) 832903 675632 (bil bj)
Belgium	ROHDE & SCHWARZ BELGIUM N.V. Excelsiorlaan 31 Bus 1 **B-1930 Zaventem**	(2) 7215002 (2) 7250936 25306 (rs bel)
Brazil	ROHDE & SCHWARZ Precisão Eletrônica Ltda. Rua Geraldo Flausino Gomes, 42 1. Andar **04575-060 São Paulo – SP**	(11) 5427377 (11) 5315793 –
Brunei	Logistics Eng. & Maint. Serv. Ltd. Unit 112, 1st Fl., P.O.B. 298 Bangunan Gadong Kumbang Pasang Mile 2, Jalan Gadong **Bandar Seri Begawan**	(2) 221176 (2) 221175 –
Bulgaria	ROHDE & SCHWARZ Representation Office 39, Fridtjof Nansen Blvd. **BG-1000 Sofia**	(92) 655133 (92) 656833 –
Canada	ROHDE & SCHWARZ CANADA INC. 555 March Rd. **Kanata, Ontario K2K 2M5**	(613) 5928000 (613) 5928009 –
	TEKTRONIX CANADA INC. 1200 Courtney Park Dr. Mississauga **Toronto, Ontario L5T 1S2**	(905) 670-3423 (905) 670-4229 –
Central America	WANDELA GOTTERMANN WGCC Apartado Postal 2761 **Guatemala City GCA 01901**	(502) 2318065 (502) 2318682 –

R & S International

		Telephone Telefax Telex
China	ROHDE & SCHWARZ Representative Office Beijing Friendship Hotel Building No. 4, Room 40429 3, Bai Shi Qiao Lu **Beijing 100086**	(1) 8498668 (1) 8425507 222676 (rsbp cn)
Chile	DYMEQ Ltda. Av. Larrain 6666 **Santiago**	2775050 2278775 –
Costa Rica		see Central America
Czech Republic	ROHDE & SCHWARZ Praha, s.r.o. Pod kastany 3 **CZ-16000 Praha 6**	(2) 341272/341280 (2) 328841 –
Denmark	ROHDE & SCHWARZ DANMARK A/S Elby Industrivej 40 **DK-2600 Glostrup**	(43) 436699 (43) 437744 –
Ecuador	Digiteg Av. Shyris 2281 y El Telégrafo Casilla 408 A, Suc. No. 3 **Quito**	(2) 430373 (2) 443782 22764 (jjaram ed)
El Salvador		see Central America
Finland	Orbis Oy Vanha Kaarpantie 9 **FIN-01610 Vantaa**	(80) 5664066 (80) 531604 –
France	ROHDE & SCHWARZ FRANCE 25-27, rue J. Bracconnier **F-92366 Meudon La Forêt Cédex**	(1) 41361000 (1) 41361010 –
	Agences régionales	
	Tertia II **F-13851 Aix-en-Provence Cédex 3**	Tél.: 42244337 Fax: 42243770
	Mini parc Gerland, Bâtiment 5 89, bd. du Parc de l'Artillerie **F-69007 Lyon**	Tél.: 78585779 Fax: 78695047
	Technopôle Metz 2000 13, rue Claude Chappe **F-57070 Metz**	Tél.: 87203304 Fax: 87203307
	rue de Bignon – Z.I. Sud-Est Immeuble Sigma 1 **F-35135 Chantepie**	Tél.: 99519700 Fax: 99419131
	Technoparc 3 – voie 5 B.P. 501 **F-31674 Labège Cédex**	Tél.: 61391069 Fax: 61399910

R&S International

		Telephone Telefax Telex
Greece	Mercury Ltd. 6, Louklanou Str. **GR-10675 Athens**	(1) 7210241 (1) 3645885 221695 (spa gr)
Guatemala		see Central America
Honduras		see Central America
Hongkong	Schmidt 2 Co. (HK) Ltd 18/Fl., Great Eagle Centre 23 Harbour Rd., P. O. B. 297 **Wanchai, Hongkong**	(5) 5070222 (5) 8275656 76762 (schmc hx)
Hungary	ROHDE & SCHWARZ Budapesti Iroda Etele út. 68 **H-1115 Budapest XI**	(1) 1850835 (1) 1850835 –
India	ROHDE & SCHWARZ Liaison Office India A-382 Defence Colony **New Delhi 110024**	(11) 4615285/4692238 (11) 4626324, 3162268 (rsbd in)
Indonesia	P. T. Dian Graha Elektrika Muslika Ratu Center, 3rd Floor Jl. Gatot Subroto Kav. 74-75 **Jakarta Selatan**	(21) 8306560 (21) 8307403/04 48661 (dgejkt ia)
Iran	ROHDE & SCHWARZ IRAN Liaison Office Tehran Dr. Beheschty Avenue **Tehran 15317**	(21) 625478/8860282 (21) 8860283 212742 (rusi ir)
Ireland		see United Kingdom
Italy	ROHDE & SCHWARZ ITALIA S.p.A. Via Tiburtina 1182 **I-00156 Roma** Via Roma 108 **I-20060 Cassina de' Pecchi (MI)**	(6) 4110011 (6) 4110414 621545 (rojrom i) (2) 95302828 (2) 95302772 353462 (i tel i)
Japan	ADVANTEST Corp. Shinjuku-NS Building 4-1, Nishi Shinjuku 2-chome, Shinjuku-ku **Tokyo 163**	(3) 33427500 (3) 33420905 2324914 (advan j)
Kenya	GES Engsales (K) Ltd. P.O.B. 46658 **Nairobi**	(2) 441209/448814 (2) 448815
Luxembourg		see Belgium
Malaysia	Dagang Teknik Sdn. Bhd. No. 9, Jalan SS 4D/2 Taman People's Park **47400 Petaling Jaya**	(3) 7035503 (3) 7033439 –
Malta	Technoline Ltd. B'Kara Road **San Gwann**	(356) 374300/374329 (356) 374353 1031 (reho mw)
Mexico	Electroingeniería de Precision Uxmal 520, Col. Ventz Narvarte Apartado 44-088 **03100 Mexico DF**	(5) 5597677 (5) 5753381 1764433 (epsa me)
Nepal	Abishek Trade Links (P) Ltd. P.O.B. 1544 **Kathmandu**	(1) 411246 (1) 414658 2619 (wind np)
Netherlands	ROHDE & SCHWARZ NEDERLAND B.V. Perkinsbaan 1 (NL-3439 ND Nieuwegein) Postbus 1315 **NL-3430 BH Nieuwegein**	(3402) 40900 (3402) 48122 70339 (rsned nl)
New Zealand	Communication Instruments Ltd. 47 Kenepuru Drive P.O.B. 51140 **Tawa, Wellington**	(4) 2379199 (4) 2379195
Nicaragua		see Central America
Norway	ROHDE & SCHWARZ NORGE Østensjøveien 36, Postboks 103 Bryn **N-0611 Oslo**	(22) 658020 (22) 658021 –
Pakistan	Telec, Electronics & Machinery (Pvt.) Ltd. 41[illegible] Chambers Abdullah Haroon Rd. P.O.B. 7430	(21) 5683988 (21) 5680908 20690 (elco pk)
Philippines	Marcom Industrial Equipment, Inc. MCC P.O.B. 1110 Eurovilla I Condominium 142 Legaspi St. Corner Herrera Legaspi Village **Makati, Metro Manila**	(2) 8170507 (2) 8105807 45930 (marco pm)
Poland	ROHDE & SCHWARZ Oddział w Warszawie ul. Sławki 2 **PL-00192 Warszawa**	(2) 6350687/6353615 (2) 6353544 –
Portugal	Mattos Tavares-Electrónica, Lda. Rua Gregório Lopes, Lote 1513-1° **P-1400 Lisboa**	(11) 3016261 (11) 3016260 12220 (matali p)
Romania	ROHDE & SCHWARZ Representation Office Str. Uranus 98, Sc. 2, Et. 5, Ap. 36 **RO-76102 Bucuresti, Sector 5**	(1) 6316878 (1) 3122013 –
Russian Federation	ROHDE & SCHWARZ Moscow Office Ul. Dubininskaja, 98 **RUS-113093 Moscow**	(095) 2221047 (095) 2221047 413330 (siem su)
Saudi Arabia	ROHDE & SCHWARZ International GmbH Liaison Office Riyadh c/o Haji Abdullah Alireza Co. Ltd. P.O.Box 361 **Riyadh 11411**	14656428 Ext. 229 14656428 Ext. 229 –
Singapore	Infotel Technologies Ltd. 19 Tai Seng Drive Kinergy Building # 06-00 **Singapore 1953**	2876822 2876577 38360 (inftel rs)
Slovak Republic		see Czech Republic
Slovenia	ROHDE & SCHWARZ Langusova ul. 8 **SLO-61000 Ljubljana**	(061) 262671 (061) 262882 –
South Africa	S.A. Electro-Medical (Pty) Ltd. 115 Siersteen Road Silvertondale P.O.B. 1784 **Pretoria 0001**	(12) 8041620 (12) 8042009 320756 (saem sa)
Spain	REMA Leo Haag S.A. Avenida de Burgos, 12 **E-28036 Madrid**	(1) 38390 (1) 76627 42838 (rema e)
Sri Lanka	Lanka Avionics Mattumagala 658/1/1, Negombo Road **Ragama**	(1) 530624 (1) 538311 21494 (global ce)
Sweden	ROHDE & SCHWARZ SVERIGE AB Flygfältsgatan 15 **S-12830 Skarpnäck**	(8) 683670 (8) 94197
Switzerland	Roschi Télécommunication AG Papiermühlestrasse 145, Postfach **CH-3063 Ittigen**	(31) 92215 (31) 9218 911759 (ragbe
Taiwan	Function Enterprise Co. Ltd. P.O.B. 36-430 5F, No. 97, Tun-Hwa South Rd., Sec. 2 **Taipei**	(2) 701 (2) 701 25172 (functic
Thailand	UCOM Ltd. 10/26 Phahonyothin Rd., Soi 5, Phayathai **Bankok 10400**	27 2
Turkey	ROHDE & SCHWARZ Istanbul Irtibat Bürosu Bagdad Cad. 191/3, Arda. Apt. **TR-81030 Selamicesme-Istanbul** ROHDE & SCHWARZ Liaison Office Kumkapi Sokak 35/1 **06610 Gaziosmanpasa-Ankara**	(216) (216) (3) (3)
United Kingdom	ROHDE & SCHWARZ UK Ltd. Ancells Business Park **GB-Fleet, Hampshire GU 13 8UZ**	85
U.S.A.	ROHDE & SCHWARZ, INC. 4425 Nicole Drive **Lanham, MD 20706** TEKTRONIX, INC. P.O.B. 500 **Beaverton, OR 97077**	5
Vietnam	Schmidt Vietnam & Co. Ltd. P.O.B. 89 International Post Office **Hanoi**	
For areas not listed		ROHDE & SCHWARZ GmbH & Postfach 80 14 69

Option CMD-B19 (Data differing from CMD57)

RF Generator 1

Frequency range..... PCS1900 band 1850,2 ...1909,8 MHz

Output level (RF IN/OUT) ..... -37 to -120 dBm
Output level (RF OUT 2)..... -37 to -120 dBm

Peak power meter (RF IN/OUT)

Frequency range..... 1930...1990 MHz

Phase and frequency error measurement

Frequency range..... 1930,2...1989,8 MHz

Level range

RF IN/OUT socket ..... 0 to +33 dBm
RF IN 2 socket..... -54 to 0 dBm

Burst power measurement

Frequency range..... 1930,2...1989,8 MHz

Reference level range for full dynamic range

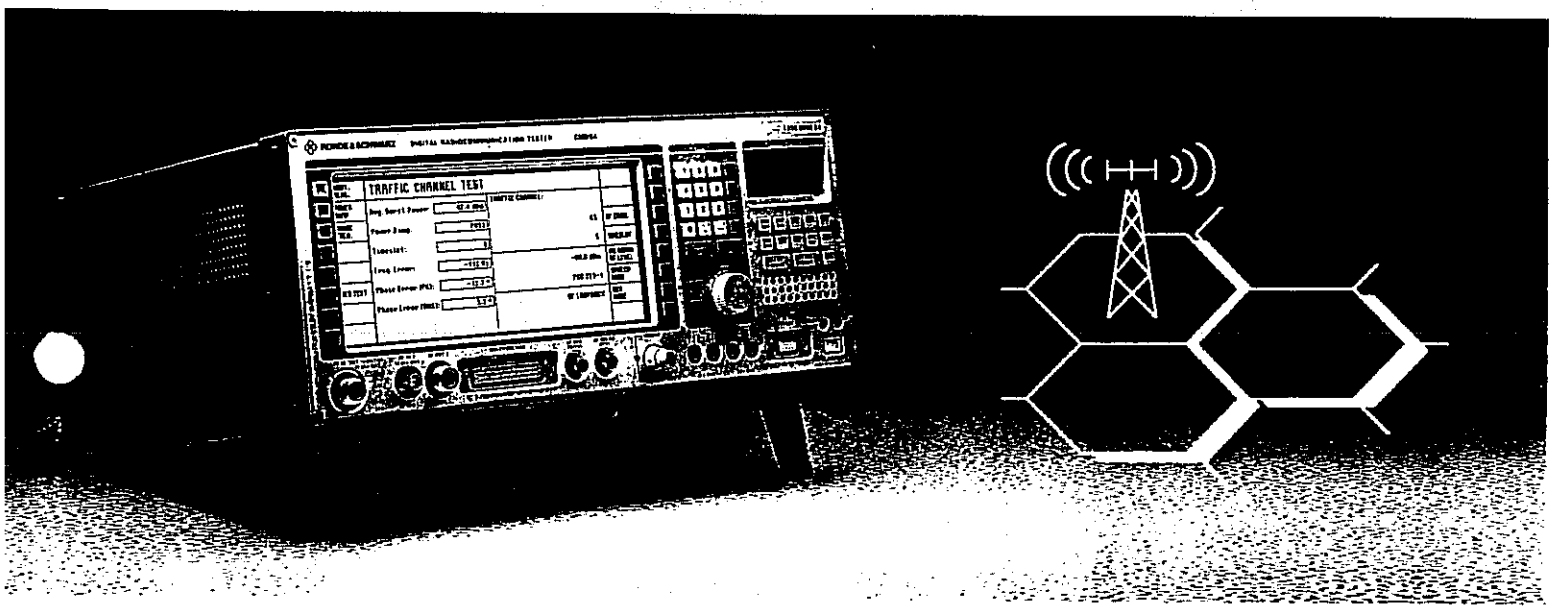
RF IN/OUT socket ..... 0 to +33 dBm
RF IN 2 socket ..... -31 to 0 dBm

Burst analysis with high dynamic

Dynamic range ..... > 72 dB

Measuring limit RF IN/OUT socket..... < -42 dBm

Measuring limit RF IN 2 socket..... < -79 dBm



Digital Radiocommunication Testers CMD 54/57

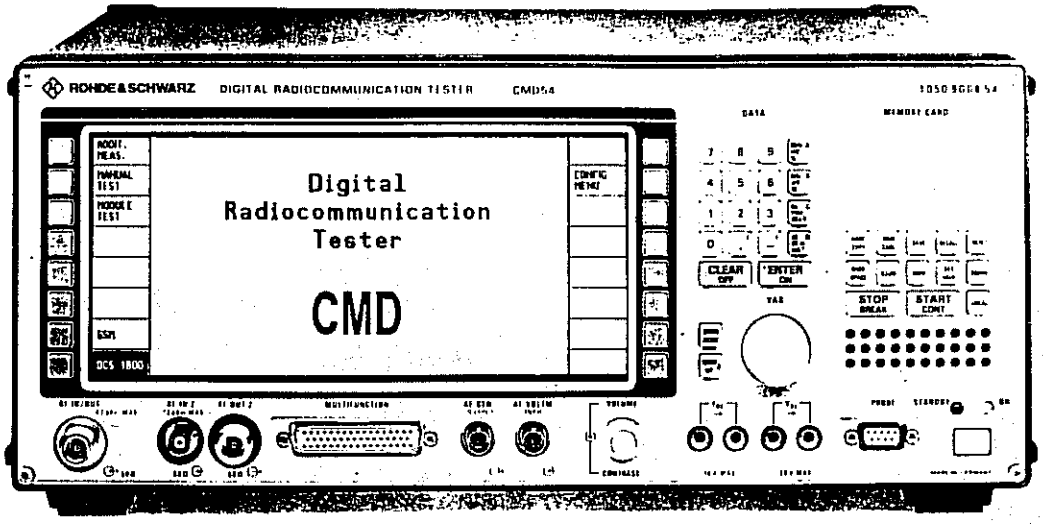
For production, installation and service of GSM and PCN base stations

Rohde & Schwarz, sole manufacturer of the GSM and PCN (DCS 1800) system simulator, has an extensive knowhow in the field of digital communications. This knowhow was fully utilized to the advantage of the customer in the design concept of the CMD 54 and CMD 57:

The Digital Radiocommunication Testers CMD 54/57 are two modern top-class instruments for use in the production, installation and service of GSM and PCN (DCS 1800) base stations (BTS). They combine a compact size with high measurement accuracy and speed and are suitable both for stationary and mobile use.

- Two models:
  - CMD 54 for GSM BTS testing
  - CMD 57 for GSM and PCN (DCS 1800) BTS testing
- All transmitter and receiver measurements without additional instruments
- Convenient, menu-guided user interface
- Excellent price/performance ratio

ROHDE & SCHWARZ



- Measurement of power ramping with full dynamic range (>72 dB), phase and frequency error measurement
- Echo test
- Bit error rate (BER) measurement via A_{bis}/IEEE-bus/RS-232-C interface, BTS loopback or CMD loopback
- Versatile BTS synchronization modes with respect to signalling and reference frequencies
- Measurement of spectrum due to modulation/switching
- Module testing (measurements even without complete signalling or synchronization)
- Conventional RF generator functions for alignment
- DC current and voltage measurements on pulsed signals
- AF measurement facilities and 60-MHz frequency counter (optional)
- Remote control via RS-232-C and IEC/IEEE-bus interface

Applications in production, installation and service

The Digital Radiocommunication Testers CMD 54/57 cover a wide range of applications. Their measurement capabilities satisfy all requirements of the various base station manufacturers and operators.

BTS module production

In BTS module production, these modules often have to be tested without signalling and via different production-specific interfaces. The CMD provides extremely versatile module test facilities.

For transmitter tests, fast measurement functions are available for power ramping, phase/frequency error and the GSM-specific spectrum measurement.

Modulated or unmodulated RF carriers (with or without power ramping) as well as various ways of measuring the bit error rate (BER) enable reliable testing of receiver modules.

The many synchronization and trigger facilities (various bit and frame clocks, C0 carrier and other reference frequencies) ensure easy integration of the CMD into any production line.

Expensive additional instruments such as ammeters/voltmeters, RF and AF signal generators, frequency counters, etc are not required when using the CMD, since a wide variety of conventional measurement facilities is already integrated.

Installation and service

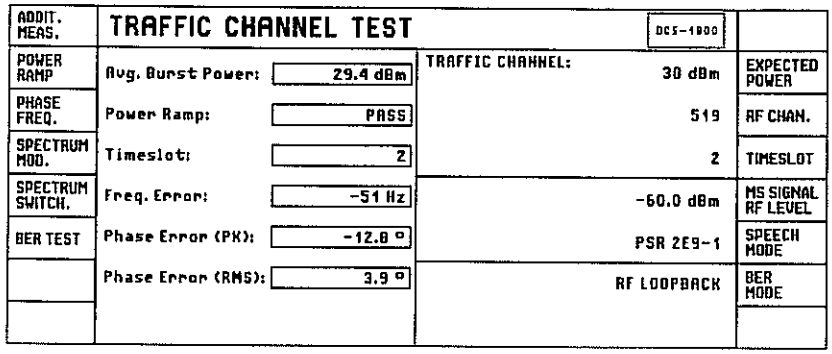
For BTS final testing, installation and service, measurements have to be performed on base stations which send RF carriers with signalling information (eg C0 carrier and TCH). The CMD is an efficient tool which fully satisfies these measurement requirements.

Additional attenuators, cables and amplifiers are often required for terminating the BTS. These are automatically taken into account by the CMD in calculating the measurement results.

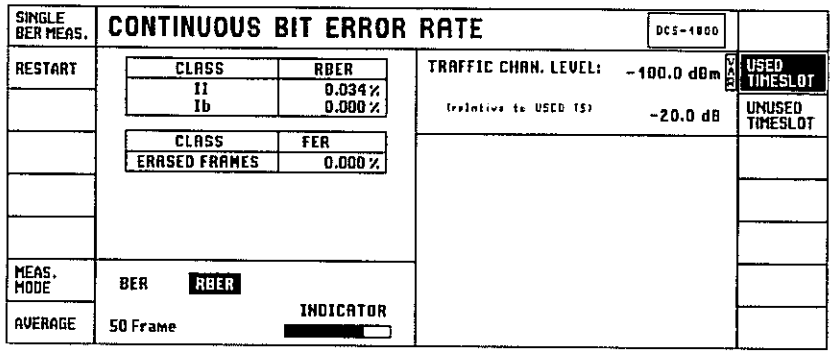
With synchronization to the C0 carrier, the transmitted power as well as the phase and frequency error are shown on the LCD display in addition to the signalling information. This allows a rapid conclusion to be made on the function-

ing of the BTS. Measurement results on the traffic channel (TCH) are obtained simply by switching to the corresponding menu: depending on the selected function, the power ramp, phase and frequency error or the spectrum measurement will be graphically displayed.

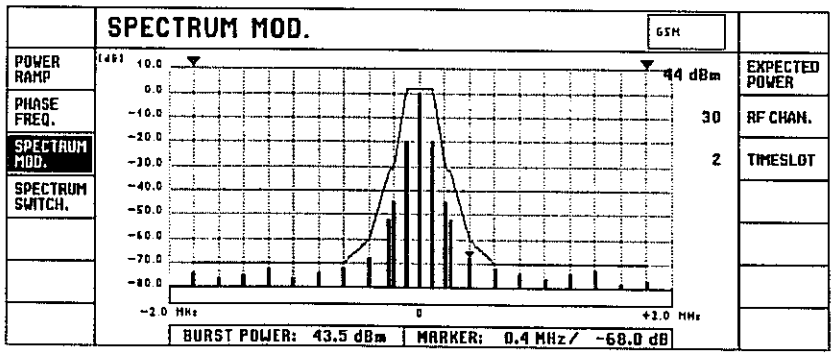
Thanks to digital signal processing (DSP), the spectrum due to modulation or switching can be measured in line with the GSM specifications within an extremely short time and displayed. The CMD evaluates for instance 500 bursts on the selected RF channel and each of its 22 offset frequencies within 100 s.



After synchronization to the base station and setting up of a traffic channel, all relevant RF parameters are immediately measured and displayed; this menu also allows a quick change of the channel, power and time slot as well as setting of the CMD transmission parameters



The sensitivity of a transceiver module of the base station is verified by means of a bit error rate (BER) test in the RF loopback mode



The spectrum due to modulation and switching can be measured in line with GSM specifications within a minimum of time and graphically displayed; the built-in marker function allows the digital value of each individual spectral line to be called up

The BER measurement is an essential criterion for evaluating a digital communication link. The CMD provides various possibilities of measuring the bit error rate, either by an internal mode or via the base station. With the option CMD-B7, the CMD is able to monitor the bit stream received by the BTS at the A_{bis} interface and to calculate the bit error rate; the result is indicated on the LCD display.

User-friendly and reliable

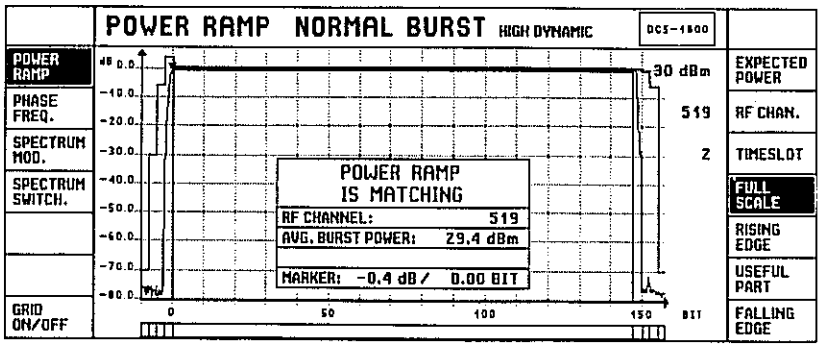
The CMD is extremely easy to operate and requires no detailed GSM/PCN knowledge. The high-contrast, backlit LCD display with softkeys on both sides allows menu-guided convenient callup of test routines.

Various GSM-specific parameters are preset and permit direct testing without any operator control. In addition, all parameters can be individually modified in the configuration menus.

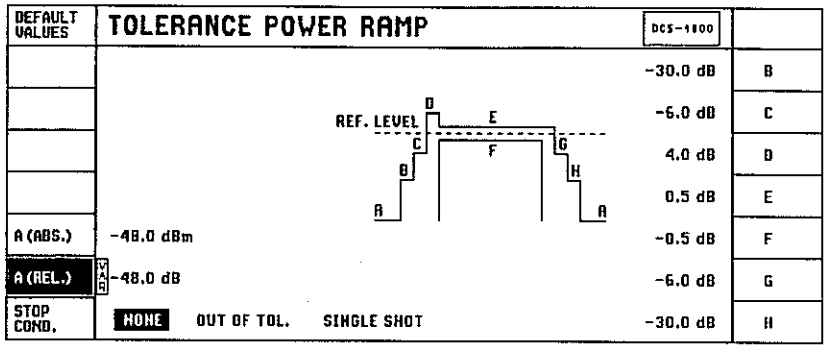
Further advantages are:

- High measurement speed
- Protection against incorrect settings
- Extremely easy program generation for computer-controlled operation
- Software update via RS-232-C interface

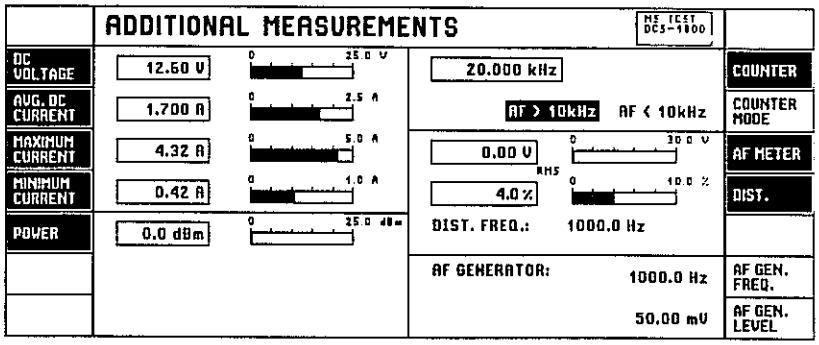
LSI technology, selftesting and automatic alignment contribute to the high reliability of the testers. The sturdy design makes them suitable for the rough handling of everyday use.



The CMD 54 allows the power ramp to be measured with high dynamic range; with graphic display, the zoom function enables application-oriented resolution of any part of a displayed curve



User-defined tolerances, in the example shown for measurement of the power ramp, can easily be entered via configuration menus



The CMD voltmeter/ammeter is designed for pulsed signals with GSM-specific time constant and allows measurement of the mobile's power consumption; AF voltmeter, AF generator and frequency counter enable measurements to be performed on the audio interface

Options

A variety of options provides additional measurement capabilities:

OCXO Reference Oscillator CMD-B1

Ensures high absolute accuracy, minimum temperature-dependent drifts and especially high long-term stability.

Reference Frequency Inputs/Outputs CMD-B3

For synchronization to an internal or external frequency of 2.048, 10, 13, 26 or 52 MHz or to the GSM bit clock.

AF Measurement Unit with Frequency Counter CMD-B41

This option comprises an AF generator, a voltmeter, a distortion meter and a frequency counter for measurement on the audio interface or on modules. CMD-B41 allows measurements up to 60 MHz as are required for LO alignment.

Adapter for CMD-B6.. Options CMD-B6

CMD-B6 is a prerequisite for operating the following two options:

IEC/IEEE Bus Interface CMD-B61

The CMD-B61 is a remote control alternative to the RS-232-C interface fitted as standard.

Memory Card Interface CMD-B62

Memory cards are a versatile medium for storing test results and instrument settings.

A_{bis} Interface CMD-B7

For BER measurements at the A_{bis} interface.

Certified Quality System
ISO 9001

Specifications

Common data for CMD 54 and 57

Timebase TCXO	standard
Nominal frequency	10 MHz
Frequency drift in temperature range 0 to 35 °C	≤1.5 x 10^{-6}
Aging	≤0.5 x 10^{-6}/year (at 35 °C)
Timebase OCXO	option CMD-B1
Nominal frequency	10 MHz
Frequency drift in temperature range 0 to 50 °C	≤1 x 10^{-7}
Aging	≤2 x 10^{-7}/year ≤5 x 10^{-9}/day after 30 days of operation
Warmup time (at 25 °C)	approx. 5 min
DC voltmeter	
Measurement range	0 to ±30 V
Resolution	10 mV
Error	≤2% + resolution
DC ammeter	
Operating modes	current averaging with GSM-adapted time constant, current peak measurement (maximum and minimum)
Measurement range	0 to ±10 A
Common-mode rejection	±30 V
Resistance	50 mΩ
Resolution for current averaging	1 mA/10 mA
Resolution for peak measurement	10 mA
Residual indication (no current at input)	≤10 mA (at room temperature)
Error	≤2% + residual indication + resolution
AF Measurement Unit	option CMD-B41
AF generator	
Frequency range	50 Hz to 10 kHz
Frequency resolution	0.1 Hz
Frequency error	same as timebase + half resolution
Level range	10 µV to 5 V
Level resolution	10 µV at a voltage <1 mV ≤1% at a voltage ≥1 mV
Level error	≤5% at a voltage ≥1 mV
Distortion	≤0.5%
Max. output current	20 mA
Output impedance	<5 Ω
AF voltmeter	
Frequency range	50 Hz to 10 kHz
Measurement range	0.1 mV to 30 V
Resolution	100 µV at a voltage <10 mV 1% at a voltage ≥10 mV
Error	≤5% + resolution
Input impedance	1 MΩ
Distortion meter	
Frequency range	300 Hz to 3 kHz
Input level range	100 mV to 30 V
Resolution	0.1% of THD
Inherent distortion	≤0.5%
Error	≤5% + inherent distortion
Measurement bandwidth	10 kHz
AF counter	
Frequency range	20 Hz to 10 kHz
Input level range	10 mV to 30 V
Resolution	≤1 Hz
Error	same as reference + resolution
Input impedance	1 MΩ
IF counter	
Frequency range	10 kHz to 60 MHz
Input level range	100 mV_{rms} to TTL
Resolution	1 Hz
Error	same as reference + resolution
Input impedance	approx. 1 MΩ ll 100 pF
Interfaces	RS-232-C (9-contact), Centronics (25-contact)

Specific data of CMD 54

RF generator 1	
Frequency range	GSM band 890.2 to 914.8 MHz
Frequency accuracy	same as timebase
Resolution	GSM channel spacing 200 kHz
Settling time	<3 ms for phase error <2
Output level	
(RF IN/OUT)/(OUTPUT 2)	-33 to -120 dBm
Resolution	0.1 dB
Level error	
(RF IN/OUT)/(OUTPUT 2), burst with max. level	≤1.5 dB (≤1 dB at -104 dBm)
Harmonics (RF IN/OUT)	<-30 dBc
Modulation	GMSK, B x T = 0.3
Phase error	≤4° rms, ≤10° peak
Peak power meter (RF IN/OUT)	
Frequency range	800 to 1000 MHz
Measurement range	10 to 47 dBm
Resolution	0.1 dB
Error in GSM band 935.2 to 959.8 MHz	≤0.5 dB + resolution (P >13 dBm)
VSWR	≤1.3
GSM phase and frequency error measurement	
Frequency range	GSM band 935.2 to 959.8 MHz
Level range	
RF IN/OUT	10 to 47 dBm
RF IN 2	-60 to 0 dBm
Inherent phase error	<1.5° rms, <5° peak
Frequency measurement error	<5 Hz + timebase error
GSM burst power measurement	
Frequency range	GSM band 935.2 to 959.8 MHz
Reference level for full dynamic range	
RF IN/OUT	10 to 47 dBm
RF IN 2	-37 to 0 dBm
Absolute measurement error of peak power	
RF IN/OUT, unsynchronized	same as peak power meter
RF IN/OUT, synchronized to C0 carrier	≤1 dB
RF IN 2	≤1 dB
Inherent ripple in active part of time slot	≤0.1 dB
High-dynamic burst analysis	
Relative error of individual test samples	≤1.5 dB to 72 dB below peak power
Dynamic range	>72 dB
Measurement limit RF IN/OUT	<-36 dBm
Measurement limit RF IN 2	<-83 dBm
Spectrum measurement	
Dynamic range	80 dB
Uncertainty	<±1.5 dB

Specific data of CMD 57

RF generator 1	
Frequency range	GSM band 890.2 to 914.8 MHz, DCS 1800 band 1710.2 to 1784.8 MHz
Frequency accuracy	same as timebase
Resolution	GSM channel spacing 200 kHz
Settling time	<3 ms for phase error <2
Output level	
(RF IN/OUT)/(OUTPUT 2)	-35 to -120 dBm
Resolution	0.1 dB
Level error	
(RF IN/OUT)/(OUTPUT2)	≤1.5 dB (≤1 dB at -104 dBm)
Harmonics (RF IN/OUT)	<-30 dBc
Modulation	GMSK, B x T = 0.3
Phase error	<4° rms, <10° peak
Peak power meter (RF IN/OUT)	
Frequency range	800 to 1000/1700 to 1900 MHz
Measurement range	
GSM band	0 to 47 dBm
DCS 1800 band	0 to 33 dBm

Resolution	0.1 dB
Error in GSM band 935.2 to 959.8 MHz	≤0.5 dB + resolution (P >10 dBm)
Error in DCS 1800 band 1805.2 to 1879.8 MHz	≤0.8 dB + resolution (P >4 dBm)
VSWR	≤1.3

Phase and frequency error measurement

Frequency range	GSM band 935.2 to 959.8 MHz; DCS 1800 band 1805.2 to 1879.8 MHz
Level range	
RF IN/OUT	GSM band: 0 to 47 dBm DCS 1800 band: 0 to 33 dBm
RF IN 2	–60 to 0 dBm
Inherent phase error	≤1.5° rms, ≤5° peak
Frequency measurement error	≤5 Hz + timebase error

Burst power measurement

Frequency range	GSM band 935.2 to 959.8 MHz DCS 1800 band 1805.2 to 1879.8 MHz
Reference level for full dynamic range	
RF IN/OUT	GSM band: 10 to 47 dBm DCS 1800 band: 0 to 33 dBm
RF IN 2	–37 to 0 dBm
Absolute measurement error of peak power	
RF IN/OUT, unsynchronized	same as peak power meter
RF IN/OUT, synchronized to C0 carrier	GSM band: ≤1.3 dB DCS 1800 band: ≤1.5 dB
RF IN 2	GSM band: ≤1.3 dB DCS 1800 band: ≤1.5 dB
Inherent ripple in active part of time slot	≤0.1 dB

High-dynamic burst analysis

Relative error of individual test samples	≤1.5 dB to 72 dB below peak power
Dynamic range	>72 dB
Measurement limit RF IN/OUT	GSM band:<–36 dBm DCS 1800 band: <–48 dBm
Measurement limit RF IN 2	GSM band: <–83 dBm DCS 1800 band: <–85 dBm

Spectrum measurement

Dynamic range	80 dB
Uncertainty	<±1.5 dB

General data

Rated temperature range	0 to +45 °C to DIN IEC 68-2-1/2
Storage temperature range	-40 to +60 °C
Electromagnetic compatibility	complies with requirements of European EMC directive (89/336/EEC)
Mechanical resistance	
Sine vibration	DIN IEC 68-2-6, 5 to 55 Hz, amplitude 0.15 mm, two cycles
Random vibration	DIN 40046, part 24, 10 to 300 Hz, 10 m/s² rms, 5 min/axis
Shock	to MIL-STD-810D, 400 m/s², shock spectrum in 6 main axes
Power supply	100 to 120 V (AC) ±10% 200 to 240 V (AC) ±10%, 50 to 400 Hz ±5%
Power consumption (without options)	approx. 85 W
Electrical safety	VDE 0411, class 1
Dimensions (W x H x D)	435 mm x 192 mm x 363 mm
Weight (without options)	approx. 14.0 kg

Options

IEC/IEEE-bus Interface	option CMD-B61 interface to IEC 625-1/IEEE 488, SCPI-compatible command set
Memory Card Interface	option CMD-B62
Reference Frequency Inputs/Outputs	option CMD-B3
Synchronization input:	
Frequency (selectable)	GSM bit clock (270.8 kHz), 2/4/16 times GSM bit clock, 1 to 13 MHz in 1-MHz steps, 2.048, 26, 39, 52 MHz
Impedance	approx. 100 Ω
Level	0 dBm to TTL
Synchronization output 1:	
Frequency	10 MHz with internal reference or frequency at synchronization input with external reference
Level	TTL, R_{out} = 50 Ω
Synchronization output 2	
Frequency (selectable)	GSM bit clock, 2/4/16 times GSM bit clock, 1, 2, 4 or 13 MHz
Level	TTL, R_{out} = 50 Ω
A_{bis} Interface	option CMD-B7
Receive channel (traffic/speech)	75 Ω/high-impedance, unbalanced; 120 Ω/high-impedance, balanced; 16 kbit/s, time slot selectable
OCXO Reference Oscillator	option CMD-B1 (see timebase)
AF Measurement Unit Level, frequency and distortion measurement in the range from 50 Hz to 10 kHz; frequency counter up to 60 MHz	option CMD-B41
Adapter for the options CMD-B61 and CMD-B62	option CMD-B6

Ordering information

Order designations		
Digital Radiocommunication Tester for GSM	CMD 54	1050.9008.54
Digital Radiocommunication Tester for DCS 1800 and GSM	CMD 57	1050.9008.57
Accessories supplied	power cord, operating manual, spare fuses	
Options (for both models)		
OCXO Reference Oscillator	CMD-B1	1051.6002.02
Reference Frequency Inputs/Outputs	CMD-B3	1051.6202.02
AF Measurement Unit with Frequency Counter	CMD-B41	1051.6902.02
Adapter for CMD-B6.. options	CMD-B6	1051.7409.02
IEC/IEEE-bus Interface (CMD-B6 also required)	CMD-B61	1051.7609.02
Memory Card Interface (CMD-B6 also required)	CMD-B62	1051.8205.02
A_{bis} Interface	CMD-B7	1051.8357.02

Printed in Germany 694 (Pe we)
57.1231.21 · Printed on chlorine-free paper · Subject to change · Data without tolerances: order of magnitude only

ROHDE & SCHWARZ
ROHDE & SCHWARZ GmbH & Co. KG · Mühldorfstraße 15 · D-81671 München
P.O.B. 801469 · D-81614 München · Telephone +4989 4129-0 · Fax +4989 4129-3115

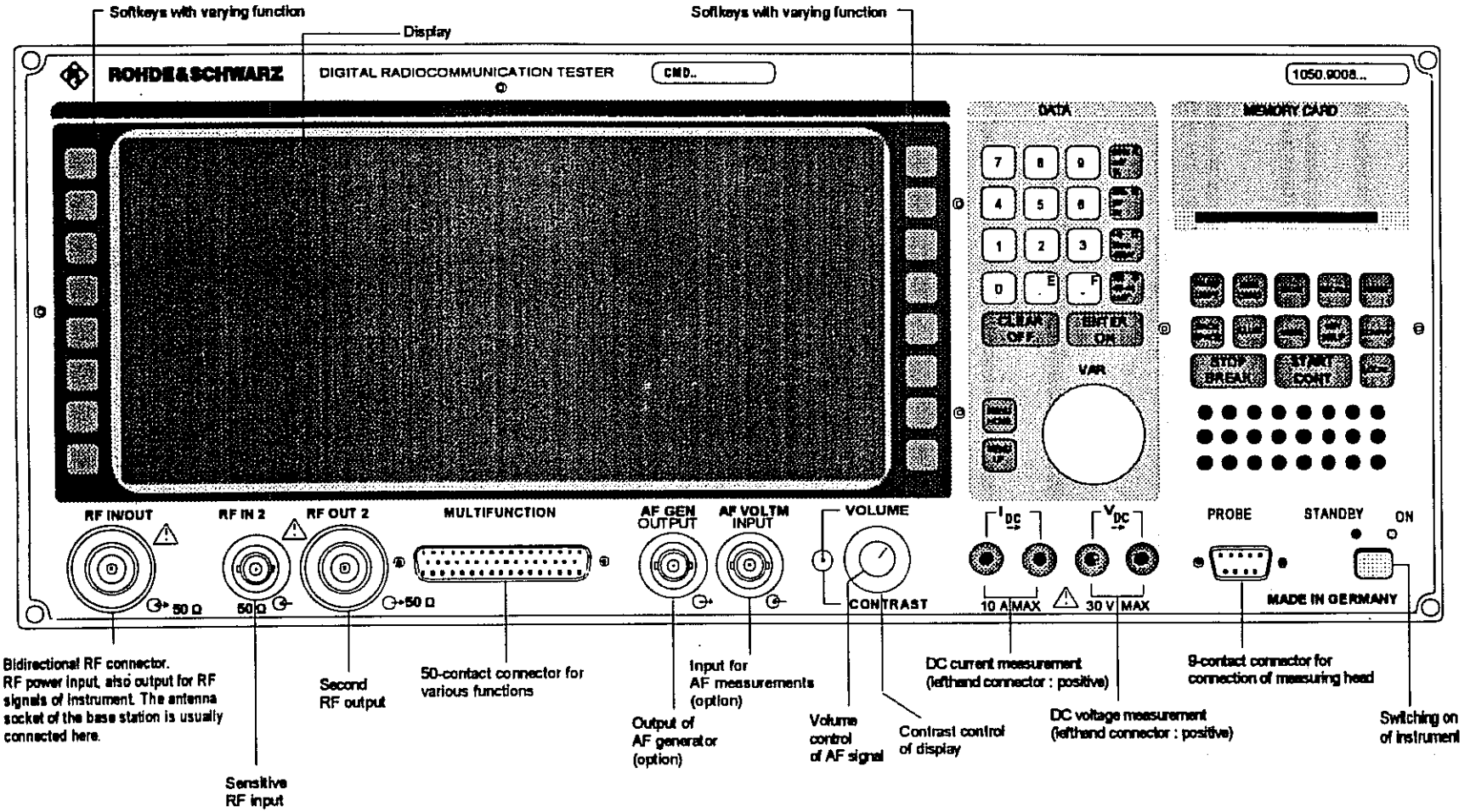
Page

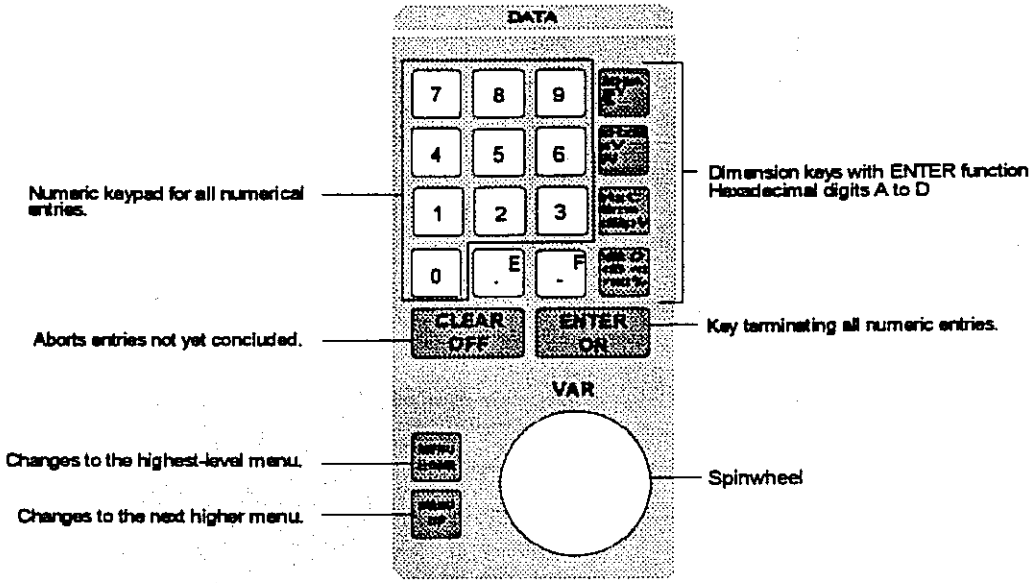
1 Preparation for Use

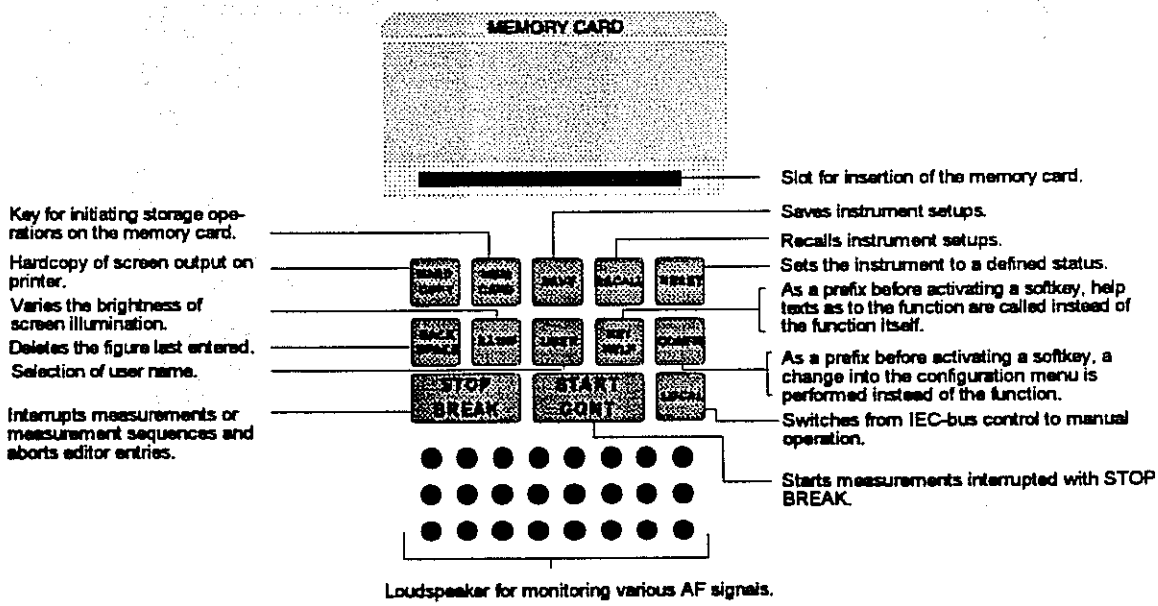
- Take the instrument out of the shipping box and check whether the items listed are all included.
- Carefully check the instrument for mechanical damage. Should the instrument be damaged, immediately notify the forwarder who shipped the instrument to you. Therefore make sure to keep the box and packing material.
- For further transport or shipment of the instrument, the original packing should also be used. It is urgently recommended to use the protective caps included in the shipping box for protection of the front and rear panel. This serves to prevent damage e.g. to the controls on the front panel.

1.1 Explanation of Front and Rear Views

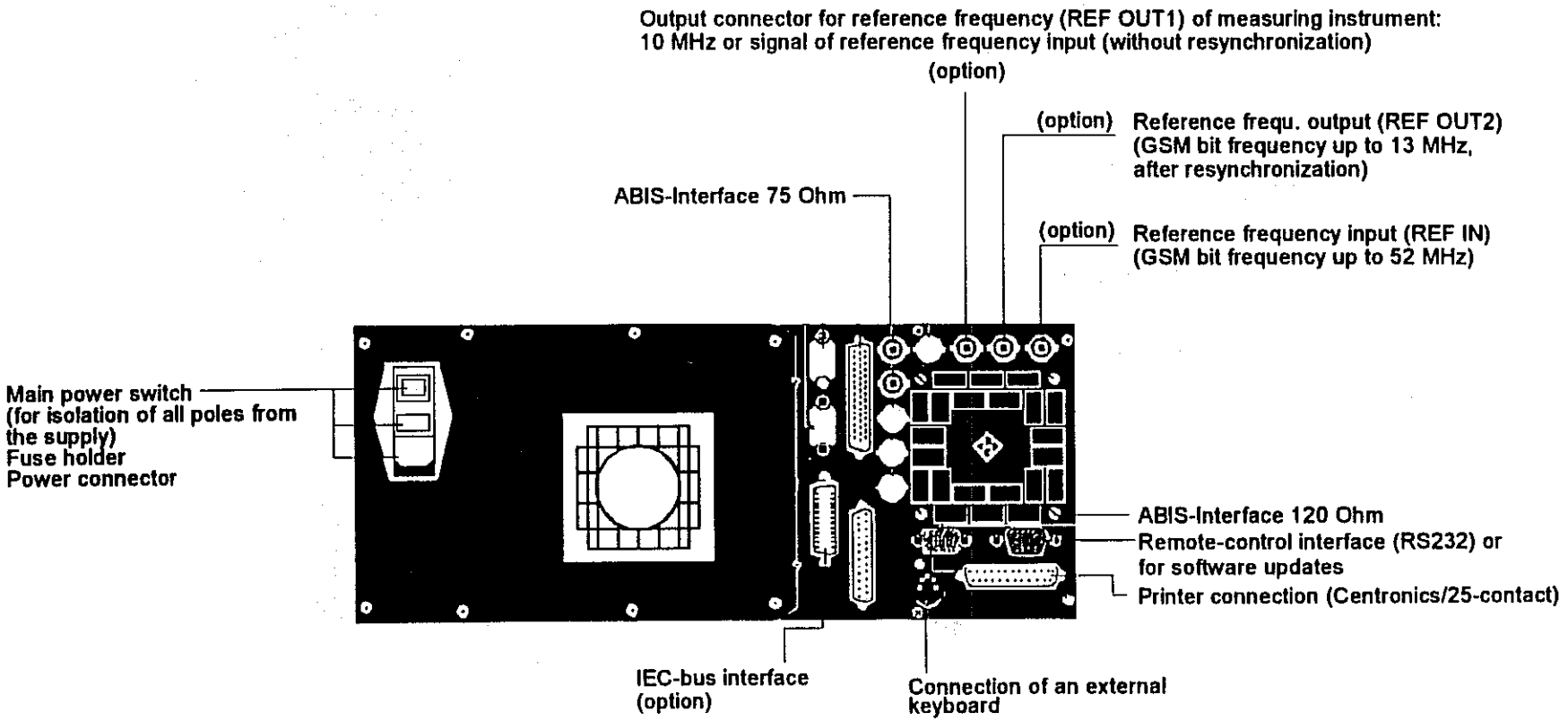
The next pages show the front and rear views of the instrument, each with brief explanations of the controls and connectors.

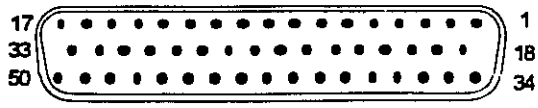






A few controls do not yet feature the described function!





Pin assignment front-panel top view

1)
Important notes!
These external I/Q modulation signals are added to the internal signals. The transmitter level is not affected.

Normal application:
Internal modulation, pin 16 and pin 32 not connected (open).

Special application:
External modulation at pin 16 and pin 32:

DC offset: -2.5 V
Level: +2.5 Vp to -2.5 Vp

Internal modulation must be switched off (e.g. RF GENERATOR menu).

Pin	Signal designation	Function
1 18 34	HANDSET OUT Ground HANDSET IN	Handset connection (Functions only with particular configurations)
2 3 19 35 36	Ground DPG HFF DPG EXTRST DPG EXTD DPG EXTW	Data pattern generator (Functions only with particular configurations)
4 5 6 7 20 21 22 23 37 38 39	SER DSR SER TXDATA SER RXDATA SER RTS Ground SER RLSD SER TXCLK SER RXCLK SER DTR SER RI SER CTS	Ser. data interface (I/O) (Functions only with particular configurations)
8 24 40 41	BICLK BIDATA Ground BIFRAME	Bit interface (Functions only with particular configurations)
9 10 11 25 26 27 42 43	FRAME 51 MULTIFRAME Ground BITCLK 26 MULTIFRAME USERTRIGGER SLOTOUT SUPERFRAME	GSM-specific clock outputs (USERTRIGGER is input) Time reference is the CMD transmitter (only with Option CMD-B6)
12 13 14 28 29 30 31 44 45 46 47	SER DUTRLSD SER DUTTXCLK SER DUTRXCLK SER DUTDTR SER DUTRI SER DUTCTS Ground SER DUTDSR SER DUTTXDATA SER DUTRXDATA SER DUTRTS	Serial data interface (I/O). (Functions only with particular configurations)
15 48	not assigned not assigned	
16 32 49	PRI EXTQ PRI EXTI Ground	1) I/Q modulation inputs (Synthesizer 1)
17 33 50	AQ EXT AI EXT Ground	I/Q demodulator outputs (level is set to max. ± 2.5 Vp via software, AC coupling)

1.2 Putting into Operation

1.2.1 Setting up the Instrument

For bench measurements, it is recommended to fold out the feet at the bottom of the instrument.

For convenient operation of the instrument note the following:

- Do not cover the ventilation openings!
- Ambient temperature 0 to 45 °C.
- Avoid moisture condensation. If it however occurs, the instrument must be wiped dry before switching on.
- Note the warm-up time of the temperature-controlled OCXO reference oscillator (option).

1.2.2 Mounting in a 19" Rack

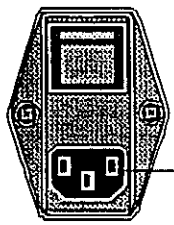
Using the rack adapter ZZA-94 (order number 396.4905.00) the instrument can be mounted in 19" racks according to the mounting instructions supplied.

As the power switch is situated at the rear of the instrument, an all-pole mains disconnection must be near at hand for safety reasons when the instrument is mounted in a rack!

1.2.3 Connecting the Instrument to the AC Supply

The CMD is equipped with an AC voltage detection, i.e. it is automatically set to the respective AC supply voltage. (Range: AC voltage 90 to 132 V and 180 to 265 V; 47 to 440 Hz).

➢ Plug the supplied power cable into the rear power connector and connect the CMD to the current supply.



1.2.4 How to ensure EMC

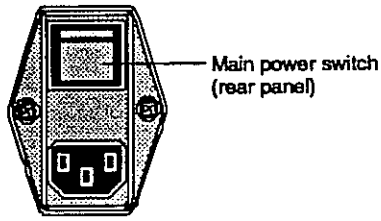
In order to avoid electromagnetic interference, the instrument may only be operated in the closed state and with all shielding covers. Only appropriate shielded signal and control cables may be used.

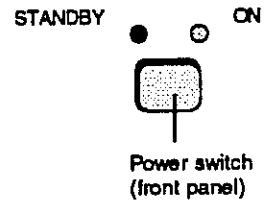
1.2.5 Switching on the Instrument

As soon as the main power switch at the rear of the instrument is in the OFF position, the complete instrument is disconnected from the power supply. If it is set to the ON position, the instrument is in standby mode or in operation, depending on the position of the power switch at the front of the instrument.

Standby position:
Only the reference frequency oscillator is supplied with operating voltage and the yellow LED (STANDBY) is illuminated.

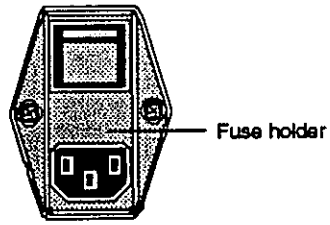
ON position:
The green LED (ON) is illuminated, all modules of the instrument are supplied with operating voltage.





1.2.6 Power Fuses

The CMD is equipped with two fuses complying with the label of the power supply. The fuses are located in the extendable fuse holder,which is inserted between power connector and main power switch.



Page

Page

Reference Description

2 Manual Operation

Despite its many facilities, the Digital Radiocommunication Tester CMD permits easy and convenient operation, which is also supported by the use of menus.

The clear front-panel layout permits fast access to the controls and connectors.

If you are not yet familiar with the CMD and want to get a fast overview of its capabilities, you should first read section 2.1, where you will be guided step by step through a GSM base station test.

Section 2.4 describes the complete functions of manual operation. Starting from the selection menu, all menus are explained completely one after the other.

2.1 Getting Started

Section 2.1 has been designed mainly for the newcomer to the CMD. You will be guided step by step through the most common tests which are performed on GSM base stations or base station modules.

It includes connection to the CMD, the steps "synchronization" and "Control Channel Test" as well as the tests performed on the TCH channel.

Each individual step is provided with reference numbers, e.g. ①, relating to more detailed information on the opposite page.

The layout and contents of this section are application-oriented and contain, in addition to information specific to the CMD, information relating to the GSM system.

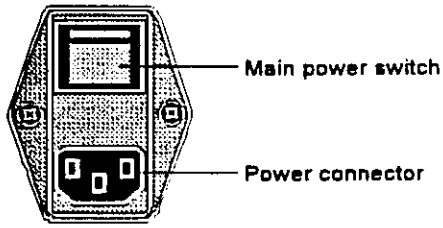
To get familiarized with the CMD and its numerous features we suggest to read through this section whilst at the same time operating the CMD.

The user will thus quickly and easily get to know the extremely user-friendly concept of the CMD and will therefore very soon achieve correct and usable measurement results.

For further information on the individual menu illustrations and keys kindly refer to the reference part starting with section 2.2.

2.1.1 Connection of the CMD and Selection of Operating Modes

Switching on

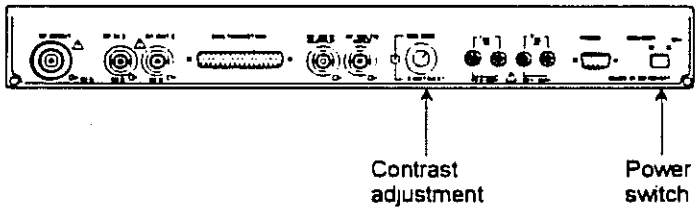


Step 1

Plug the power cable into the power connector at the rear of the instrument and connect the CMD to the current supply. ①

Switch the CMD to standby mode using the main power switch at the rear. ②

Contrast, operating modes



Step 2

Switch on the CMD by means of the power switch on the front panel. ①

Adjust the display contrast as desired. ②

The CMD now shows the display shown opposite and is ready to test your test item.

Note that the "NETWORK" softkey at the bottom left of the menu display appears only with model CMD57.

Press the softkey to select the desired operating mode. ③

Additional Information

Step 1

① **Power supply**
The CMD automatically detects the available line voltage and adapts itself to this voltage. (Range: AC voltage 90 to 132 V and 180 to 265 V; 47 to 440 Hz).

② **Main power switch at the rear**
When the power switch at the rear is set to the OFF position, the complete instrument is disconnected from the power supply. When the main power switch is set to the ON position, the instrument is in standby mode or in operation, depending on the position of the power switch on the front panel.

Step 2

① **Power switch at the front**
The power switch at the front of the instrument determines whether the instrument is in standby mode or in operation.

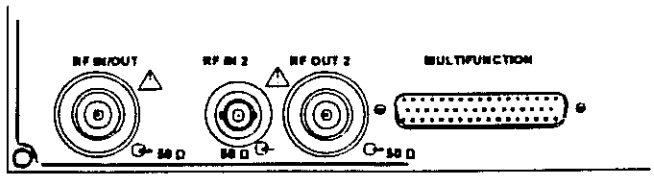
STANDBY position:
Only the reference frequency oscillator is supplied with operating voltage, and the yellow LED (STANDBY) is illuminated.

ON position:
The green LED (ON) is illuminated and all modules of the instrument are supplied with operating voltage.

② **Contrast**
The display contrast can be adjusted using the rotary knob CONTRAST on the front panel. The contrast adjustment depends on the viewing angle of the user relative to the unit and can be readjusted if the viewing angle changes.

③ **Operating mode**
The CMD57 can perform measurements both on GSM and PCN (DCS1800) base stations. If the Option CMD-B19 is installed, measurements on PCS1900 base stations are also possible. The operating mode set is marked by black display. To change the operating mode press the "NETWORK" softkey, select the desired network using the rotary knob and confirm the choice by means of the "ENTER" hardkey.

RF connectors, configuration menus



Step 3

Select the correct RF connectors for your tests.
The RF connectors RF IN/OUT, RF IN 2 and RF OUT 2 are available.①②

CONFIG MENU

Select the softkey "CONFIG MENU" in the selection menu on the right side in order to change to the configuration menus.③

ADDIT. MEAS.	CONFIGURATION MENU	
TOL.MASK	10	IEEE ADDRESS
BER TEST		
		PRINTER
CONNECT/ EXT. ATT.		BER INTERFACE
SYNC.		OTHER
RF GEN.		OPTIONS

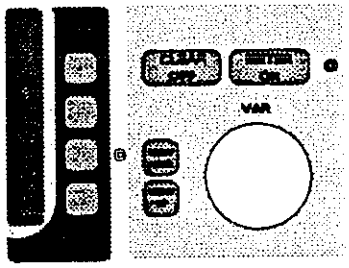
Select the softkey

CONNECT/ EXT. ATT.

in order to select the desired connection in the called menu.

	RF CONNECTOR / EXT. ATTENUATION		
RF IN/OUT	RF CONNECTOR IN USE:	EXT. ATTENUATION: 20.0 dB	EXT. ATT. RF IN/OUT
RF IN 1/ RF OUT 2		10.0 dB	EXT. ATT. RF IN 2
RF IN 2/ RF OUT 1		0.0 dB	EXT. ATT. RF OUT 2
RF IN 2/ RF OUT 2			

Select one out of four different connections. Enter external attenuations on the right.④



After the setting has been completed, select MENU HOME to the left of the rotary knob in order to return to the main selection menu.⑤

Additional Information

Step 3

① **RF connection of the test item**
High-grade cables with an attenuation ideally below 0.5 dB should be used for RF connection. The connectors RF IN/OUT and RF OUT 2 require cables with N-type connectors, which are used for connection to the in most cases separate RF inputs and outputs of the BTS.

② **Input and Output Level**
Pulsed signals with a total power of max. 47 dBm (CMD57, DCS1800: 33 dBm) can be applied to the input RF IN/OUT. The minimum input level is 10 dBm (0 dBm for CMD57).

The level range for the second (sensitive) input is -60 dBm to 0 dBm.

③ **Configuration Menus**
The settings which need be changed only rarely during the measurements are stored in these menus. In addition to the input and output connections, they also comprise the tailor-made tolerances and the preset parameters for certain measurements.

All possible configurations can be selected and set from the main selection menu via the configuration tree.
During the measurements, however, only certain useful configuration menus can be selected using the "CONFIG" hardkey on the right side of the instrument.

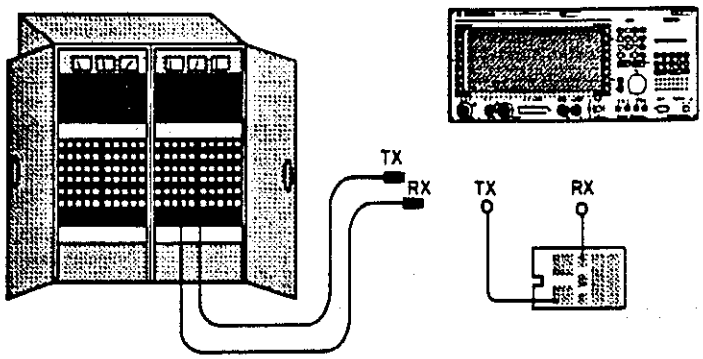
④ **Configuration Menu RF Connectors**
The softkey mentioned above is used to change to the configuration menu for the individual RF connectors and the settings of external attenuations.

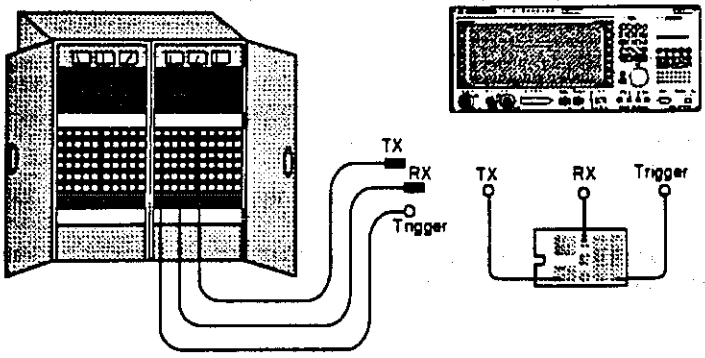
The CMD features 3 RF connectors:
- A bidirectional input/output (RF IN/OUT) for high input powers
- A sensitive input (RF IN 2) for low input powers
- An output (RF OUT 2) for low output powers

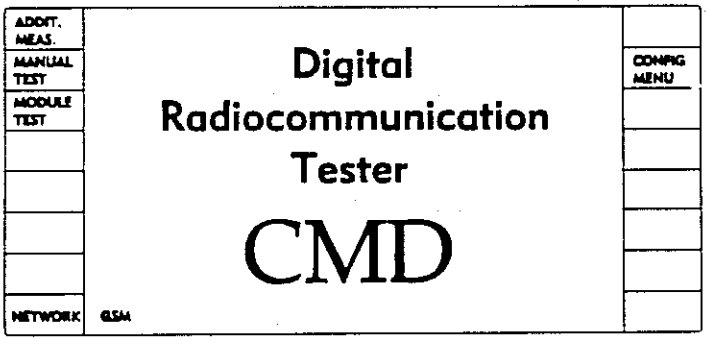
These three connectors can be used both alternatively and in combinations. There are 4 possible combinations. For each of the connectors, an attenuation value can be entered using the softkeys on the right side of the menu display, which the CMD will take into account with level settings and level measurements; negative attenuation values are gains. For the bidirectional input/output, there is only one uniform attenuation or gain. The four softkeys on the left of the menu display permit to select one of the four input/output combinations alternatively.

⑤ **MENU HOME/MENU UP**
On actuation, "MENU HOME" aborts all currently running measurements or actions and causes the instrument to return to the main selection menu of the CMD.

With "MENU UP", the CMD changes to the next higher or to the calling menu level, i.e. several keystrokes are necessary to enter the main selection menu from the lowest menu.







Step 4

There are two main operating modes for the CMD:

1) Unsynchronized ①

2) Synchronized ②

Unsynchronized operation

Select the softkey

MODULE TEST

in the main selection menu for unsynchronized operation. The following section 2.1.2 describes this operating mode.

Synchronized operation

The softkey

MANUAL TEST

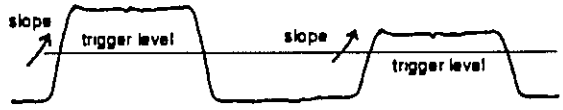
permits to select synchronized mode. For this operating mode, please continue with section 2.1.3. This operating mode requires a few further settings to be made before.

Additional Information

Step 4

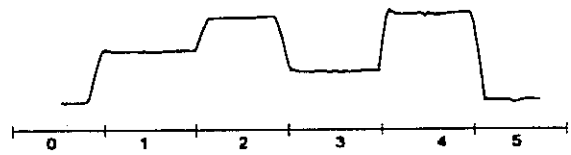
① **Unsynchronized operation, module test**
The CMD is capable of performing measurements on test items which are not synchronized with the CMD. This operating mode is particularly suitable in production for testing modules and in final testing when external control facilities may cause the test item to transmit. The CMD requires a burst signal corresponding to GSM specifications. The training sequence (midamble) must correspond to one of the 8 permissible possibilities.
The CMD triggers on the slope of the incoming RF signal, searching for the specified midamble. As soon as the CMD receives an appropriate signal at the RF input set, transmitter measurements can be performed.
It is to be noted that only one timeslot is activated, since otherwise several slopes would be detected and make the measurement impossible. External reference frequencies for frequency synchronization can additionally be applied in this case.

Permissible signals for measurements in the module test



Impermissible signal for measurements in the module test

② **Synchronized operation, Manual BTS Test**
In this mode, the CMD receives the time reference signal either via the RF from an applied C0 carrier (BCCH) or via external TTL trigger signals.
(Frame clock/multiframe clock).
The edge of this signal exactly determines the beginning of timeslot 0. Thus, accurate timeslot measurements are possible both on the C0 carrier and on further carriers, e.g. TCH. Before the measurement is started, the timeslot in which the measurement is to be performed is determined. Thus the signal shown here can also be processed in addition to the signals for the module test (see above).



The training sequence (midamble) must correspond to one of the 8 permissible possibilities. The CMD searches for the specified midamble and can perform both transmitter and receiver measurements in this mode. In the case of BCCH synchronization, external reference frequencies for frequency synchronization can additionally be applied, whereas in the case of TTL triggering they must be additionally applied. In the case of RF evaluation, the CMD automatically detects the transmitted midamble.
This mode is particularly suitable for installation and service of comlete base stations or for final testing.

2.1.2 Module Test, Unsynchronized Mode

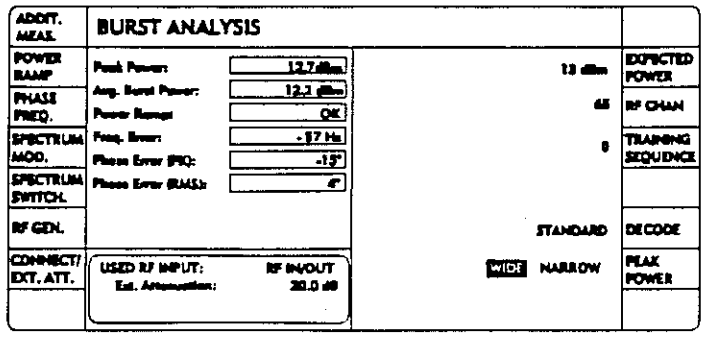
The CMD is capable of performing measurements on modules and test items which are not connected with the CMD via a trigger signal.

Transmitter adjustments can be performed, supported by the major transmitter measurements with full dynamic range.

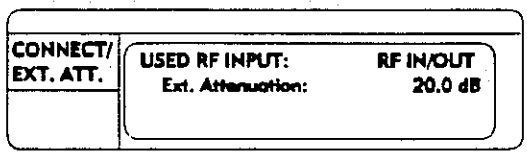
Receiver adjustments are supported by an RF generator with various possible modulations.

Module test, levels and frequencies

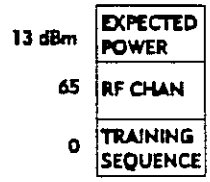
Step 1



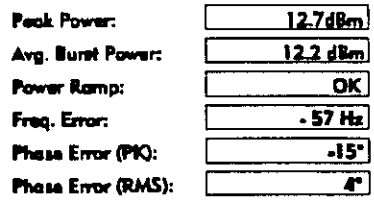
After selection of the module test in the main selection menu, the opposite picture appears on the display. ①



Check the inputs and outputs set. Press the "CONNECT/EXT. ATT." softkey in case you want to change the setting. ②



Enter the expected power, the RF channel and the training sequence. ③④



The measurement results are displayed on the left. ⑤

Additional Information

Step 1

① **Module test**
In unsynchronized operation, receiver adjustments and the most important transmitter measurements can be performed. To this end, a versatile RF generator and the full dynamic range are provided even in the extended GSM frequency range (Extended GSM, E-GSM, 10 MHz below the frequency band, channel number 975 to 1023).

② **RF input and external attenuation**
If required, this softkey can be used to select the RF input again. The currently selected connector is indicated together with the entered attenuation. External amplifiers are entered as negative attenuations.

③ **RF level and channel number**

Level
The CMD will set its internal attenuators to the expected transmitter level of your test item entered here. Based on this value, the CMD will automatically adapt the level (autoranging) and set the optimal measurement range.

Frequency
Enter the transmitter channel number of your test item. The CMD will set to this frequency and perform the measurements. Enter one of the possible channel numbers 1 to 124 for the GSM frequency range. For the extended GSM band, enter a number between 975 and 1023 or 0. For PCN (DCS1800) the numbers 512 to 885 are provided.

Range	Channel numbers n	Frequency Downlink (MS --> BS)	BS --> MS
GSM	1 to 124	f = 935 MHz + (n * 0.2 MHz)	- 45 MHz
E-GSM	0 to 124	f = 935 MHz + (n * 0.2 MHz)	- 45 MHz
E-GSM	975 to 1023	f = 935 MHz + (n - 1024) * 0.2 MHz)	- 45 MHz
PCN (DCS1800)	512 to 885	f = 1805.2 MHz + (n - 512) * 0.2 MHz)	- 95 MHz

Training sequence
For correct evaluation of the transmitter timing, the CMD evaluates the transmitted midamble or training sequence. 8 different bit sequences can be selected according to GSM specifications. During the measurements, the CMD searches for the bit sequence set and then performs the measurements. Select the training sequence transmitted by your test item.

④ **Input waveform**
In unsynchronized operation, the CMD can evaluate a burst signal (1 burst per frame).

⑤ **Measurement results**
As soon as the CMD detects a suitable signal, this is analyzed and the following measurement results are displayed:

a) Peak power in order to detect overshoots on power-on,
b) the average power in the useful part of burst (about the middle part of a burst),
c) the power ramp of a burst together with a pass/fail statement and
d) the phase and frequency error of the transmitter.

Peak Power:	12.7dBm
Avg. Burst Power:	12.2 dBm
Power Ramp:	OK
Freq. Error:	-157 Hz
Phase Error (PK):	-15°
Phase Error (RMS):	4°

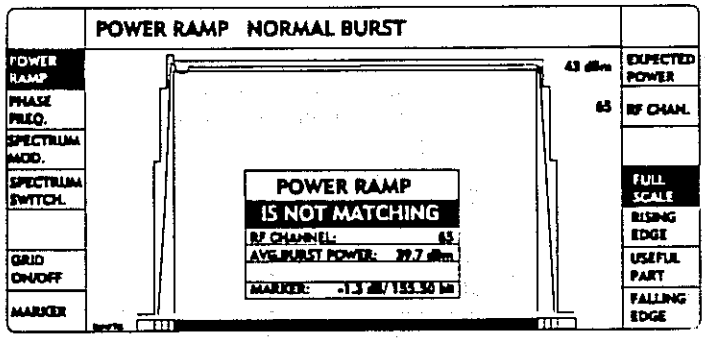
The power ramp is measured and a message output, indicating whether the measurement is within the tolerance limits. If the measurement is out of tolerance, the result is immediately displayed in inverse mode. ①

Power ramp measurement

Step 2

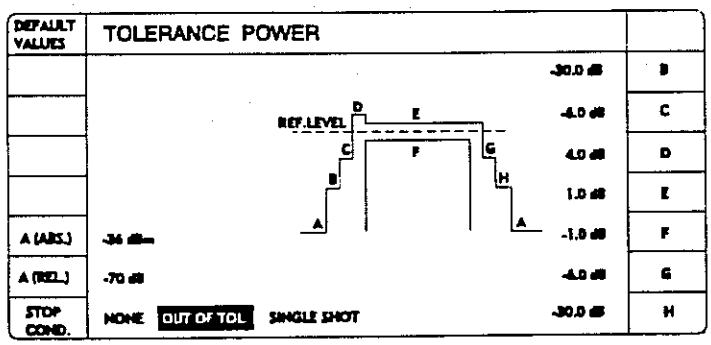
POWER RAMP
PHASE FREQ.
SPECTRUM MOD.
SPECTRUM SWITCH.

For detailed investigations and further transmitter measurements select one of these softkeys. ②



Select "POWER RAMP" in order to obtain the power ramp versus time.

If the power ramp is out of tolerance, the respective segment is marked by black display at the bottom edge of the screen. ③



Using the hardkey "CONFIG" and the softkey "POWER RAMP", select the tolerance mask and enter the desired tolerances. ④

Set the desired abort criterium for the measurement. ⑤

Press "MENU UP" to return to the measurement menu. ⑥

Additional information

① **Measurement results**
According to GSM specifications, the peak-phase error may be max. 20°, the rms-weighted phase error max. 5° and the frequency error max. 0.05 ppm of the set RF frequency. The current measurement results of these measurements are indicated here. As soon as one of the measurements is out of tolerance, the result is displayed in inverse mode. In the case of a very large frequency error check whether both the test item and the CMD are connected to the same reference frequency and whether the values have been entered accordingly in the configuration files (see also section 2.1.3 Synchronized Operation, Step 1).

Please note that the average power may well be out of tolerance although the shape of the power ramp lies within the tolerances. This may happen, because the power ramp is calculated with respect to the average power. The same applies to the opposite case.

Step 2

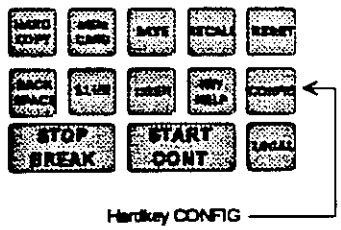
② **Transmitter measurements**
For detailed measurements, graphical displays of the transmitter measurements are also available. It is possible to directly change from one measurement to another one. This is very convenient, since it is not necessary to change into a higher menu first and call the desired measurement then. Press the corresponding softkey for the desired measurement. In general, the CMD uses a sampling rate of four samples per GSM data bit for the transmitter measurements, which corresponds to a sample frequency of approx. 1 MHz.

③ **Power Ramp**
The measured power ramp is compared with the set tolerance window. As soon as the measured power ramp exceeds the tolerances, the information "Not matching" is displayed in the middle of the display. To analyze the burst in detail, the softkeys RISING EDGE, USEFUL PART and FALLING EDGE are provided. Thus the edges or the upper part of the burst are made visible (Zoom). The softkey FULL SCALE permits to display the complete burst again.

Press the softkey "GRID ON/OFF" to fade a grid in or out. The softkey "MARKER" permits to activate the marker function. The marker can then be shifted on the curve using the rotary knob. The respective measured value is indicated.

The power ramp is recorded and measured approx. once a second. This also permits adjustments to be performed in quasi real-time mode. During this measurement, another RF channel or another power can also be applied and measured. Press the corresponding key on the right half of the menu to this end.

④ **Configuration tolerance mask**
By pressing the hardkey "CONFIG" followed by the softkey "POWER RAMP", the configuration menu for this measurement can be entered. This item can also be selected from the highest main menu via the configuration tree. This menu permits to adapt the tolerance mask to your own requirements which might be more stringent. GSM specifies 9 segments for this mask which can be entered separately in this menu. The softkey "DEFAULT VALUES" at the top left restores the GSM settings. Both an absolute and a relative level is to be entered for segment A.



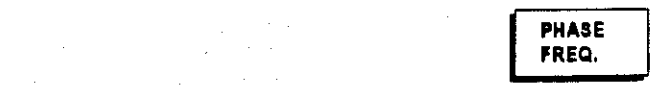
⑤ **Abort criterium**
The softkey "STOP COND." permits to enter an abort criterium. As soon as the measurement exceeds the tolerance, the measurement is either continued or immediately interrupted. It is also possible to set single-shot operation, i.e. when pressing the POWER RAMP softkey, exactly one measurement is performed.

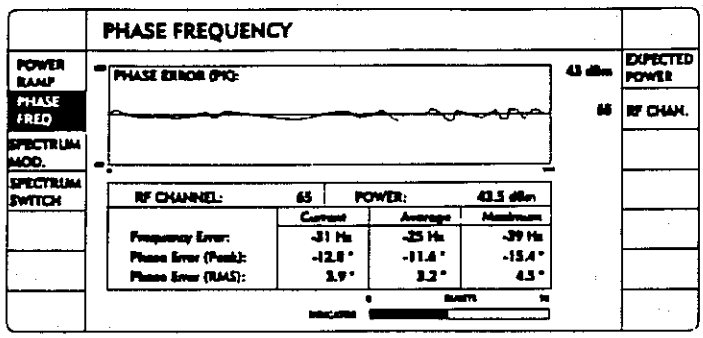
⑥ **MENU UP**
Press the MENU UP key to return to the measurement menu.

Phase and frequency error measurement

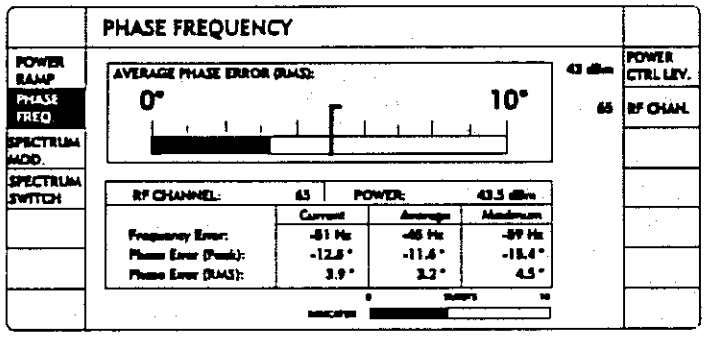
Step 3

Select "PHASE FREQ." for graphical display of the phase and frequency error.

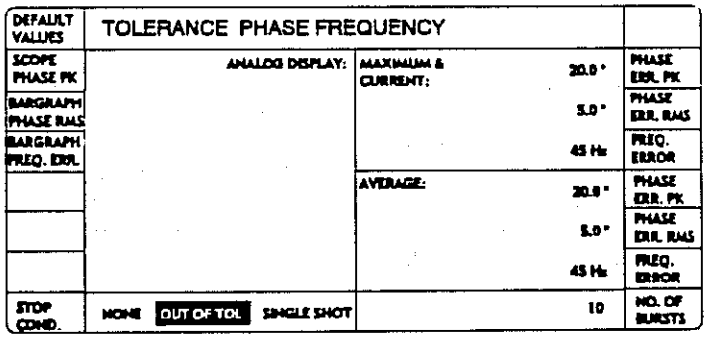




Both instantaneous and averaged and maximal results are displayed. ①



For adjusting purposes, the bar display is very helpful. ②



Select the tolerance configuration using the hardkey "CONFIG" and the softkey "PHASE FREQ." and enter your own tolerance values.

Also set the desired display of measurement results. ③

Set the desired abort criterium for the measurement. ④

Press "MENU UP" to return to the measurement menu. ⑤

Additional information

Step 3

① **Phase and frequency error measurement**
GSM specifies a particular type of modulation referred to as GMSK. The bits to be transferred are contained in the phase information of the RF signal. Check that this modulation is observed as strictly as possible. The deviations are recorded in the measurement results phase and frequency error. According to GSM specifications, the peak phase error may be max. 20°, the rms-weighted phase error max. 5° and the frequency error max. 0.05 ppm of the set RF frequency.

The CMD records the actual phase trajectory. From the bits transferred, the CMD calculates an ideal phase trajectory and determines the deviations of the measured curve from the nominal curve.

The phase error versus time is graphically displayed by the CMD approx. once a second (oscilloscope mode). In addition, the average measured values and the maximum measured value occurred are indicated referred to a given number of bursts. The bar indicator shows how far the average calculation has progressed.

② **Bar display**
The measured values for the frequency error and the rms-weighted phase error can also be displayed in a bar display. This permits adjustments to be performed very easily.

During the measurement, a channel change or a power change can also be performed. For this purpose, press the appropriate softkeys in the right half of the menu.

③ **Configuration phase and frequency error**
By pressing the hardkey "CONFIG" followed by the softkey "PHASE FREQ." the configuration menu can be entered. This menu can also be reached from the highest main menu via the configuration tree.

This menu permits to adapt the tolerance mask to your own requirements that might be more stringent.

The softkey "DEFAULT VALUES" at the top left restores the GSM settings.

The average maximal limit values can also be specified here. The number of bursts to be taken into account is specified using the softkey "NO. OF BURSTS".

The softkey "SCOPE PHASE PK" configures the display in oscilloscope mode (display as with upper illustration).

The softkeys "BARGRAPH ...." configure the display of the measurement results as bar display. The operating mode currently set is displayed on black background.

④ **Abort criterium**
The softkey "STOP COND." permits to enter an abort criterium. As soon as the measurement exceeds the tolerance the measurement is either continued or immediately interrupted. It is also possible to set single-shot operation, ie when pressing the softkeys "PHASE FREQ." exactly one measurement is performed. The set operating mode is displayed on black background.

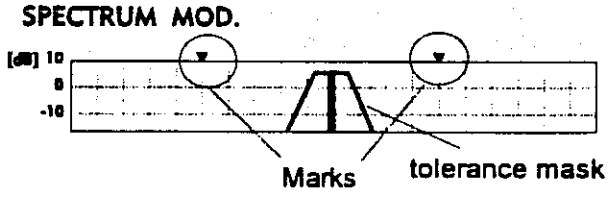
⑤ **MENU UP**
Press the MENU UP key to return to the measurement menu.

Modulation spectrum measurement

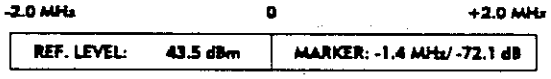
Step 4

Select "SPECTRUM MOD." to call the measurement of the modulation spectrum.

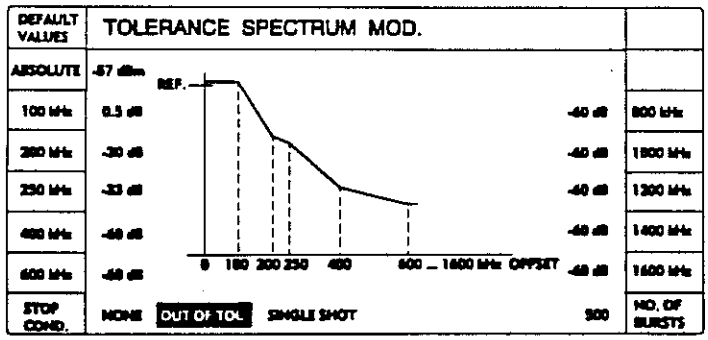
The modulation spectrum is displayed up to the maximum offset frequency of ± 1.8 MHz. ①



The current measurement is marked by triangles. ②



The marker exactly indicates the measured value. ③



Select the tolerance configuration using the hardkey "CONFIG" and the softkey "SPECTRUM MOD." and enter your own tolerance values. ④

Select the number of bursts to be taken into account. ⑤

Set the desired abort criterium for the measurement. ⑥

Press "MENU UP" to return to the measurement menu. ⑦

Additional Information

Step 4

① **Measurement of the modulation spectrum (Spectrum Due To Modulation)**
Due to the GMSK modulation the data bits produce a spectrum on the used RF channel as well as on the adjacent channels for each burst.

The spectrum must be checked at the carrier frequency and at the up to 22 adjacent frequencies. It must not exceed the tolerances specified by GSM. The measurement result is characterized by one measured value per offset frequency.

The CMD records the power ramp at each of the specified offset frequencies up to ± 1.8 MHz and with the dynamic of more than 75 dB required for this measurement. A particular number of bursts is considered for each frequency.

The CMD uses the power values (recorded and filtered with the specified filter of 30 kHz) to calculate the modulation spectrum and displays the result graphically.

Caution: Due to the filtering, the measured value "REF. LEVEL" is not identical with the power of the set power level.

Due to the sampling technique, the CMD achieves an extremely high measurement rate. The measuring time for 23 frequencies and 500 bursts per frequency lies at approx. 60 s.

During the measurement, a channel change or power change can be performed. For this purpose, press the appropriate softkeys in the right half of the menu.

② **Marking**
The triangular marks at the top of the menu display exactly indicate the offset frequency being calculated. The measured values outside the marked area are the results of a previous measurement, the measured values inside the marked area are the results of the currently running measurement.

③ **Marker**
A marker can be set to each measured value using the rotary knob. The respective measurement result is indicated as numerical value.

④ **Configuration Spectrum Due To Modulation**
By pressing the hardkey "CONFIG" followed by the softkey "SPECTRUM MOD." the configuration menu can be entered. This menu can also be reached from the highest main menu via the configuration tree. This menu permits to adapt the tolerance mask to your own requirements which might be more stringent. The values for each offset frequency are to be set using the appropriate softkeys. The weaker requirement of absolute and relative limit value is used as tolerance limit, i.e. if the relative values are smaller than the absolute value, they are not taken into account.

Example:	Settings:	Absolute -27 dBm, relative at 200 kHz: -30 dB
	Measurements:	Burst power at the carrier frequency: 0 dBm,
→	Tolerance limit at 200 kHz:	-27 dBm, since weaker requirement.

The softkey "DEFAULT VALUES" at the top left restores the GSM settings.

⑤ **Number of bursts**
The number of bursts to be taken into account is specified using the softkey "NO. OF BURSTS".

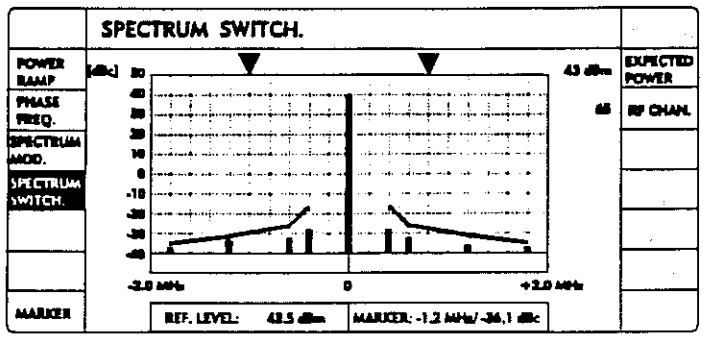
⑥ **Abort criterium**
The softkey "STOP COND." permits to enter an abort criterium. As soon as the measurement exceeds the tolerance, the measurement is either continued or immediately interrupted. It is also possible to set single-shot operation, i.e. when pressing the softkey "SPECTRUM MOD." exactly one measurement is performed. The set operating mode is displayed on black background.

⑦ **MENU UP**
Press the MENU UP key to return to the measurement menu.

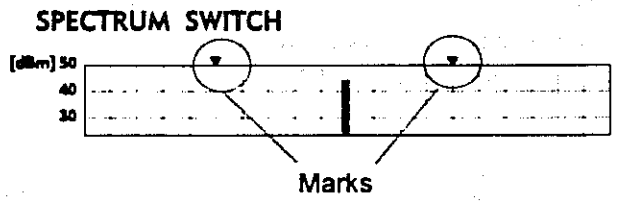
Spectrum Due To Switching

Step 5

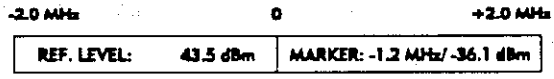
Select "SPECTRUM SWITCH." to call the measurement of the switching spectrum.



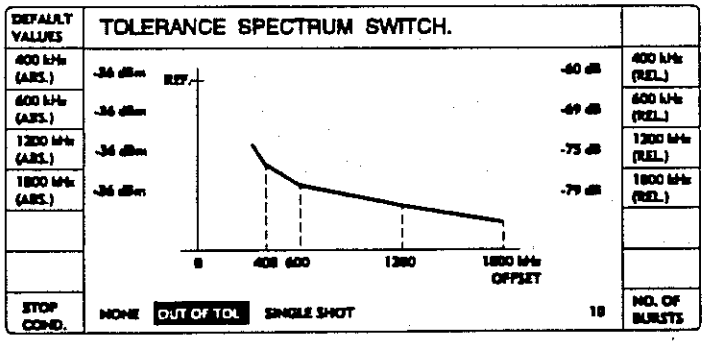
The switching spectrum is displayed up to the maximal offset frequency of ± 1.8 MHz. ①



The current measurement is marked by triangles. ②



The marker exactly indicates the measured value. ③



Select the tolerance configuration using the hardkey "CONFIG" and the softkey "SPECTRUM SWITCH." and enter your own tolerance values. ④

Select the number of bursts to be taken into account. ⑤

Set the desired abort criterium for the measurement. ⑥

Press "MENU UP" to return to the measurement menu. ⑦

Additional information

Step 5

① **Measurement of Spectrum Due To Switching**
GSM exactly specifies the switching response of the power. The case may arise where, although the power ramp is within the tolerances (see Step 2), disturbances occur in the adjacent channels due to fast switching on and off.

The spectrum must be checked at several adjacent frequencies and must not exceed certain tolerances specified by GSM. The measurement result is characterized by one measured value per offset frequency.

As with the measurement "Spectrum Due To Modulation" the measured values are calculated (see also Step 4, note ①), however a 100-kHz filter is used in this case. In its default setting, the CMD records ten bursts for each offset frequency. The time required for a complete measurement is a few seconds.

Caution: As a result of the filtering, the measured value "REF. LEVEL" is not identical with the power of the set power level.

During the measurement, a channel change or a power change can be performed. To this end, press the respective softkeys in the right half of the menu.

② **Marking**
The triangular marks at the top of the menu display exactly indicate the offset frequency being calculated. The measured values outside the marked area are the results of a previous measurement, the measured values within the marked area are the results of the currently running measurement.

③ **Marker**
A marker can be set to each individual measured value using the rotary knob. The respective measurement result is displayed as numerical value.

④ **Configuration Spectrum Due To Switching**
Pressing the hardkeys "CONFIG" followed by the softkey "SPECTRUM SWITCH." permits to enter the configuration menu. This menu can be reached even from the highest main menu via the configuration tree. This menu permits to adapt the tolerance mask to your own requirements that might be more stringent. The values per offset frequency are to be set using the respective softkeys. The weaker requirement of absolute and relative limit value is used as tolerance limit, ie if the relative values are smaller than the absolute value, they are not considered.

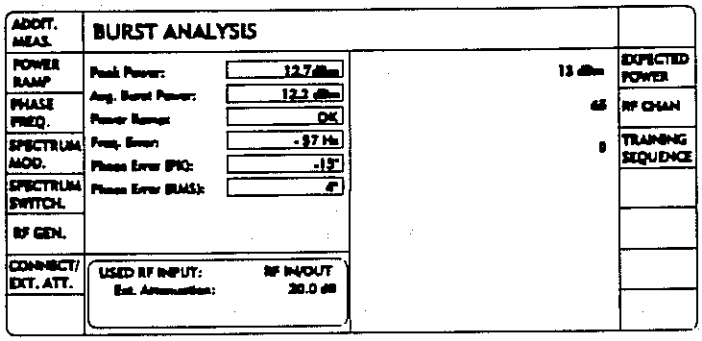
Example:	Settings at 400 kHz:	Absolute -23 dBm, relative: -60 dB
	Measurements:	Burst power at the carrier frequency: 35 dBm,
→	Tolerance limit at 400 kHz:	-23 dBm, since weaker requirement.

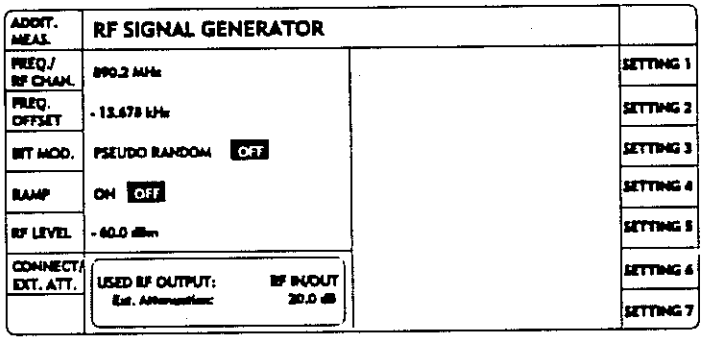
⑤ **Number of bursts**
The number of bursts to be considered is specified using the softkey "NO. OF BURSTS".

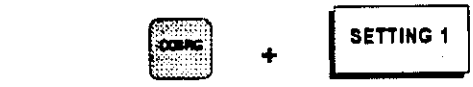
⑥ **Abort criterium**
The softkey "STOP COND." permits to enter an abort criterium. When the measurement exceeds the tolerance, the measurement a) continues or b) is immediately interrupted. It is possible to set c) single-shot mode, ie on pressing the softkeys "SPECTRUM SWITCH." exactly one measurement is performed. The set operating mode is displayed on black background.

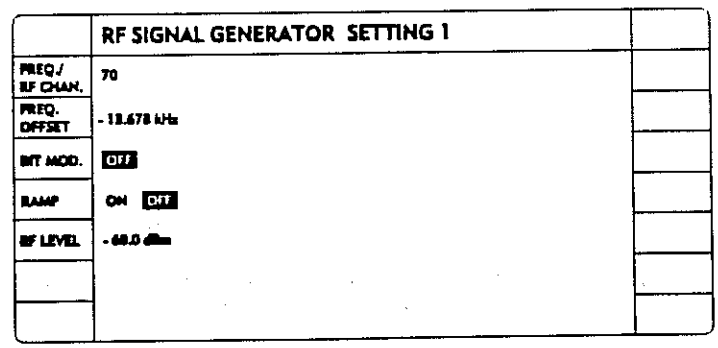
⑦ **MENU UP**
Press the MENU UP key to return to the measurement menu.

Receiver measurements









Step 6

Press the "MENU UP" key again to return to the menu "BURST ANALYSIS".

The menu shown opposite allows you to reach the RF generator in order to adjust your receiver.

Press the softkey "RF GEN." to enter the RF generator menu.

The versatile RF generator provides signals with and without moduation, etc. ①

Press the hardkey "CONFIG" and a softkey, eg "SETTING 1". ②

The parameters of the preset softkeys can be changed. ③

Press "MENU UP" to return to the measurement menu. ④

Additional information

Step 6

① **RF generator for receiver adjustment**
The versatile RF generator of the CMD can be used for receiver adjustments. It permits eg to adjust the I/Q signals or perform a sensitivity measurement.

Frequency range
The frequency range can be set from 800 to 1000 MHz. This permits to perform even measurements in the extended GSM band (E-GSM). For the CMD 57, this range is even extended from 1697.6 to 1897.6 MHz.

Frequency fine tuning
For particular purposes, eg I/Q adjustment, a fine frequency offset is required related to the centre frequency of the carrier. If an offset of eg + or - 67.708 kHz is set, this corresponds to a carrier modulated with a continuous data stream 00000 or 1111.

Modulation
The carrier can also be modulated with a pseudo random bit sequence. A random data stream with or without midamble is transferred in the useful part of burst. The choice marked by black display is activated immediately (TSC means Trainings Sequence Code).

Power Ramp
The carrier can be generated with or without power ramp. The choice marked by black display is activated immediately.

Level
The full level range of the CMD is available. This permits to generate RF signals with a level up to -120 dBm for sensitivity measurements.

② **SETTING 1 ... 7**
To ensure fast access to the versatile functions, seven frequently used settings can be assigned to the respective softkeys. Press the hardkey "CONFIG" followed by the desired softkey and enter your settings.

③ **Configuration menu**
The possible settings in the configuration menu correspond to those in the main menu.

④ **MENU UP**
If you press "MENU UP" again, your settings are assigned to the selected softkey. By pressing "MENU UP" a second time, you can change back to the measurement menu. Selecting one of the possible softkeys, however, permits you to perform further configurations.

The measurement menu thus provides seven preset configurations at a keystroke.

2.1.3 Manual BTS Test, Synchronized Mode

The CMD is able to perform measurements on test items and complete base stations which provide either a C0 carrier (BCCH) or a trigger signal.

Measurements are performed both on the C0 carrier and on the TCH (Traffic Channel).

Transmitter adjustments supported by the most important transmitter measurements are performed with full dynamic range. The time-slot accuracy of the base station is also checked.

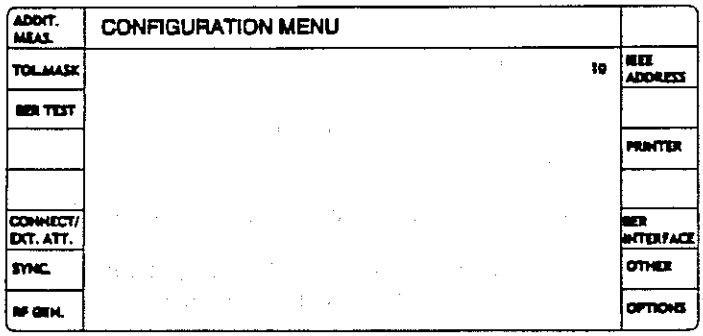
Receiver adjustments are supported by various possible bit error rate measurements.

Frequency and time synchronization

Step 1

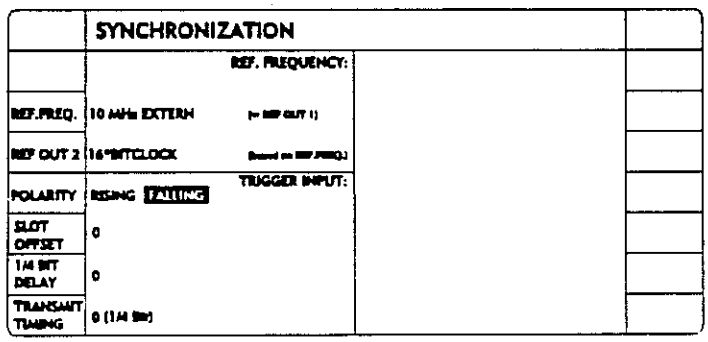
To perform accurate frequency measurements, the reference frequencies must be entered. ①

To change to the configuration menus select the softkey "CONFIG MENU" on the right side of the main selection menu. ②



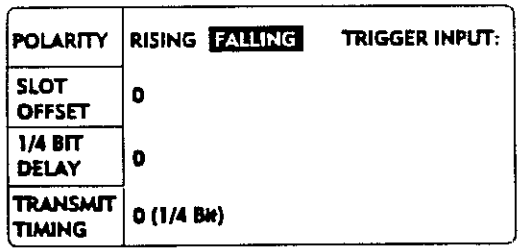
Select the softkey

to choose the desired reference frequency in the menu.



This menu permits to configure a great variety of reference frequency signals and the external TTL trigger signal for time synchronization. ③

Set the desired reference frequency and confirm using the ENTER hardkey. ④



Set the signal characteristics here if you use an external trigger signal for time synchronization. ⑤⑥

Press "MENU HOME" to return to the main selection menu. ⑦

Additional information

Step 1

① **Manual BTS test**
In time-synchronized mode, receiver adjustments and the most important transmitter measurements can be performed. The measurements can be performed in GSM, PCN or E-GSM (Extended GSM) mode.

It is possible to
a) apply a C0 carrier (BCCH) via the RF
b) apply an external trigger signal.

The time information is determined from the applied signals and thus accurate time-slot measurements are possible.

Accurate frequency measurements (e.g. frequency error measurement) require a reference frequency. This can be provided by the CMD or externally applied to the instrument. If the time information is applied via the C0 carrier, a synchronization can be made via an external reference frequency. If the time information is applied via an external trigger signal, a synchronization must be made via an external reference frequency.

② **Change to the configuration menus**
As with the settings of the RF connectors change to the configuration menus. Select the softkey "SYNC" there to configure the sync signals.
This menu only exists if the Option CMD-B3 is installed in the instrument.

③ **Configuration menu Synchronization**
The menu display is divided into two parts:
a) Reference frequency settings
b) Trigger signal setting

a)
Three BNC connectors REF.FREQ, REF OUT 1 and REF OUT 2 are to be found at the rear of the instrument at the top right.

The set signals can be applied or tapped there.
The signal set at REF FREQ. (or the externally applied one) is always present at REF OUT 1. The signal configured using the softkey "REF OUT 2" is always applied at REF OUT2.

b)
The multifunction connector of the CMD is situated at the front of the instrument. A trigger signal (TTL level) can be applied at pin 27. Please note that, in this operating mode, you have to specify and enter a signal also under item a). Modification Kit CMD-U5 provides an additional BNC connector for this signal on the rear panel.

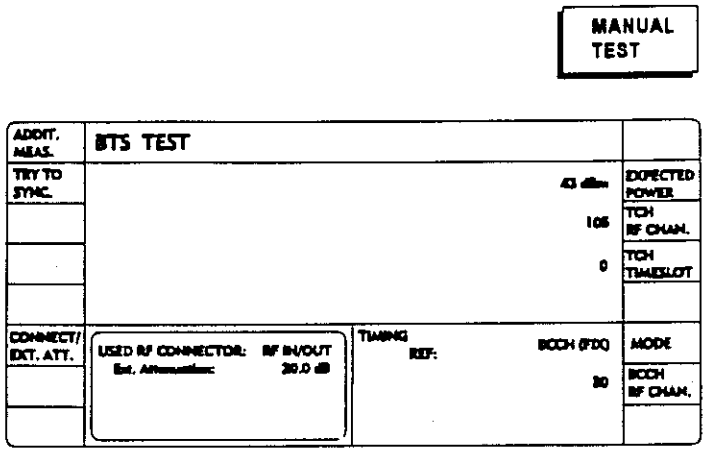
④ **Setting the reference frequency**
You can use the rotary knob to select the various settings. Possible settings: 1 to 13 MHz in 1-MHz steps, 26, 39, 52 MHz external, 10 MHz internal, 16.384 and 2.048 MHz. If the Option CMD-B7 is installed, the facility "ABIS" is additionally available. When you have achieved the desired setting, press the "ENTER" hardkey to terminate the entry.

⑤ **Trigger signal**
By pressing the softkey "POLARITY" select the edge of the trigger signal with which the CMD is to start the evaluation. The softkeys "SLOT OFFSET" and "1/4 BIT DELAY" permit to set a delay in the CMD related to the trigger signal applied. The CMD starts after occurrence of the signal edge according to the settings.

⑥ **Transmit Timing**
The time of transmission is exactly referred to the timeslot limit (simulation of timing advance).

⑦ **MENU UP**
Press the MENU UP to return to the main selection menu.

Settings Manual BTS Test



Step 2

Select the softkey "MANUAL TEST" in the main selection menu.

The opposite menu of the synchronized base station measurements appears on the display. ①

Enter the expected transmitting power of the test item. ②

Press the "MODE" softkey and set the operating mode BCCH (FIX) using the rotary knob. Confirm using the "ENTER" hardkey. Enter the channel number. Select this type of time synchronization if you provide a C0 carrier. ③

Press the "MODE" softkey and set the operating mode EXT. TRIGGER using the rotary knob. Confirm using the "ENTER" hardkey. Enter the used training sequence. Select this type of time synchronization if you provide an external trigger signal. ④

This menu again permits to select the input connector and enter external attenuations. ⑤

Press the softkey "TRY TO SYNC" to start the time synchronization. ⑥

Additional information

Step 2

① **Synchronized base station test**
The display shows the input menu for the synchronized base station measurements. The different operating modes are selected and the respective configurations set. After the settings have been performed, the time synchronization is started and the CMD tries to synchronize. Enter the TCH channel to be measured and the TCH timeslot.

② **Expected Power**
The CMD will set its internal attenuator pads to the expected transmitting power of your test item entered here. Based on this value, the CMD will perform automatic level matching (autoranging) and set the ideal measurement range.

③ **Mode = BCCH (FIX)**
Selecting this operating mode using the softkey "MODE" determines that the CMD will receive the time information via the RF from a C0 carrier (BCCH).

Frequency
Using the softkey "BCCH RF CHAN." set the number of the RF channel on which this carrier is to be found. The CMD will analyze this RF carrier, decode the data and perform the measurements.

Enter one of the possible channel numbers 1 to 124 for the GSM frequency range. For the extended GSM band please enter a number between 975 and 1023 or 0. For PCN (DCS1800) the numbers 512 to 885 are available.

Range	Channel numbers n	Frequency Downlink (MS --> BS)	BS --> MS
GSM	1 to 124	f = 935 MHz + (n * 0.2 MHz)	- 45 MHz
E-GSM	0 to 124	f = 935 MHz + (n * 0.2 MHz)	- 45 MHz
E-GSM	975 to 1023	f = 935 MHz + ((n - 1024) * 0.2 MHz)	- 45 MHz
PCN (DCS1800)	512 to 885	f = 1805.2 MHz + ((n - 512) * 0.2 MHz)	- 95 MHz

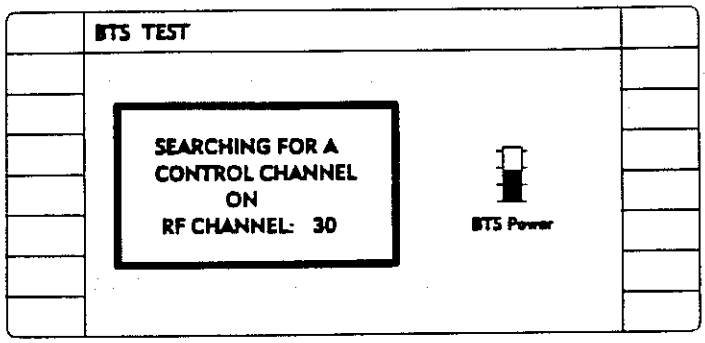
④ **Mode = EXT. TRIGGER**
Selecting this operating mode using the "MODE" softkey determines that the CMD receives the time information via an external trigger signal at multifunction pin 27. As soon as the trigger signal has been detected, a change is made to the menu "TRAFFIC CHANNEL TEST". In this operating modes, no measurements can be performed on a C0 carrier (BCCH).

⑤ **RF input and external attenuation**
This softkey permits again to select the RF input, if desired or required. The currently selected connector is indicated together with the attenuation entered. External amplifiers are entered as negative attenuations.

⑥ **TRY TO SYNC.**
Press this softkey as soon as all settings have been performed. The CMD will now try to decode the time information and set its internal counters accordingly. This may take a few seconds.

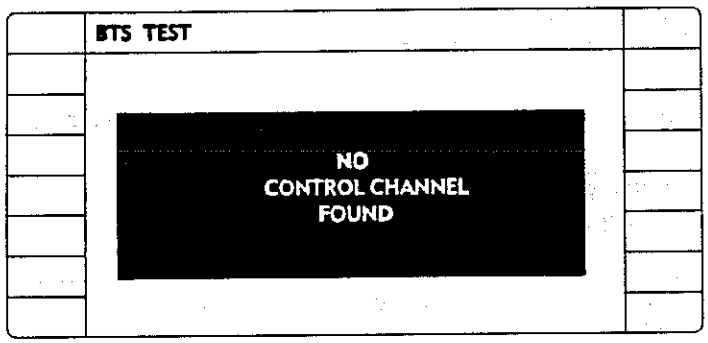
Synchronization active

Step 3



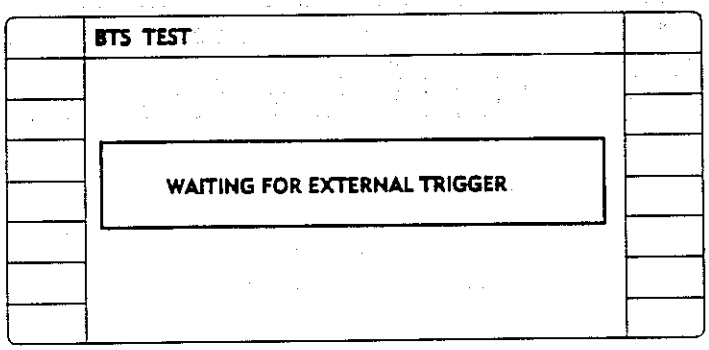
Only for mode = BCCH (FIX)

The CMD searches for a C0 carrier (BCCH) at the frequency specified. The evaluation of the time information and setting of the internal counters may take a few seconds. ①



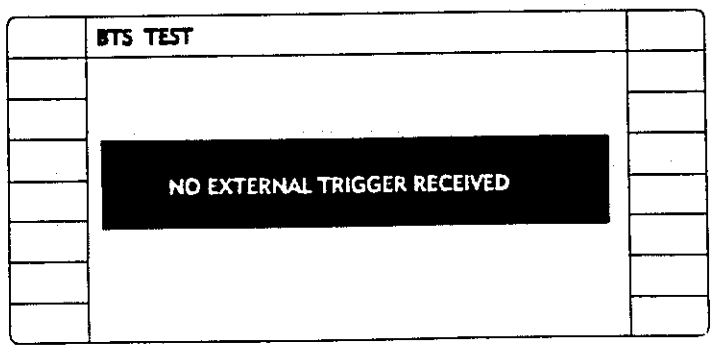
Only for mode = BCCH (FIX)

If the CMD does not receive a BCCH an error message is displayed. ②



Only for mode = EXT. TRIGGER

The CMD is waiting for the trigger signal specified. The evaluation of the time information and the respective setting of the internal counters may take a few seconds. ③



Only for mode = EXT. TRIGGER

If the CMD receives no trigger signal, an error message is displayed. ④

Additional information

Step 3

① **Searching For a Control Channel**
When the time synchronization is started, this menu appears on the display. The CMD will search for a C0 carrier on the RF channel number indicated. This may take up to 60 seconds.

According to GSM, the C0 carrier will transfer the required information in timeslot 0. The signal is transmitted in all timeslots with the same level. The various channel combinations specified by GSM may be applied.

The CMD first searches for the FCCH (Frequency Correction Channel) on the specified carrier in order to detect timeslot 0.

In order to obtain the desired time information, the SCH (Synchronisation Channel) is decoded. If these channels are both detected, a change is made to the menu "CONTROL CHANNEL" .

② **No Control Channel Found**
If the CMD cannot decode any data for time synchronization after a certain period of time, an error message appears, and the menu display for setting the parameters appears again. In this case please check the channel number and the level settings again.

Should you use external attenuations or amplifiers, please check whether these have been specified for the right RF input.

High-grade cables and RF connectors must be used to obtain correct measurement results. Dirty or broken connections will soon cause problems, in particular at the high frequencies used by GSM and PCN.

③ **Waiting For External Trigger**
When the time synchronization is started, this menu appears on the display. The CMD is waiting for a trigger signal in order to synchronize its internal counters. The CMD must be started approx. 1 to 2 s before releasing the trigger signal.

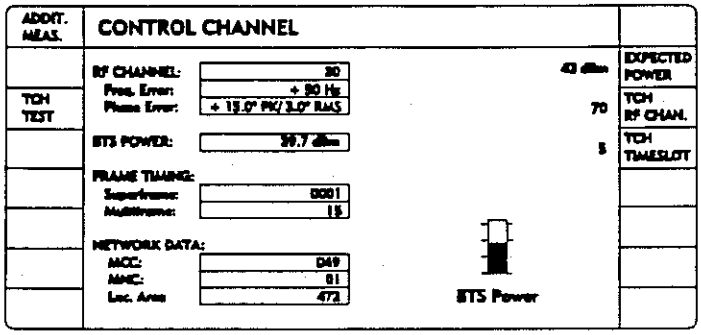
As soon as the signal has been detected, a change is made to the menu "TRAFFIC CHANNEL TEST".

④ **No External Trigger Received**
If the CMD does not receive a trigger signal within a certain time period, an error message is produced and the menu for setting the parameters is displayed again. In this case please check your settings again. Please also read section 2.4.7.9 (Configuration Menu Synchronization) in the Reference Part of this operating manual. Additional settings and hints are described there.

C0 carrier measurements

Step 4

Only for
C0 carrier synchronization



As soon as the C0 carrier has been detected and the time information decoded, the CMD changes to the menu "CONTROL CHANNEL" (C0 carrier measurement menu). ①

RF CHANNEL:	30
Freq. Error:	+ 50 Hz
Phase Error:	+ 15.0° PK/ 3.0° RMS

The RF carrier used and the phase and frequency errors are displayed. ②

BTS POWER:	39.7 dBm

The transmitting power of the C0 carrier is displayed. ③

FRAME TIMING:	
Superframe:	0001
Multiframe:	15

The current timing is indicated. ④

NETWORK DATA:	
MCC:	049
MNC:	01
Loc. Area	472

The network data are displayed. ⑤

43 dBm	EXPECTED POWER
70	TCH RF CHAN.
5	TCH TIMESLOT

Enter the values of the second channel (TCH). Please note that the cable spacing must be at least 30 channels. ⑥

TCH TEST

Select this softkey to test the TCH. ⑦

Additional information

Step 4

① **Control Channel Test**
As soon as the CMD detects an appropriate signal, this is analyzed and the measurement results are displayed in the left half of the menu.

Both RF measurements are performed and signalling information is indicated. This allows to draw conclusions on the characteristics of the C0 carrier. This menu also permits to change to the adjacent carrier (TCH) in order to perform further measurements.

② **Phase and frequency error measurement**
GSM specifies a max. peak phase error of 20 °, a max. rms-weighted phase error of 5 ° and a frequency error of max. 0.05 ppm of the set RF frequency. The current measurement results of these measurements on the C0 carrier are indicated here. When a measurement exceeds the tolerance, the result is displayed in inverse mode. In the case of a very high frequency error please check whether the test item and the CMD are connected to the same reference frequency and whether the values have been entered in the configuration data (Step 1).

③ **BTS Power**
The average transmitting power of the C0 carrier is displayed. The transmitting signal is assumed to have the same RF level in all timeslots.

④ **Frame Timing**
The time information transferred in the SCH (Synchronisation Channel) is partly indicated here. This permits to determine very easily whether the time information transmitted by the C0 carrier is correct. The numeric values are updated accordingly.

⑤ **Network Data**
The parameters sent on the BCCH "Mobile Country Code" (MCC; country code, 3 digits), "Mobile Network Code" (MNC, network code, 2 digits) and "Location Area Code" (LAC, code of the base station) are also displayed. E.g. "MCC = 262" refers to a network from Germany. When testing base stations in the field (e.g. when putting into operation), this information is often very helpful, allowing to check whether the values have been correctly set and transferred by the Operation / Maintenance Center .

⑥ **TCH Parameter**
For further measurements please enter the respective values for the TCH.

EXPECTED POWER (transmitting power TCH)
The CMD will set its internal attenuator pads to the expected transmitting level of your test item entered here. Based on this value, the CMD will perform automatic level matching (autoranging) and set the ideal measurement range.

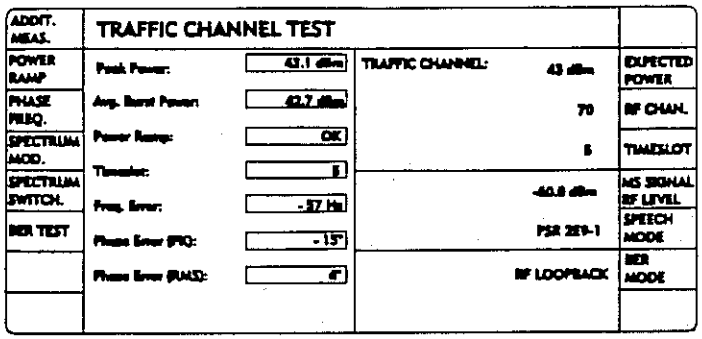
TCH RF CHAN.
Please enter the transmitting channel number of the TCH. The CMD will set to this frequency and perform the measurements. For the channel assignment please refer to the table under step 2. If the TCH is transmitted at the same frequency as the BCCH, enter the channel number of the C0 carrier here. If the TCH is transmitted on a different channel, note that the channel spacing to the C0 carrier must be at least 30 channels.

TCH TIMESLOT
The CMD only evaluates the timeslot specified here. Therefore, signals of different levels can be evaluated in the different timeslots.

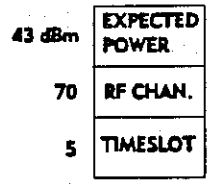
⑦ **TCH TEST**
When this softkey is selected, the CMD changes to the menu "TRAFFIC CHANNEL TEST" and measures the specified TCH.

TCH measurements

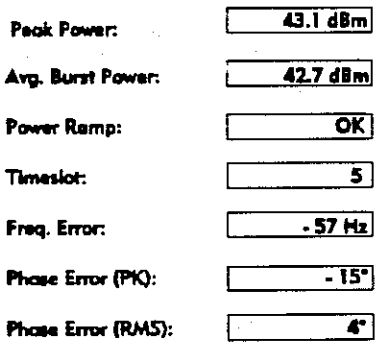
Step 5



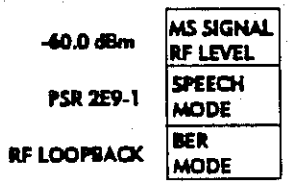
The measurement menu of the TCH is displayed. The measured values are displayed in a clearly structured format. ①



A new channel can be set in this menu. Please note again that the channel spacing to the C0 carrier must be at least 30 channels. ②



The measurement results of the TCH are displayed in the opposite picture. ③



These values are required for the receiver measurements, selecting the transmitting level of the CMD and the transmit data.
The receiver measurements will be explained under step 10. ④

Additional information

Step 5

① **TCH test**
In synchronized operation, both transmitter and receiver measurements can be performed on the TCH. The most important transmitter measurements are shown in the left half of the display in a clearly structured format. Various submenus for transmitter and receiver measurement can be called in this menu.

② **TCH parameters**
For the measurements enter the respective values for the TCH.

EXPECTED POWER (transmitting power TCH)
The CMD will set its internal attenuator pads to the expected transmitting level of your test item. Based on this value, the CMD will perform automatic level matching (autoranging) and set the optimal measurement range.

RF CHAN.
You can enter a new channel number and thus cause a channel change. However, note that the new channel must still be synchronous with the original C0 carrier (BCCH). Should you reach this menu when applying an external trigger signal, also enter the TCH RF channel to be measured.

TIMESLOT
The CMD only evaluates the timeslot specified here. Therefore, signals with different levels can be evaluated in the various timeslots. If you enter a different value here, a change of the timeslot is thus performed.

③ **Measurement results**
When the CMD detects a suitable signal, this is analyzed and the most important measurement results are displayed.

The average power measured in the useful part of burst (about the middle part of a burst) is displayed. If several timeslots with a different power each are active on the carrier, only the power of the active (displayed) timeslot is measured in this menu.

At the same time the power ramp of the burst is also measured and a pass/fail statement is indicated. If the specified carrier performs no power ramping, a respective message is output. This is the case, eg, if a TCH timeslot is tested on the C0 carrier.

The used timeslot is displayed again.

Besides, the phase and frequency error of the transmitter is calculated and the measurement result indicated.

④ **Receiver measurements**
For the receiver measurement, the CMD sends with the power set in this menu. The "SPEECH MODE" permits to set different transmit data. The setting PSR 2E9-1, eg, causes pseudo random data to be sent on the TCH according to CCITT 0.151 or 0.153. The sensitivity measurements are explained in detail after step 10.

Peak Power:	43.1 dBm
Avg. Burst Power:	42.7 dBm
Power Ramp:	OK
Timeslot:	5
Freq. Error:	-157 Hz
Phase Error (PK):	- 15°
Phase Error (RMS):	4°

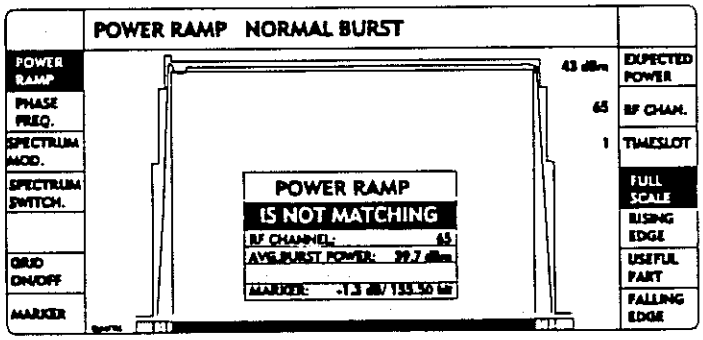
The power ramp is tested and a message appears, indicating whether the measurement is within the tolerances or not. If one of the measurements exceeds the tolerance, the result is immediately displayed in inverse mode. ①

Power ramp measurement

Step 6

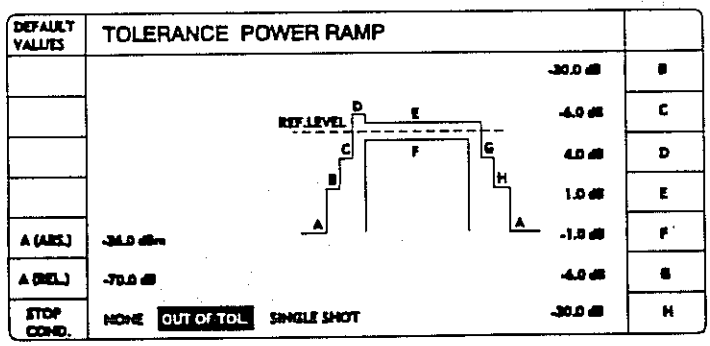
POWER RAMP
PHASE FREQ.
SPECTRUM MOD.
SPECTRUM SWITCH.

For detailed investigations and further transmitter measurements select one of these softkeys. ②



Select "POWER RAMP" to obtain the power ramp versus time.

If the power ramp exceeds the tolerance, the respective segment at the lower edge of the screen is displayed on black background. ③



Use the hardkey "CONFIG" and the softkey "POWER RAMP" to select the tolerance mask and enter the desired tolerances. ④

Set the desired abort criterium for the measurement. ⑤

Press "MENU UP" to return to the measurement menu. ⑥

Additional information

① **Measurement results**

GSM specifies a peak phase error of max. 20°, an rms-weighted phase error of max. 5° and a frequency error of max. 0.05 ppm of the set RF frequency. The current measurement results of these measurements are displayed here. If one of the measurements exeeds the tolerance, the result is displayed in inverse mode. In the case of a very great frequency error, please check whether the test item and the CMD are connected to the same reference frequency and whether the values have been entered accordingly in the configuration data (see also 2.1.3, Synchronized Mode, step 1).

Please note that the average power may exceed the tolerance although the power ramp lies within the tolerances. This may happen because the power ramp is calculated referred to the average power. The same applies to the opposite case. The power ramp may also exceed the tolerance if several timeslots are active. In order to measure the full dynamic of the burst, the adjacent timeslots must be switched off.

Step 6

② **Transmitter measurements**

For detailed measurements graphical displays of the transmitter measurements are also provided. It is possible to directly change from one measurement to another one. This is very convenient, because it is not necessary to change to a higher menu first to call the desired measurement. Press the respective softkey for the desired measurement. In general, the CMD uses a sampling rate of four samples per GSM data bit for the transmitter measurements, which corresponds to a sample frequency of approx. 1 MHz.

③ **Power Ramp**

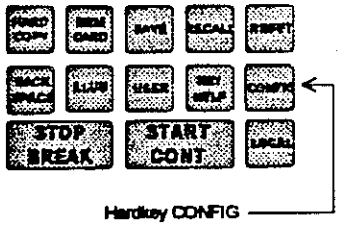
The measured power ramp is compared with the set tolerance windoe. As soon as the tolerance is exceeded in one point, the information "NOT MATCHING" appears in the middle of the display. To analyze details of the burst, the softkeys "RISING EDGE", "USEFUL PART" and "FALLING EDGE" are provided. Thus the edge or the upper part of the burst are made visisble (zoom). The softkey "FULL SCALE" permits to display the complete burst again.

Press the softkey "GRID ON/OFF" to fade a grid in or out. The "MARKER" softkey permits to activate the marker function so that the marker can be shifted on the curve using the rotary knob. The respective measured value is indicated.

The power ramp is recorded and tested approx. once per second. This also permits to perform adjustments in quasi real-time mode. During this measurement, another RF channel or another power can also be applied and measured. To this end press the respective softkeys in the right half of the menu.

④ **Configuration tolerance mask**

By pressing the "CONFIG" hardkey followed by the "POWER RAMP" softkey, the configuration menu for this measurement is entered. This menu can also be entered from the highest main menu via the configuration tree. This menu permits to adapt the tolerance mask to your own requirements which might be more stringent. GSM specifies nine segments for this mask which can be entered separately in this menu. The softkey "DEFAULT VALUES" at the top left restores the GSM settings. Both an absolute and a relative level is to be entered for segment A.



⑤ **Abort criterium**

The softkey "STOP COND." permits to enter an abort criterium. When the measurement exceeds the tolerance, the measurement a) continues or b) is immediately stopped. It is also possible to c) set single-shot operation, ie when pressing the softkey "POWER RAMP" exactly one measurement is performed.

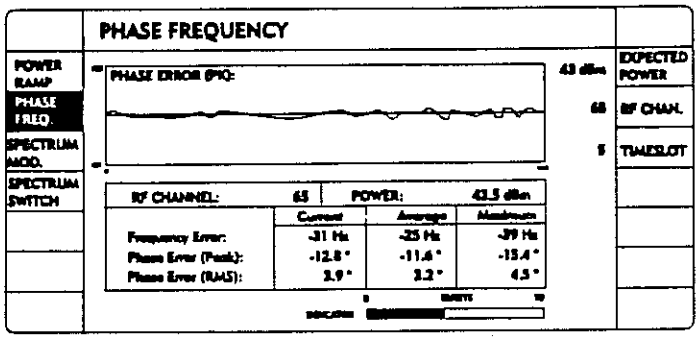
⑥ **MENU UP**

Press the MENU UP key to return to the measurement menu.

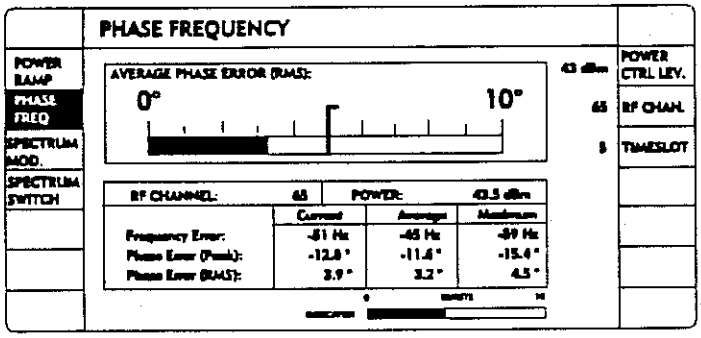
Phase and frequency error measurement

Step 7

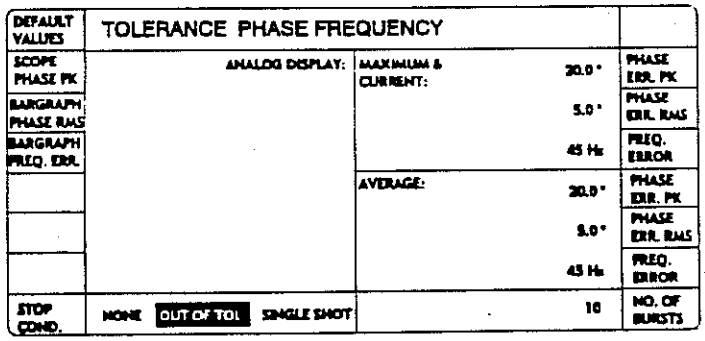
Select "PHASE FREQ." for graphical display of the phase and frequency error.



Both instantaneous and averaged and maximum results are displayed. ①



For adjustment purposes, the bar display is very helpful. ②



Use the hardkey "CONFIG" and the softkey "PHASE FREQ." to select the tolerance configuration and enter your own tolerance values.

Also set the desired result display. ③

Set the desired abort criterium for the measurement. ④

Press "MENU UP" to return to the measurement menu. ⑤

Additional information

Step 7

① **Phase and frequency error measurement**
GSM specifies a particular type of modulation (GMSK). The bits to be transmitted are contained in the phase information of the RF signal. Check that this modulation is observed as strictly as possible. The deviations are included in the measurement results phase and frequency error. As already mentioned in step 5, GSM specifies a peak phase error of max. 20°, an rms-weighted phase error of max. 5° and a frequency error of max. 0.05 ppm of the set RF frequency.

The CMD records the actual phase trajectory. The CMD calculates an ideal phase trajectory from the bits transferred and determined the deviations of the measured curve from the nominal curve.

The phase error versus time is graphically displayed by the CMD approx. once per second (oscilloscope mode). In addition, the average measured values and the maximum measured value occurred is displayed referred to a defined number of bursts. The bar indicator shows the progress of the average calculation.

② **Bar display**
The measured values for the frequency error and the rms-weighted phase error can also be shown in a bar display. This permits adjustments to be performed very easily.

During the measurement, a channel change or a power change can also be performed. Please press the respective softkeys in the right half of the menu.

③ **Configuration phase and frequency error**
By pressing the "CONFIG" hardkey followed by the "PHASE FREQ." softkey, the configuration menu is entered. This menu can also be reached from the highest main menu via the configuration tree.

This menu permits to adapt the tolerance mask to your own requirements which might be more stringent.

The softkey "DEFAULT VALUES" at the top left restores the GSM settings.

The average maximum limit values can also be specified in this menu. The number of bursts to be considered is specified using the softkey "NO. OF BURSTS".

The softkey "SCOPE PHASE PK" configures the display in oscilloscope mode (display as with the upper illustration).

The softkeys "BARGRAPH ...." configure the display of the meausrement results as bar display. The currently set operating mode is displayed on black background.

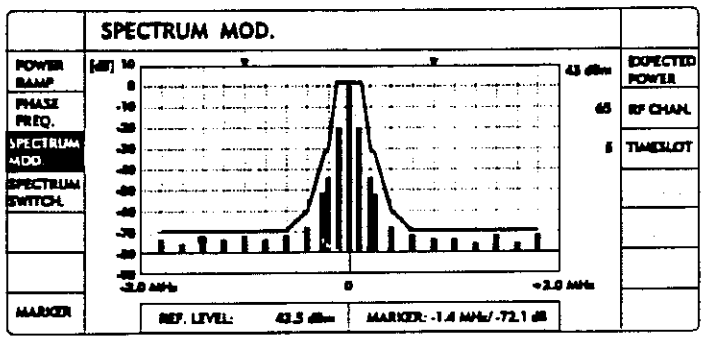
④ **Abort criterium**
The softkey "STOP COND." permits to enter an abort criterium. When the measurement exceeds the tolerance, the measurement a) continues or b) is immediately stopped. It is also possible to set c) single-shot operation, ie when pressing the "PHASE FREQ." softkey, exactly one measurement is performed. The set operating mode is displayed on black background.

⑤ **MENU UP**
Press the MENU UP key to return to the measurement menu.

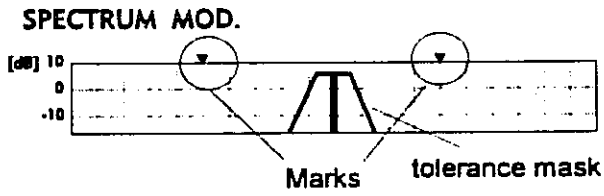
Modulation spectrum measurement

Step 8

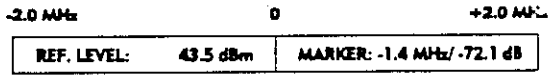
Select "SPECTRUM MOD." to call the measurement of the modulation spectrum.



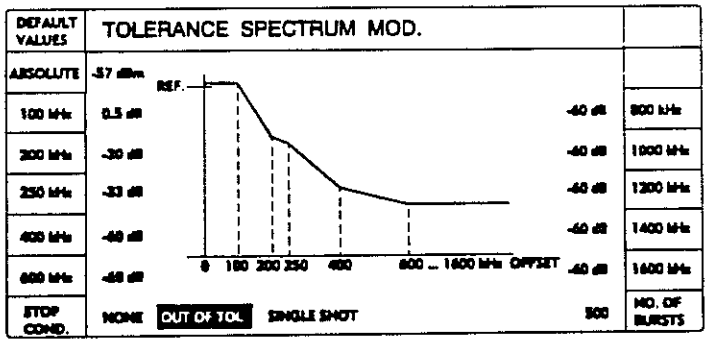
The modulation spectrum is displayed up to the maximum offset frequency of ± 1.8 MHz. ①



The current measurement is marked by triangles. ②



The marker exactly indicates the measured value. ③



Use the "CONFIG" hardkey and the "SPECTRUM MOD." softkey to select the tolerance configuration and enter your own tolerance values. ④

Select the number of bursts to be considered. ⑤

Set the desired abort criterium for the measurement. ⑥

Press "MENU UP" to return to the measurement menu. ⑦

Additional information

Step 8

① **Measurement of the modulation spectrum (Spectrum Due To Modulation)**
Due to the GMSK modulation the data bits produce one spectrum per burst on the used RF channel as well as on the adjacent channels.

The spectrum must be checked at the carrier frequency and at the up to 22 adjacent frequencies. It must not exceed the tolerances specified by GSM. The measurement result is characterized by one measured value per offset frequency.

The CMD records the power ramp at each of the specified offset frequencies up to ± 1.8 MHz and with the dynamic of more than 75 dB required for this measurement, but evaluates only the frequencies up to ± 1.6 MHz. A particular number of bursts is considered per frequency.

The CMD uses the power values (recorded and filtered using a 30-kHz filter) to calculate the modulation spectrum and displays the result graphically.

In order to fully utilize the dynamic range of the CMD note that the timeslot to be measured uses the highest level related to the other timeslots on this carrier.

Due to the sampling technique, the CMD achieves an extremely high measurement rate. The measuring time for 23 frequencies and 500 bursts per frequency is approx. 60 seconds.

During the measurement, a channel change or power change can be performed. Please press the respective softkeys in the right half of the menu.

② **Marking**
The triangular marks at the top of the menu display exactly indicate the offset frequency being calculated. The measured values outside the marked area are the results of a previous measurement, the measured values inside the marked area are the results of the currently running measurement.

③ **Marker**
A marker can be set to each measured value using the rotary knbo. The respective mesurement result is indicated as numerical value.

④ **Configuration Spectrum Due To Modulation**
By pressing the "CONFIG" hardkey followed by the "SPECTRUM MOD." softkey, the configuration menu can be entered. This menu can also be reached from the highest main menu via the configuration tree. This menu permits to adapt the tolerance mask to your own requirements which might be more stringent. The values per offset frequency are to be set using the respective softkeys. The weaker requirement of absolute and relative limit value is used as tolerance limit, ie, if the relative values are smaller than the absolute value, they are not considered.

Example:	Settings:	Absolute -27 dBm, relative at 200 kHz: -30 dB
	Measurements:	Burst power at the carrier frequency: 0 dBm,
→	Tolerance limit at 200 kHz:	-27 dBm, since weaker requirement.

The softkey "DEFAULT VALUES" at the top left restores the GSM settings.

⑤ **Number of bursts**
The number of bursts to be considered is specified using the softkey "NO. OF BURSTS".

⑥ **Abort criterium**
The softkey "STOP COND." permits to enter an abort criterium. When the measurement exceeds the tolerance, the measurement a) continues or b) is stopped immediately. It is also possible to set c) single-shot operation, ie when pressing the softkeys "SPECTRUM MOD." exactly one measurement is performed. The set operating mode is displayed on black background.

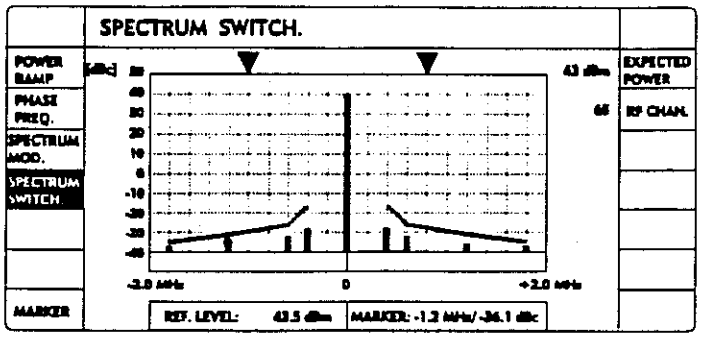
⑦ **MENU UP**
Press the MENU UP key to return to the measurement menu.

Spectrum Due To Switching

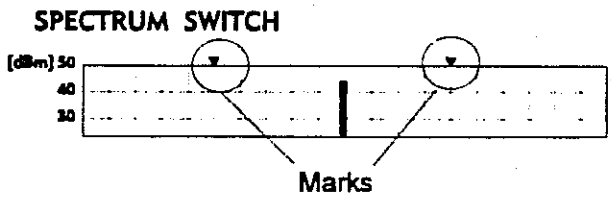
SPECTRUM SWITCH.

Step 9

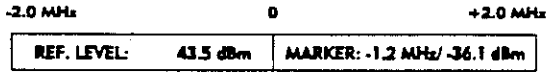
Select "SPECTRUM SWITCH." to call the switching spectrum.



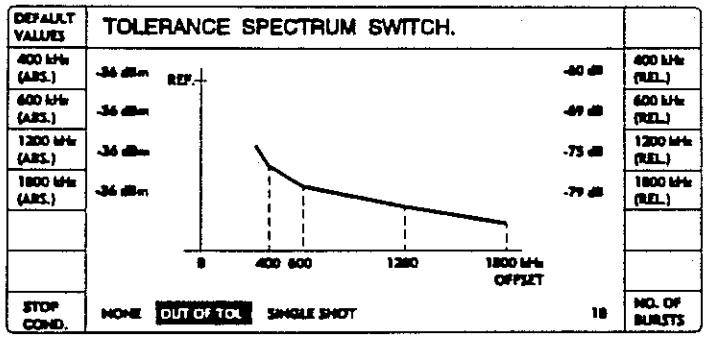
The switching spectrum is displayed up to the maximum offset frequency of ± 1.8 MHz. ①



The current measurement is marked by triangles. ②



The marker exactly indicates the measured value. ③



Use the "CONFIG" hardkey and the "SPECTRUM SWITCH." softkey to select the tolerance configuration and enter your own tolerance values. ④

Select the number of bursts to be considered. ⑤

Set the desired abort criterium for the measurement. ⑥

Press the "MENU UP" key to return to the measurement menu. ⑦

Additional information

Step 9

① **Measurement of Spectrum Due To Switching**
GSM exactly specifies the switching response of the power. The case may arise where although the power ramp is within the tolerances (see Step 2), disturbances occur in the adjacent channels due to fast switching on and off.

The spectrum must be checked at several adjacent frequencies and must not exceed certain tolerances specified by GSM. The measurement result is characterized by one measured value per offset frequency.

As with the measurement "Spectrum Due To Modulation" the measured values are calculated (see also Step 4, note ①), however a 100-kHz filter is used in this case. In its default setting, the CMD records ten bursts for each offset frequency. The time required for a complete measurement is a few seconds.

Caution: As a result of the filtering, the measured value "REF. LEVEL" is not identical with the power of the set power level.

During the measurement, a channel change or a power change can be performed. To this end, press the respective softkeys in the right half of the menu.

② **Marking**
The triangular marks at the top of the menu display exactly indicate the offset frequency being calculated. The measured values outside the marked area are the results of a previous measurement, the measured values within the marked area are the results of the currently running measurement.

③ **Marker**
A marker can be set to each individual measured value using the rotary knob. The respective measurement result is displayed as numerical value.

④ **Configuration Spectrum Due To Switching**
Pressing the hardkeys "CONFIG" followed by the softkey "SPECTRUM SWITCH." permits to enter the configuration menu. This menu can be reached even from the highest main menu via the configuration tree. This menu permits to adapt the tolerance mask to your own requirements that might be more stringent. The values per offset frequency are to be set using the respective softkeys. The weaker requirement of absolute and relative limit value is used as tolerance limit, ie if the relative values are smaller than the absolute value, they are not considered.

Example:	Settings at 400 kHz:	Absolute -23 dBm, relative: -60 dB
	Measurements:	Burst power at the carrier frequency: 35 dBm,
→	Tolerance limit at 400 kHz:	-23 dBm, since weaker requirement.

⑤ **Number of bursts**
The number of bursts to be considered is specified using the softkey "NO. OF BURSTS".

⑥ **Abort criterium**
The softkey "STOP COND." permits to enter an abort criterium. When the measurement exceeds the tolerance, the measurement a) continues or b) is stopped immediately. It is possible to set c) single-shot mode, ie on pressing the softkeys "SPECTRUM SWITCH." exactly one measurement is performed. The set operating mode is displayed on black background.

⑦ **MENU UP**
Press the MENU UP key to return to the measurement menu.

Step 10

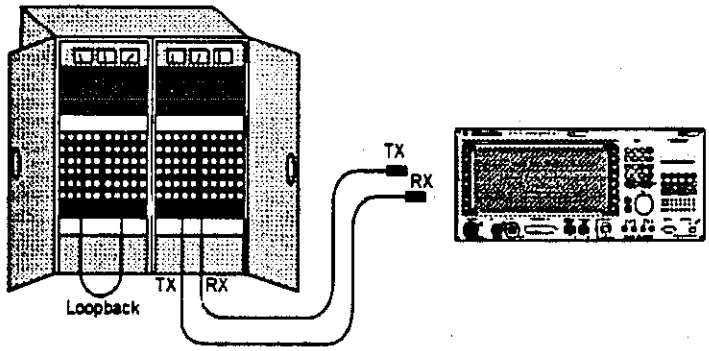
Receiver measurements

The receiver measurement of the base station can be performed in various ways, depending very much on the implementations of the manufacturers. The following illustrations show different configurations with the CMD. This variety will certainly offer the optimal configuration for the sensitivity measurement of your base station.

Note that the BTS must be set to the operating mode required to perform the measurements using an external computer, a service kit or similar.

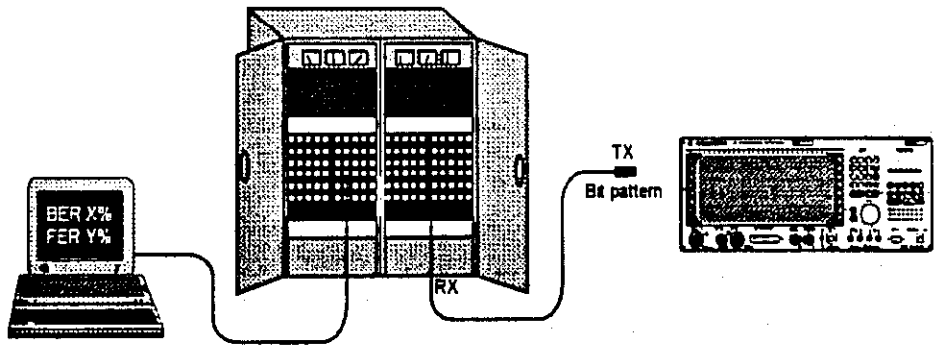
Possibility 1:

CMD evaluates, CMD sends bit pattern, BTS in loopback mode.



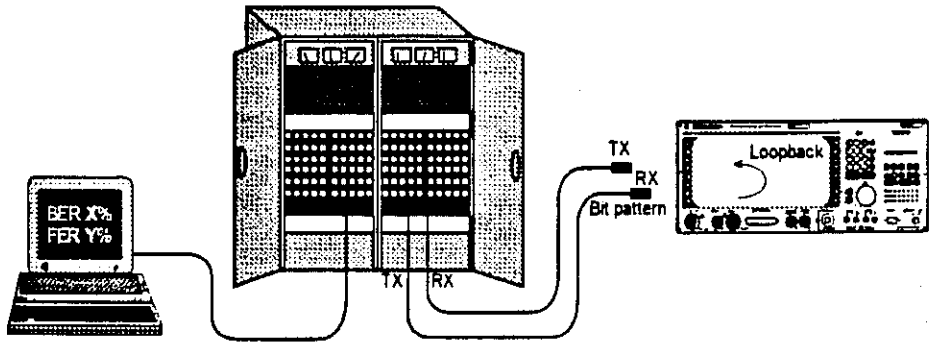
Possibility 2:

BTS evaluates, CMD sends bit pattern.



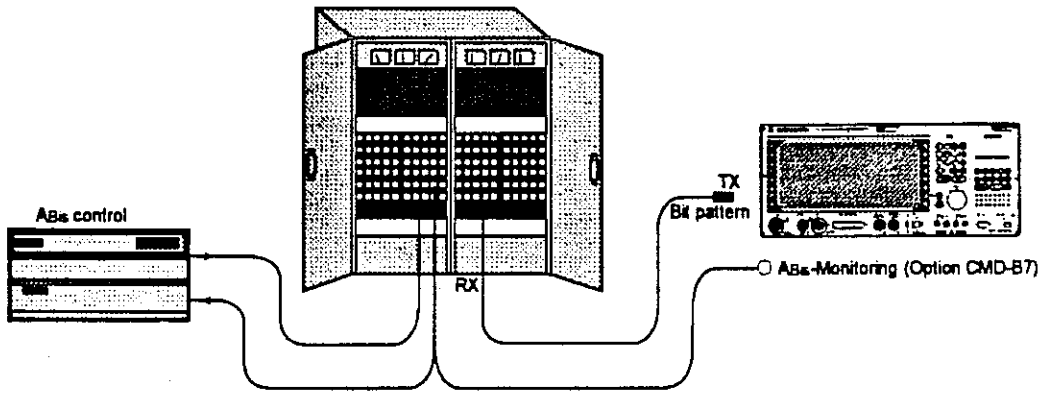
Possibility 3:

BTS evaluates, BTS sends bit pattern, CMD in loopback mode.



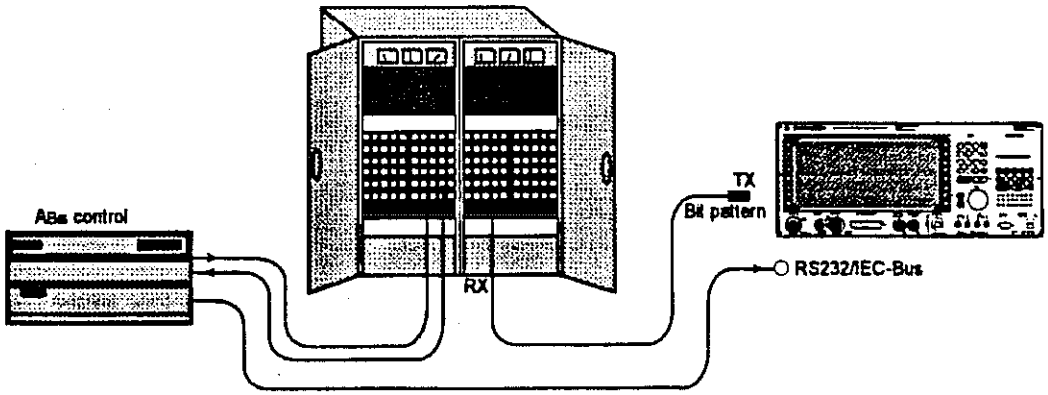
Possibility 4:

CMD evaluates, CMD sends bit pattern, BTS receives bits via RF, CMD monitors at ABis-Interface (Monitoring, with Option CMD-B7).



Possibility 5:

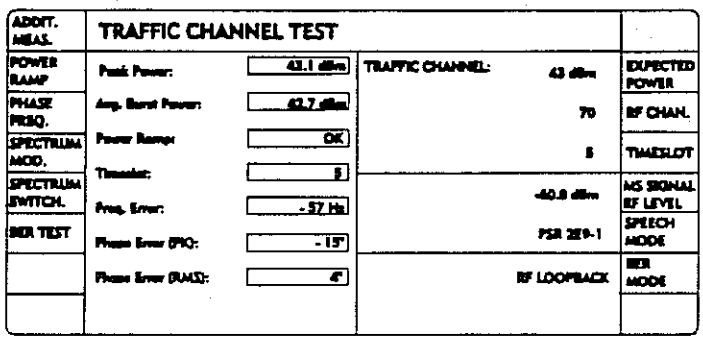
CMD evaluates, CMD sends bit pattern, BTS receives bits via RF, transmission to CMD via RS232/IEC bus, (only possible in remote-control mode).



Receiver measurements

Steps 10

Press "MENU UP" again to return to the menu "TRAFFIC CHANNEL" TEST.



The receiver measurements can be started from the opposite menu. ①

43 dBm — EXPECTED POWER
70 — TCH RF CHAN.
5 — TCH TIMESLOT

Set the RF channel and the timeslot of your receiver.

When the BTS transmitter is required again, enter the expected transmitting power. ②

-60.0 dBm — MS SIGNAL RF LEVEL
PSR 2E9-1 — SPEECH MODE
RF LOOPBACK — BER MODE

Enter the transmitting power of the CMD and select the data to be transmitted. ③

ABIS — BER MODE

This softkey only appears if the Option CMD-B7 (ABIS card) is installed. Select whether you want to perform the sensitivity measurement via ABIS interface or RF loopback. ④

BER TEST

Select this softkey to reach the menus for the bit error rate measurement. ⑤

Additional information

Step 10

① **Traffic channel test**
The measurements described so far are performed on the transmitter of the base station. A very important test is the sensitivity test of the base station receiver. This menu permits to reach the settings for the transmit data if the evaluation is to be in the BTS as well as the evaluation menus for the bit error rate measurement if the evaluation is done by the CMD.

② **TCH parameters**
Enter the channel number and the timeslot of the receiving channel. As already described before, the transmitter path of the BTS can be used for some possible measurements (eg loopback in the BTS or time synchronization). Please enter the transmitting power of the transmitter in this case.

③ **Transmitting level and data**
For the sensitivity measurement of the receiver, the transmitting level of the CMD can be set. The CMD will immediately send out with this level. Enter a new value via the numerical keypad or using the rotary nob.

Using the softkey "SPEECH MODE" select the transmit data to be used for the sensitivity test. The rotary knob can be used to switch between the different possibilities. The set operating mode is immediately active and the respective data are sent.

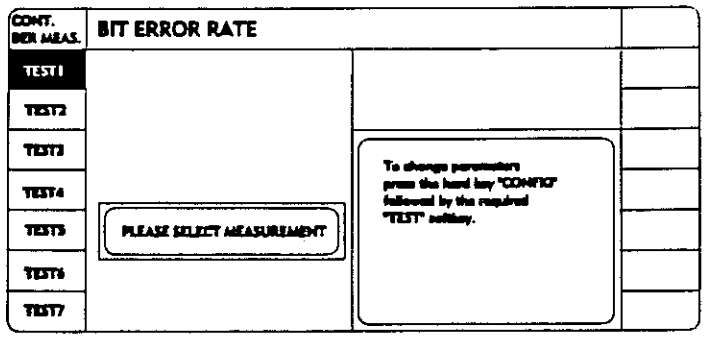
ECHO	The CMD returns all data received on the TCH after 50 speech frames (echo). If the CMD does not receive any speech data in this operating mode, dummy bursts are sent automatically.
PSR 2E9-1	Transmission of pseudo random sequence to CCITT O.153
PSR 2E11-1	Transmission of pseudo random sequence to CCITT O.153
PSR 2E15-1	Transmission of pseudo random sequence to CCITT O.151
PSR 2E16-1	Transmission of a pseudo random sequence (Polynomial: $x^{16}+x^5+x^3+x^2+1$)
Loopback	The CMD returns all data received on the TCH after 1 speech frame.

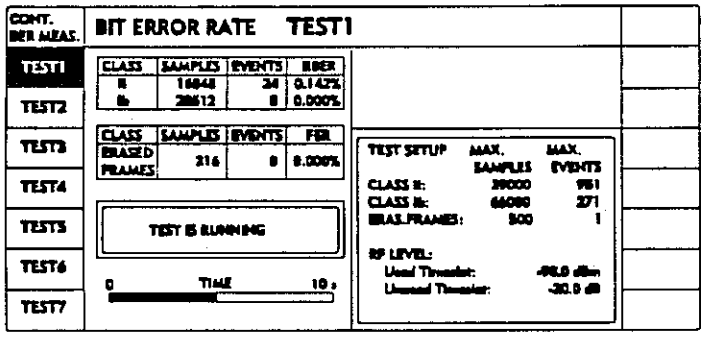
④ **BER MODE**
If the Option CMD-B7 (ABIS Interface) is installed in the CMD, the evaluated data can be returned to the CMD both via the RF and via the ABIS interface. Please select the desired operating mode.
a) RF loop: The CMD expects the sent speech data to be received by the BTS and returned as valid speech data. To this end, a loop must be closed ahead of the speech decoder and after speech coder from the point of view of the CMD (this corresponds to the measuring method of the sensitivity for GSM mobile phones).
b) ABIS Interface: The CMD can monitor the data received by the BTS at the activated ABIS interface and use the data for bit error rate calculation. The data received at the ABIS interface must not be speech-decoded yet.

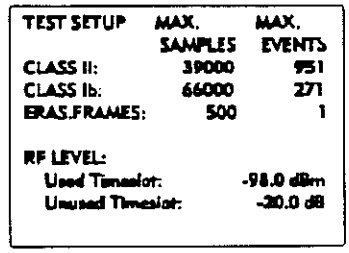
Note:
In remote-control mode, the evaluation data can additionally be returned to the CMD via the RS232 or the IEC-bus interface.

⑤ **BER TEST**
If you have selected eg one of the pseudo random sequences under "SPEECH MODE" and your base station returns the data to be evaluated to the CMD via the transmission path, the evaluation may be performed in the CMD. Pressing of this softkey causes the CMD to change to the bit error rate evaluation menus.

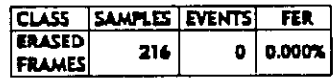
BER evaluation in the CMD (Single BER)



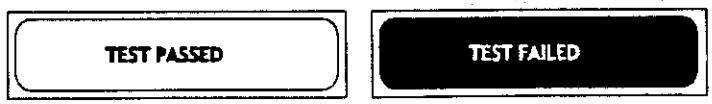




CLASS	SAMPLES	EVENTS	RBER
II	16848	24	0.142%
Ib	28512	0	0.000%



CLASS	SAMPLES	EVENTS	FER
ERASED FRAMES	216	0	0.000%



Step 11

Each of the "TEST" softkeys is preprogrammed and a test can be called by pressing the respective softkey. ①

Select eg "TEST1" to perform a test.

TEST 1 is called and performed with preset parameters. ②

The test parameters and the tolerances are indicated on the right side of the display. ③④

While a test is running, the current status is displayed. ③④

At the end of the test, the measurement result is displayed in a clearly readable way. ⑤

Additional information

Step 11

① **BER TEST menu**
This menu permits to call preset measurements. This is very useful eg when putting a base station into operation, since all that is needed is to call a preprogrammed test without the need for knowing details of the measurement. The settings can be configured at will.

Furthermore, the continuous BER measurement can be accessed. This will be explained in the next step.

② **Default Values**
The default values comply with the tests of GSM specification 11.20.

③ **Bit classes**
The speech bits transferred in the GSM system are divided into classes. Class II bits feature no error protection and are therefore very sensible to transmission errors. Class Ib bits feature a limited error protection, class Ia bits are very well protected. The bits are transferred in frames of 260 bits (without error protection bits). The BTS itself can detect errors of class Ia bits, declare a complete frame to be faulty and thus invalid and report this to the CMD. The ratio between good and invalid frames is referred to as FER = Frame Erasure Rate.

④ **Samples and events**
A particular test is to sent a certain number of frames with a certain number of bits of the different classes. The bits correspond to the samples to be sent.

The fact that a certain number of frames or bits is faulty can be accepted at a certain (low) RF level. These are the maximally acceptable events. At any time, during and at the end of the test, the CMD indicates the ratio (BER = bit error rate) (BER = events / samples x 100).

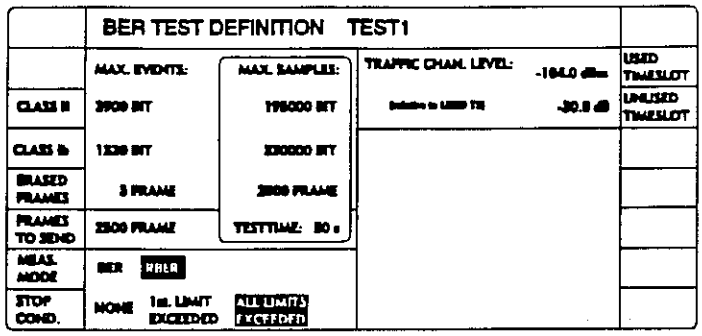
⑤ **Test result**
The details of a BER test being very complex, the result is calculated by the CMD and displayed. If the test is to be repeated, it is sufficient to press the respective "TEST" softkey again.

In the event that a BER test is not terminated with "PASS", please note the following:

1. Make sure that the cable attenuations or additional attenuator pads are considered by the CMD. External attenuations can be entered in the configuration menu "RF CONNECTOR/EXT. ATTENUATION" for each output. This menu can be reached either from the main configuration menu or from the menu "MANUAL BTS TEST".

   During the test, the receiver is checked with very small RF signals. Low additional attenuations may already cause the CMD to display "FAIL". High-grade cables and RF connectors must be used to obtain correct measurement results. Dirty or broken connections quickly cause problems, in particular at the high frequencies used by GSM and PCN.

Select the "CONFIG" hardkey and a softkey, eg "TEST 1".



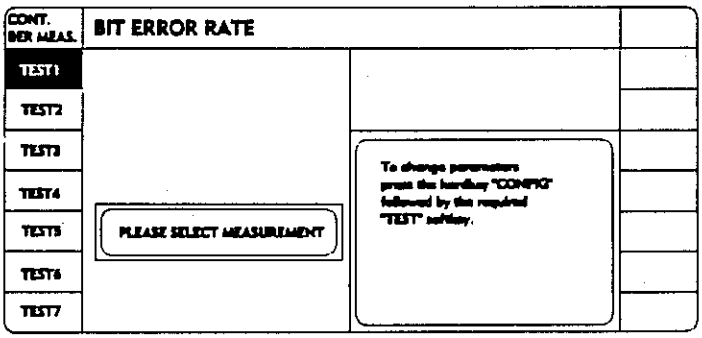
You can now assign your individual test parameters to the selected softkey. ①

Press "MENU UP" to return to the measurement menu.

BER evaluation in the CMD (Continuous BER)

Step 12

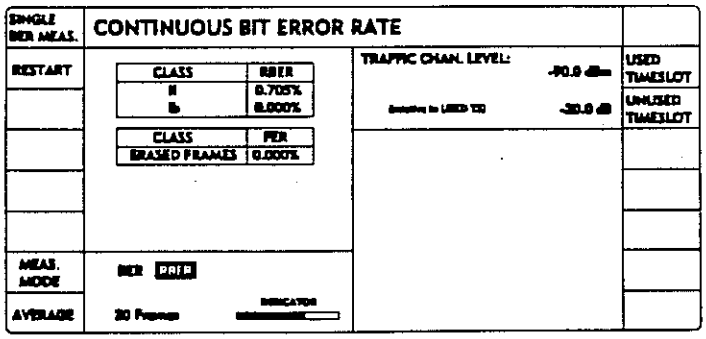
Press "MENU UP" to return to the selection menu.



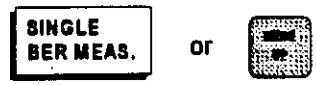
Select the softkey

CONT. BER MEAS.

in the opposite menu for the continuous BER measurement. ②



The continuous BER measurement is excellently suitable for adjusting purposes.



Selection of one of these keys permits to return to the next higher menu.

Reference Description

2.2 Menu Structure

The CMD makes use of a very clear menu structure for user prompting. This allows measurement results to be easily read off. Setting parameters that are only rarely required are to be found in separate menus.

Starting with the initial menu, various menu paths can be selected. The first selection probably refers to the operating modes GSM or DCS1800 / PCN in the case of model CMD57.

For GSM-specific measurements on modules, boards or complete base stations (BTS) two menu paths are provided.

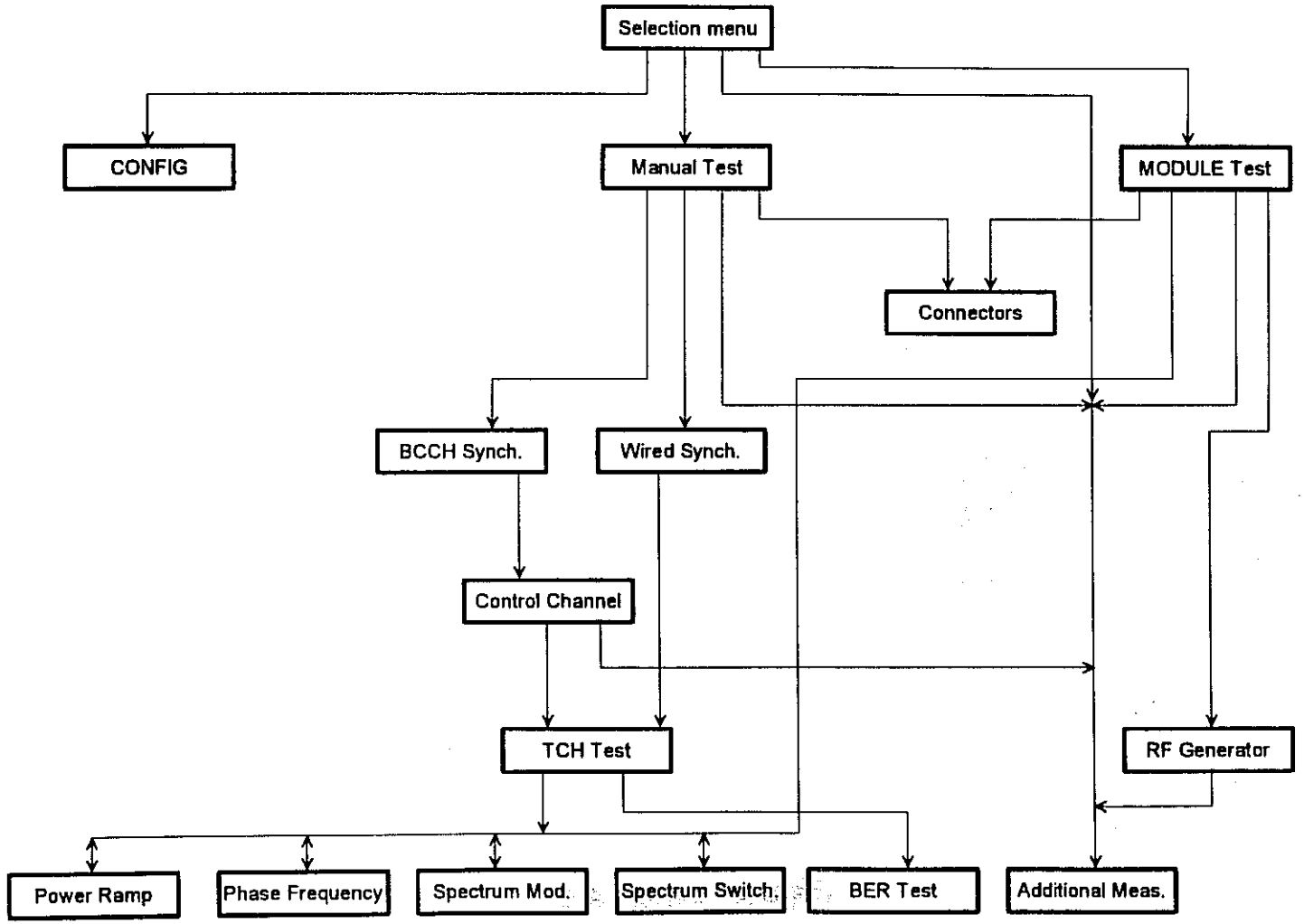
Menu path MANUAL TEST. The test item and the CMD are synchronized with each other either via RF by means of trigger signals. Thus a fixed time reference is defined even before the measurements are started. The time when eg time slot 2 or 3 are active is also defined exactly; thus accurate time-slot GSM measurements can be performed. In addition to the most frequent transmitter measurements like power ramp and phase and frequency error, the receiver measurements are also available. Transmitter measurements on the BCCH and TCH can be performed as well as receiver measurements on the TCH. A short keystroke permits to call up the DC and AF measurements in the ADDITIONAL MEASUREMENTS menu from almost all menus.

Menu path MODULE TEST. This menu path allows for the most frequenctly used transmitter tests without the need for a special synchronism between test item and CMD. It is important that the test item usually transmits bursts with midamble so as to be able to establish a correct time reference during the measurement. The phase and frequency error measurement can be performed via this path. For receiver measurements, a special generator is available.

Menu path CONFIG. If you wnat, eg, to set your own tolerances, external attenuations or use particular inputs and outputs of the instrument during the test, select the menu path CONFIG. In addition to the parameters mentioned, the reference frequency source can also also configured here.

Menu path ADDIT. MEAS. In order to perform measurements on modules or boards referring to voltage, current or AF measurements, the menu path ADDIT. MEAS is to be selected.

Thus, the user-friendly menu concept quickly and easily leads to correct and usable measurement results.



2.3 Basic Steps of Operation

Numerical entry (VAR spinwheel permissible)

With the softkey on a bright background, no entry is possible. Pressing of the softkey causes the softkey to be displayed on dark background and a small VAR symbol to appear, indicating that the VAR spinwheel can be used.

1) Rotation of the VAR spinwheel directly increases or reduces the setting value.

2) Pressing the first numerical key causes an input window to be opened, which already displays the first digit. The small VAR symbol is masked, the spinwheel variation can no longer be used. Then further digits can be entered. BACKSPACE deletes the last digit, CLEAR is used to clear the complete entry, STOP BREAK causes the input window to be closed without recording the value. Terminating the entry with ENTER or a unit key causes the desired value to be set, the input window to be closed and leaves the softkey labelled in inverted form and featuring the VAR symbol. Spinwheel variation is now possible again. Press any other softkey or the ENTER key or the same softkey to render this softkey inactive, which is shown by the softkey being displayed on bright background.

3) Units:

a) The entry of numerical values can be terminated by pressing the unit key.
[1] [5] [dBm] ⇒ 15 dBm

b) When using the ENTER key, the currently provided unit is used again.
[1] [7] [ENTER] ⇒ 17 dBm

c) For parameters without units, e.g. "power stages", there are no specific unit keys. Either the ENTER key or a forbidden unit key can be used to terminate the entry.
[1] [4] [Hz or kHz or MHz] ⇒ Power stage 14
forbidden unit keys

[1] [5] [ENTER] ⇒ Power stage 15

d) Conversion of units is accomplished by pressing the respective (forbidden) unit key.

Power stage 15	[dBm]	⇒ 13 dBm
13 dBm	[Hz]	⇒ Power stage 15
5000 Hz	[kHz]	⇒ 5.000 kHz

1 out of n selection with softkeys

1 out of n softkeys describe n different possible operating modes.
One of the n possibilities is always active, marked by inverse display.

Loop Toggle

Two (or several) operating states are faded in next to a softkey. The softkey being active is marked by inverse display. Changing of the operating state is effected by (repeated) pressing of the softkey.

Selection with confirmation

After activation of the softkey, all possible settings can be selected using the rotary knob. The settings are to be confirmed using the ENTER key.

Hardkeys

In addition to the measurement menus, a number of configuration menus are provided, which permit to specify and vary parameters for measurements as well as default settings. These configuration menus can be selected directly via the "CONFIG menu tree" on the one hand; on the other hand, it is possible to press the CONFIG key in a measurement menu and subsequently press a softkey to call the configuration menus associated with this measurement menu.

This key permits to change to the next higher menu. For example, it is thus possible to leave configuration menus or partial submenus.

This key permits to return directly to the selection menu.

Printer mode

After pressing the HARD COPY key, the current screen display is output on a connected printer. Since the output is in graphics mode, it is necessary to call the printer configuration menu in the configuration menu using the PRINTER softkey in order to select the appropriate printer driver.

RESET

After pressing the RESET key the menu shown in Fig. 2.3-1 is called.

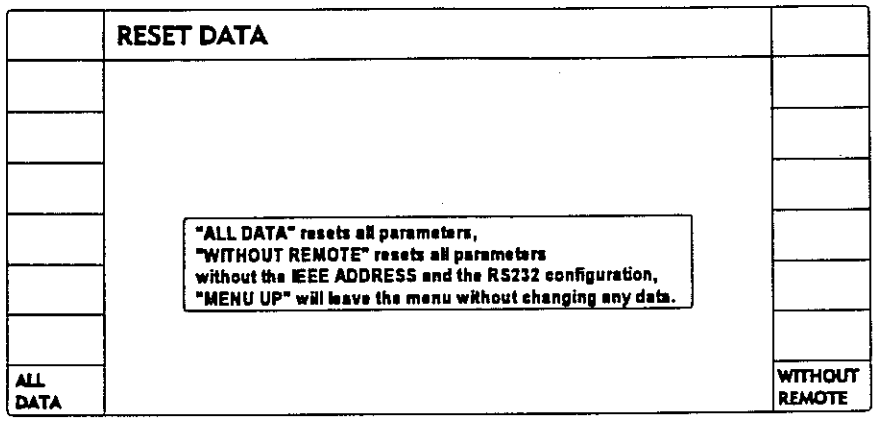


Fig. 2.3-1 RESET DATA menu

The functions offered in this menu permit the user to set the CMD to a default status predefined by Rohde & Schwarz.

ALL DATA All device-internal parameters including the remote registers are reset.

WITHOUT REMOTE All device-internal parameters are reset; however, this does not apply to the remote register. This function is to be preferably used in remote mode in order for the remote connection not to be interrupted.

If no reset is to be performed, the menu can be left using then MENU HOME or MENU UP keys.

After execution of the two reset functions a change is made to the Home menu.

User selection

By pressing the USER key the menu shown in Fig. 2.3-2 is called.

	USER		
USER 1	MUSTERMANN	MUSTERFRAU	USER 8
USER 2	MUELLER	MY DATA	USER 9
USER 3	MAYER		USER 10
USER 4	SCHMIDT		USER 11
USER 5	UNKNOWN		USER 12
USER 6	NOT KNOWN		USER 13
USER 7	NOBODY		USER 14

Fig 2.3-2 USER menu

The SAVE/RECALL functions in the CMD can be used by several users (max. 14) independently of each other. This permits every user to store his own settings with his own names on a directory of his own.

This user directory is selected by pressing one of the softkeys in the USER menu. The menu can be left using the MENU UP or MENU HOME keys.

The user names are entered in an extra configuration menu (see Fig.2.3-3). This can be called from the USER menu (Fig. 2.3-2) by pressing the CONFIG key.

	CONFIGURATION		
USER 1	MUSTERMANN	MUSTERFRAU	USER 8
USER 2	MUELLER	MY DATA	USER 9
USER 3	MAYER		USER 10
USER 4	SCHMIDT MUELLER		USER 11
USER 5	UNKNOWN		USER 12
USER 6	NOT KNOWN		USER 13
USER 7	NOBODY		USER 14

Fig. 2.3-3 CONFIGURATION menu

After activation of the associated softkey, the respective user name can be entered via the numeric keypad and confirmed using the ENTER key. When an external AT keyboard is connected (rear of instrument), an alphanumerical entry is also possible.

The MENU UP key permits to return to the USER menu (Fig. 2.3-2).

SAVE/RECALL function

The SAVE function is used to store the current instrument setup of the CMD. The RECALL function loads a stored setup.

After pressing the SAVE key, the menu shown in Fig. 2.3-4 is called.

	SAVE USER 4 SCHMIDT		
1	FILE_XYZ	FREE	8
2	SETTING 1	FREE	9
3	FREE		10
4	FREE	FREE	11
5	FREE	FREE	12
6	SETTING 5	SPECIAL	13
7	FREE	MEMCARD INTERN	MEMORY

Fig. 2.3-4 SAVE menu

1 to **13**

By pressing one of these softkeys, the current instrument setup is stored under the name indicated next to the softkey. These names can be changed in a configuration menu (see Fig. 2.3-5). Depending on the setting of the MEMORY softkey, the internal hard disk of the CMD or a memory card serve as storage medium.

MEMORY

Selects the storage medium.

"INTERNAL" position: The instrument setup is stored on the CMD-internal hard disk on pressing one of the softkeys 1 to 13. The CMD provides 13 memories per user.

"MEMCARD" position: The instrument setup is stored on the memory card on pressing one of the softkeys 1 to 13 (only with Option CMD-B6 and CMD-B62). In contrast to "INTERNAL", only a total of thirteen memories are provided, and there is no user selection.

The menu can be left using the keys MENU UP or MENU HOME.

After pressing the CONFIG key in the SAVE menu (Fig. 2.3-4) the configuration menu for entering the memory name is called up (see Fig. 2.3-5).

	CONFIGURATION		
1	FILE_XYZ	FREE	8
2	SETTING 1	FREE	9
3	FREE		10
4	FREE Test 13.11 - 13.12	FREE	11
5	FREE	FREE	12
6	SETTING 5	SPECIAL	13
7	FREE		

Fig. 2.3-5 CONFIGURATION menu

After activation of the associated softkey, every memory name can be entered via the numerical keypad and confirmed using the ENTER key. When an external AT keyboard is connected (rear of instrument), an alphanumerical entry is also possible.

Note:
If settings are stored on the memory card, the configured name is also written to the memory card as directory name.

The MENU UP key permits to return to the SAVE menu (Fig. 2.3-4).

By pressing the RECALL key the menu shown in Fig. 2.3-6 is called.

DEFAULT VALUES	RECALL USER 4 SCHMIDT		
1	FILE_XYZ	FREE	8
2	SETTING 1	FREE	9
3	FREE		10
4	FREE	FREE	11
5	FREE	FREE	12
6	SETTING 5	SPECIAL	13
7	FREE	MEMCARD INTERN	MEMORY

Fig. 2.3-6 RECALL menu

1

to

13

By pressing one of these softkeys, the instrument setting is loaded which is stored under the name indicated next to the softkey. The storage medium is the internal hard disk of the CMD or a memory card (depending on the setting of the MEMORY softkey).

MEMORY

Selects the storage medium.

"INTERNAL" position: The instrument setting is loaded from the CMD-internal hard disk on pressing one of softkeys 1 to 13.

"MEMCARD" position: The instrument setting is loaded from a memory card (only with Option CMD-B6 and CMD-B62) on pressing one of the softkeys 1 to 13. The setting is only selected according to the storage medium, the user name is not considered.

Note:
Reading of the directory of the memory card is started when the menu is entered. In order for the file name and the file data to comply with each other, the menu is to be left first and recalled again when the card is changed.

The menu can be left using the keys MENU UP or MENU HOME.

2.4 Description of the Menus

2.4.1 Default Menu

After switching on the instrument, the default menu is displayed for a few seconds. While this menu is being displayed, the CMD performs a selftest. The initial menu indicates the software version installed in the instrument and shows built-in options. Then a change is made to the selection menu.

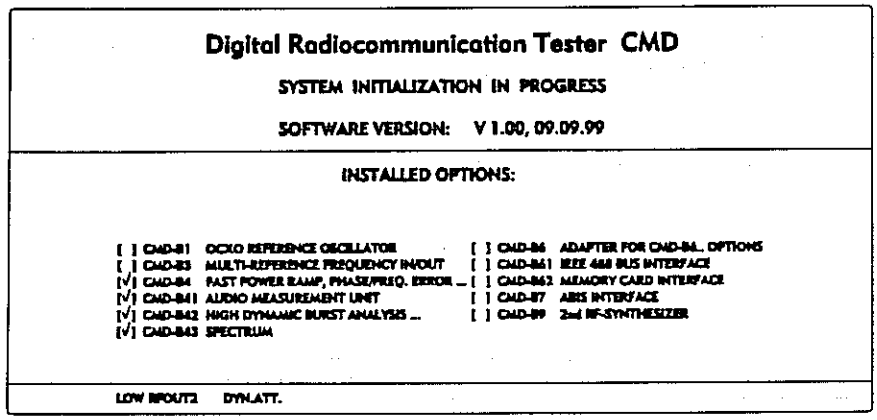


Fig. 2.4-1 Default menu

2.4.2 Selection Menu

After selecting the operating mode GSM or DCS1800 (PCN), the specific measurements provided by the instrument in this menu by pressing a softkey.

Fig. 2.4-2 Selection menu

ADDIT. MEAS.

Selection of the menu ADDITIONAL MEASUREMENTS. This menu permits to perform DC voltage, several DC current and AF measurements (only with Option CMD-B41) (see section 2.4.5.1).

MANUAL TEST

Selection of the BTS TEST menu. This menu permits to start base-station measurements in time-synchronized mode (see section 2.4.3.1)

MODULE TEST

This main menu permits to perform measurements on modules or on GSM/PCN base stations in service mode (unsynchronized) (see section 2.4.6).

NETWORK TYPE

Switchover between GSM and PCN (DCS-1800) mode (only model 57). After pressing of this softkey, the desired network can be selected using the VAR spinwheel with subsequent pressing of the ENTER key.

CONFIG MENU

Selection of the configuation menus (see section 2.4.7).

Specifications of GSM, PCN (DCS-1800) and PCN (PCS-1900)

	GSM	PCN (DCS-1800)	PCN (PCS-1900)
Frequency range MS ⇒ BS	890...915 MHz	1710...1785 MHz	1850...1895 MHz
Frequency range BS ⇒ MS	935...960 MHz	1805...1880 MHz	1930...1975 MHz
Duplex spacing	45 MHz	95 MHz	80 MHz
Channels	1...124	512...885	512...735
Channel spacing	200 kHz	200 kHz	200 kHz

2.4.3 Manual Test

2.4.3.1 BTS TEST Menu

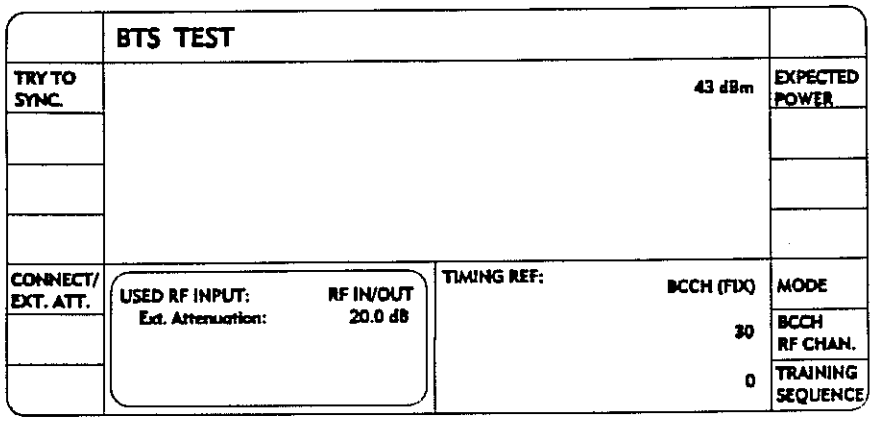


Fig. 2.4-3 BTS TEST menu

TRY TO SYNC.

After pressing of this key, the CMD tries to get synchronized to the specified BCCH carrier. After successful synchronization, the CONTROL CHANNEL menu is selected (Mode = BCCH (Fix)).
The CMD tries to get synchronized to the applied trigger signal. Then a change is made to the TCH TEST menu (Mode = Ext. Trigger).

CONNECT/ EXT. ATT.

This softkey permits to call a configuration menu in which the RF inputs and outputs of the CMD can be selected. If external attenuations are used or a path attenuation is included in the test setup, the values for the attenuation can be entered here (see section 2.4.7.6).

EXPECTED POWER

After pressing this key, enter the expected transmitting power of your test item on the numerical keypad. To be on the safe side, enter a level that is about 2 to 3 dB higher, e.g. transmitter level -20 dBm --> setting -18 dBm or transmitter level 40 dBm --> setting 42 dBm.

MODE

Synchronization with the RF carrier (C0/BCCH) or an external trigger signal: superframe clock at multifunction port pin 27.

BCCH RF CHAN.

Only with BCCH (FIX) mode: After pressing this key enter the channel number of the BCCH carrier on the numerical keypad. Note that the channel spacing to the TCH carrier must be at least 30 channels (test only possible with mode = BCCH (Fix)).

TRAINING SEQUENCE

Only with EXT.TRIGGER mode: Input of the training sequence of the test item.

2.4.3.2 CONTROL CHANNEL Menu

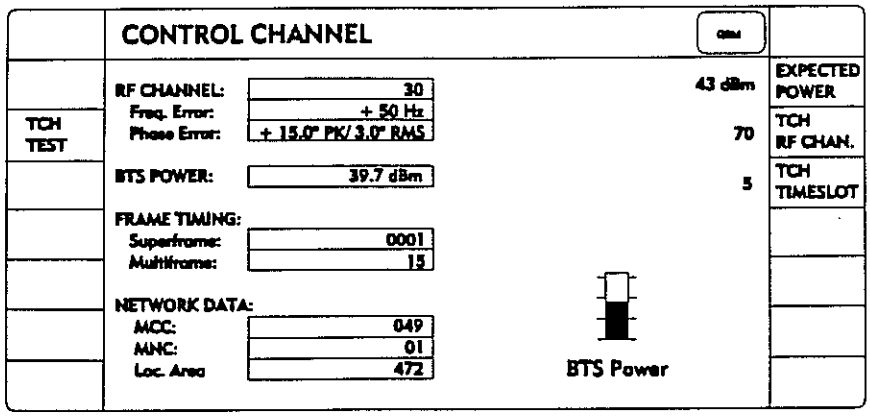


Fig. 2.4-4 CONTROL CHANNEL menu

As soon as this menu is displayed, the first measurement results of the BCCH carrier can be read in the result fields. The currently set channel number and the associated phase and frequency error are indicated at the top. The measured transmitting power of the BCCH carrier can be read below.

The BCCH carrier transfers synchronization information. The superframe and multiframe number currently transmitted by the base station is displayed and continuously updated.

The parameters "Mobile Country Code" (MCC), "Mobile Network Code" (MNC) and "Location Area Code" (LAC) received by the CMD on the BCCH are also indicated. E.g. the meaning of MCC = 262: country code for Germany.

TCH TEST — This key permits to select the TCH TEST menu, where the individual measurements are performed on the specified TCH carrier activated by the BTS.

EXPECTED POWER — After pressing this key, enter the expected power of your test item on the numerical keypad. To be on the safe side, enter a level that is about 2 to 3 dB higher, e.g. transmitter level -20 dBm --> setting -18 dBm or transmitter level 40 dBm --> setting 42 dBm.

TCH RF CHAN. — After pressing this key, enter the channel number of the TCH carrier on the numerical keypad. Note that the channel spacing to the BCCH carrier must be at least 30 channels.

TCH TIMESLOT — After pressing this key, enter the timeslot to be used for the TCH measurements on the numerical keypad.

2.4.3.3 TRAFFIC CHANNEL TEST Menu

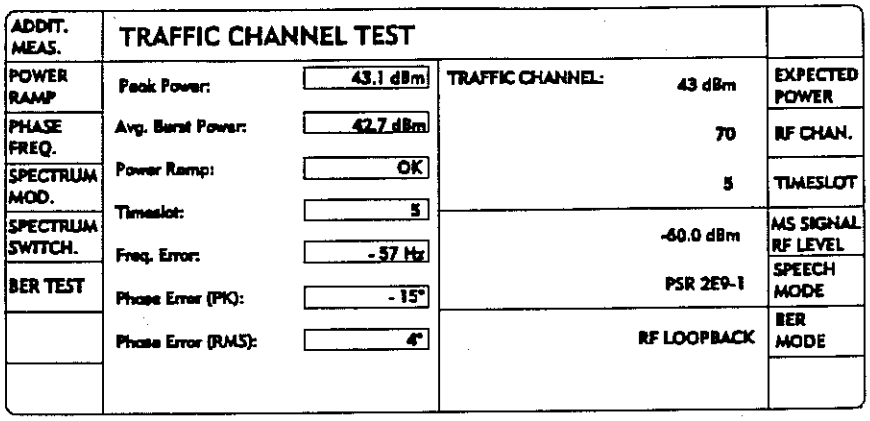


Fig. 2.4-5 TRAFFIC CHANNEL TEST Menu

Result fields left
As soon as the CMD receives a burst on the specified TCH carrier and the specified timeslot, it starts the measurements. The average burst power, the power ramp and the phase and frequency error are measured. As soon as one of the measured values exceeds the set tolerances, the result field is marked by display on black background.

Result fields right
The set parameters can be read here.

ADDIT. MEAS.
The menu ADDITIONAL MEASUREMENTS is called. This menu permits to perform DC voltage, several DC current and AF measurements (only with Option CMD-B41) (see section 2.4.5.1).

POWER RAMP
This softkey permits to change to the graphical display of the power ramp.

PHASE FREQ.
This softkey permits to change to the graphical display of the phase and frequency error measurement.

SPECTRUM MOD.
This softkey permits to change to the menu for the spectrum due to modulation measurement.

SPECTRUM SWITCH.
This softkey permits to change to the menu for the spectrum due to switching measurement.

BER TEST
This softkey permits to change to the menus for the sensitivity test (bit error rate measurement).

EXPECTED POWER
After pressing this key, enter the expected power of your test item on the numerical keypad. To be on the safe side, enter a level that is about 2 to 3 dB higher, e.g. transmitter level -20 dBm --> setting -18 dBm or transmitter level 40 dBm --> setting 42 dBm.

RF CHAN

After pressing this key, enter the channel number of the TCH carrier on the numerical keypad. Note that the channel spacing to the BCCH carrier must be at least.30 channels.

TIMESLOT

After pressing this key, enter the timeslot to be used for the TCH measurements on the numerical keypad.

MS SIGNAL RF LEVEL

The CMD transmits the RF level set here.

SPEECH MODE

Various transmitting signals of the CMD can be set here. An echo or a pseudo random sequence may be generated.

PSR9-1 corresponds to 0.153
PSR11-1 corresponds to 0.153
PSR15-1 corresponds to 0.151

BER MODE

If the Option CMD-B7 (A_{Bis} Interface) is installed in the CMD-B7, the evaluation data can be returned to the CMD both via the RF and via the A_{Bis} Interface. Please select the desired operating mode.

a) RF loop: The CMD expects the transmitted speech data to be received by the BTS and returned as valid speech data. From the point of view of the CMD, a loop must be closed to this end ahead of the speech decoder and after the speech coder (this corresponds to the sensitivity measuring method for GSM mobile phones).

b) A_{Bis} interface: The CMD can monitor the data received by the BTS at the activated A_{Bis} interface and use the data for bit error rate calculation. The data received at the A_{Bis} interface must not be speech-decoded yet.

Note:
In remote mode, the evaluation data can additionally be returned to the CMD via the RS232 or the IEC-bus interface.

2.4.4 GSM Measurements

2.4.4.1 POWER RAMP Menu

For entering tolerances, a configuration menu is provided (see section 2.4.7.3).

The initial menu for measurements is the menu TCH TEST or BURST ANALYSIS (module test).

In this menu, the power ramp is represented as a function of the time.

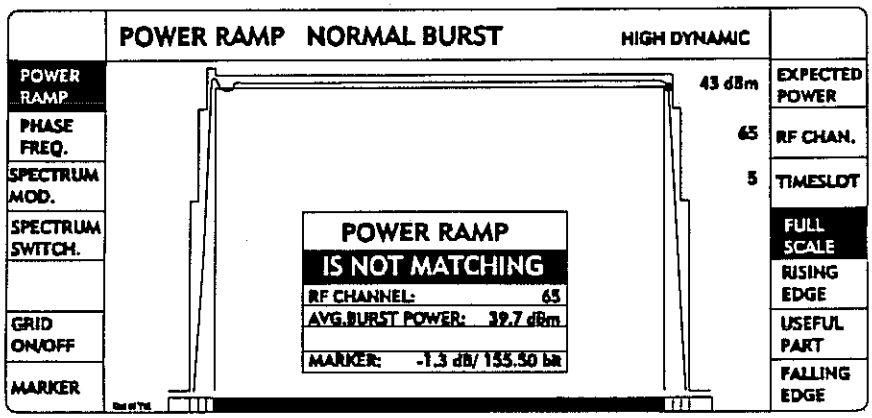


Fig. 2.4-6 POWER RAMP menu

The display in this measurement menu consists of the following items:

- Tolerance mask. The tolerance mask must not be exceeded by the measurement curve. The position of the tolerance mask in the direction of the power coordinate can be changed in the configuration menu.

- Reference line. It runs through the center of the horizontal center part of the tolerance mask (useful part). The average value from maximum power and minimum power during the "useful part" in the burst results in the reference line.
  Note that, with "AVG.BURST POWER" in the text part, the avarage is taken from all measured values in the "useful part" of the burst. Therefore, the values for "AVG. BURST POWER" and the reference line are similar in most cases.

- Text part. The frequency channel on which the measurement was made as well as the value for "AVG. BURST POWER" are indicated.

- Overall judgement. Unless all tolerances are observed, the message "POWER RAMP IS NOT MATCHING" is displayed. The tolerance is exceeded if the tolerance mask is exceeded or fallen below by the measurement curve of if the time position of the entire measurement curve is not observed. The transferred data information is demodulated and the training sequence (midamble) searched for. The measurement curve is then compared with the tolerance mask referred to the middle of the training sequence (bit 13/14) and checked for tolerance violations. 4 measured values are recorded and evaluated for each data bit. This corresponds to a sampling rate of approx. 1 MHz. Below the measurement curve, the segments where the tolerance has been exceeded are marked (see also configuration tolerance mask).

- Header line. The power ramp is measured with a high dynamic range (>72 dB). The message "HIGH DYNAMIC" is displayed.

POWER RAMP	Restart of the measurement in single-shot operation or after a stop because of exceeded tolerance. Measurement stop and start in continuous mode.
PHASE FREQ.	Change to the phase/frequency error measurement menu.
SPECTRUM MOD.	This softkey permits to change to the menu for the spectrum due to modulation measurement.
SPECTRUM SWITCH.	This softkey permits to change to the menu for the spectrum due to switching measurement.
GRID ON/OFF	This softkey permits to fade in a grid in order to facilitate reading of the measurement curve.
MARKER	Switches on the marker function. After activating this function, the marker can be shifted on the measurement curve using the rotary knob.
EXPECTED POWER	After pressing this key enter the expected power of your test item on the numerical keypad. To be on the safe side, enter a level that is about 2 to 3 dB higher, e.g. transmitter level -20 dBm --> setting -18 dBm or transmitter level 40 dBm --> setting 42 dBm.
RF CHAN.	After pressing this key enter the channel number of the TCH carrier on the numerical keypad. Note that the channel spacing to the BCCH carrier must be at least 30 channels.
TIMESLOT	After pressing this key enter the timeslot used for the TCH measurements on the numerical keypad. Should you reach this menu from the module test, this key is not available.
FULL SCALE	Display of the complete power ramp.
RISING EDGE	The rising edge of the power ramp is displayed (zoom function).
USEFUL PART	The active part of the timeslot is indicated with higher resolution (zoom function).
FALLING EDGE	The falling edge of the power burst is indicated (zoom function).

2.4.4.2 PHASE FREQUENCY Menu

For entering tolerances, a configuration menu is provided (see section 2.4.7.4).

In this measurement menu, the phase error of the modulation is displayed as a function of the time and the peak phase error, the RMS phase error and the frequency offset are indicated in measured values.

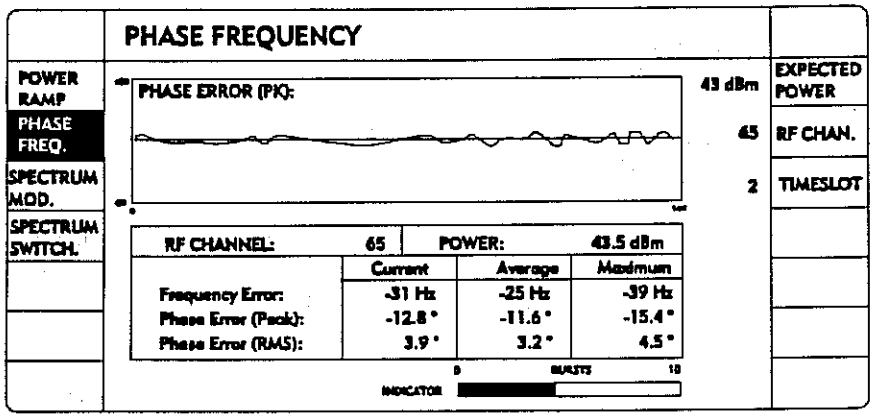


Fig. 2.4-7 PHASE FREQUENCY menu

The display is divided into several fields:

The upper field indicates the phase error during the burst. In continuous mode, the graphics is permanently updated. Thus a quasi real-time measurement is available for adjustment purposes.

The centre field contains the measurement parameters frequency channel and power. The associated measurement results are the frequency error and the phase error, indicated as peak value and as average value. The GSM specifications specify +/-20° peak phase error and +/-5° average phase error. The maximum frequency error may be 0.05 ppm referred to the transmitter frequency. A maximum value of 45 Hz is set on the CMD. These values are the default values for the tolerances, however they can be varied at will by the user in the configuration menus.

As soon as a measured value exceeds the tolerance, it is indicated on black background.

For this purpose, the phase trajectory is recorded during the entire burst and stored. From the measured values, the transferred data information is demodulated and the training sequence (midamble) searched for.

The complete data contents of the burst is arithmetically modulated using an ideal modulator and the resulting ideal phase trajectory compared with the measured curve. By calculating a regression line, the frequency error is thus obtained. The deviations of the phase trajectory result in the phase error, which is both peak weighted and rms weighted.

The measurement curve (phase error curve) is then compared with the tolerance mask referred to the middle of the training sequence (bit 13/14) and checked for exceeded tolerance. Four measured values are recorded and evaluated per data bit, which corresponds to a sampling rate of approx. 1 MHz.

POWER RAMP	Change to the POWER RAMP menu.
PHASE FREQ.	Restart of the phase/frequency error measurement in single-shot operation or after a stop because of exceeded tolerance. Measurement stop and start in continuous mode.
SPECTRUM MOD.	This softkey permits to change to the menu for spectrum due to modulation measurement.
SPECTRUM SWITCH.	This softkey permits to change to the menu for spectrum due to switching measurement.
EXPECTED POWER	After pressing this key, enter the expected power of your test item on the numerical keypad. To be sure, enter a level that is about 2 to 3 dB higher, e.g. transmitter level -20 dBm –> setting -18 dBm or transmitter level 40 dBm --> setting 42 dBm.
RF CHAN	After pressing this key, enter the channel number of the TCH carrier on the numerical keypad. Note that the channel spacing to the BCCH carrier must be at least 30 channels.
TIMESLOT	After pressing this key, enter the timeslot used for the TCH measurements on the numerical keypad. Should you not reach this menu from the module test, this key is not available.

If the softkey BARGRAPH PHASE RMS or BARGRAPH FREQ. ERR. is selected in the respective configuration menu, the graphical display is replaced by a bar display.

2.4.4.3 SPECTRUM MOD. / SPECTRUM SWITCH. Menu

For entering tolerances a configuration menu is provided.

The menus of the measurements "Spectrum Due To Modulation" and "Spectrum Due To Switching" can be entered both in unsynchronized mode (Module Test, Burst Analysis) and in synchronized mode (via menu Control Channel Test or wired sync.).

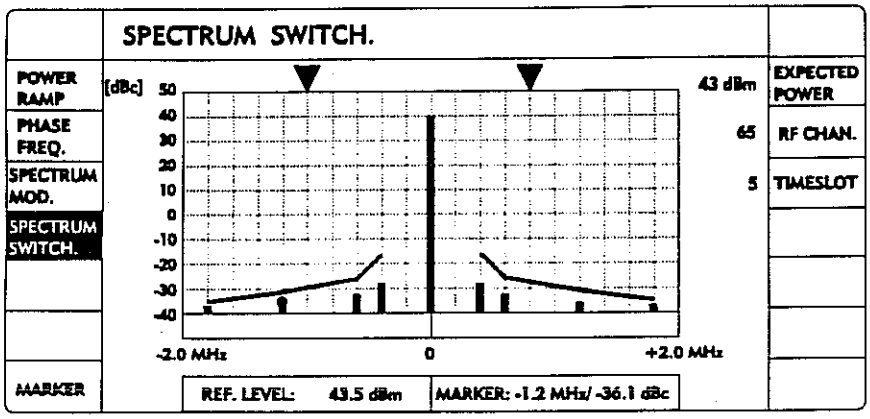


Fig. 2.4-8 SPECTRUM SWITCH. menu

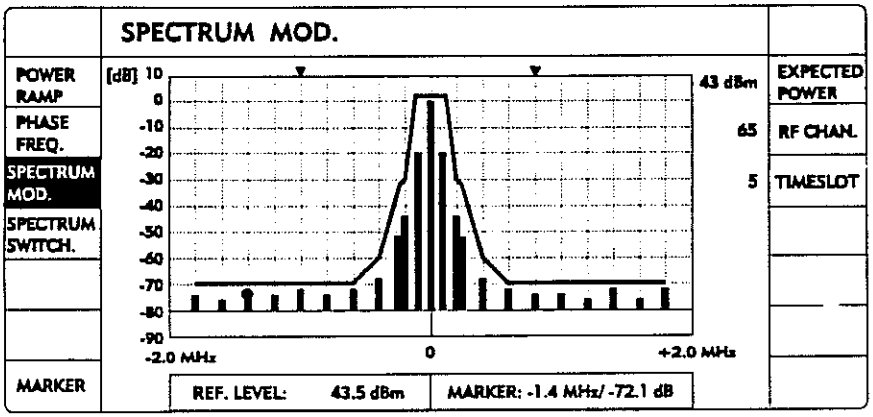


Fig. 2.4-9 SPECTRUM MOD. menu

These menus permit to measure the spectrum produced either by the modulation with the data stream or by the rising or falling edges (switching) of the RF burst.

In line with the GSM specifications, a certain number of bursts is considered in the calculation of the measured value for each offset frequency. The number of bursts per offset frequency can be set in the configuration menus. In the case of a large number, the measurement may take longer. The marks in the upper part of the picture exactly indicate the offset frequency being calculated. The measured values outside the marked area are the results of an earlier measurements, those within the marked area are the results of the currently running measurement.

A marker can be set to an individual measured value using the rotary knob. The respective measurement result is indicated as numerical value.

POWER RAMP	Change to the POWER RAMP menu.
PHASE FREQ.	Change to the PHASE FREQUENCY menu.
SPECTRUM MOD.	This softkey permits to change to the menu for the spectrum due to modulation measurement.
SPECTRUM SWITCH.	This softkey permits to change to the menu for the spectrum due to switching measurement.
EXPECTED POWER	After pressing this softkey, enter the expected transmitting power of your test item. To be on the safe side, enter a level that is 2 to 3 dB higher, eg transmitting level -20 dBm --> setting -18 dBm or transmitting- level 40 dBm --> setting 42 dBm.
RF CHAN	After pressing this softkey enter the channel number of the TCH. Please note that the channel spacing to the BCCH must be at least 30 channels.
TIMESLOT	After pressing this softkey enter the timeslot on which the TCH measurements are to be performed. Should you reach this menu from the module test, this softkey is not available.

2.4.4.4 BIT ERROR RATE Menu

Test parameters can be set in the configuration menus (see section 2.4.7.7).

This measurement menu can be selected by pressing the softkey BER TEST in the TCH TEST menu.

In this menu, various receiver tests based on bit error rate tests are selected. The bits to be evaluated are received via the air interface. The BER measurement can also be performed in remote-control mode via the serial interface RS232 or via IEC bus.

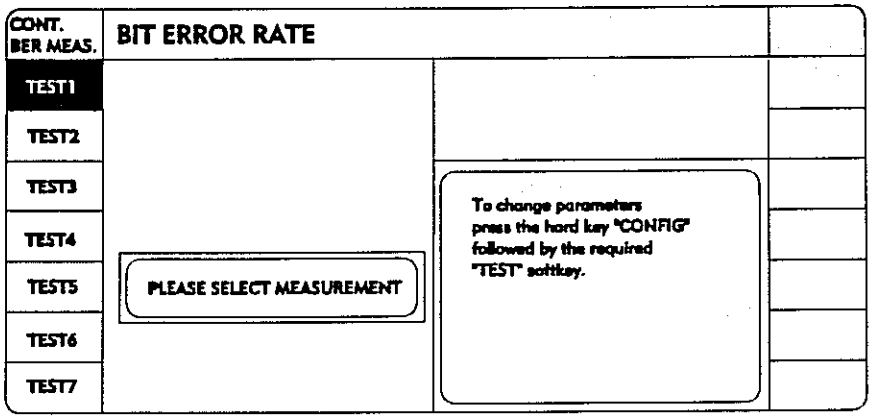


Fig. 2.4-10 BIT ERROR RATE menu

BER with RF loopback
This is a very elaborate way of determining the sensitivity of a BTS receiver. To this end, the CMD transmits a pseudo random bit stream with the set level. The BTS receiver demodulates the bits and evaluates them in the channel decoder. Normally, these bits would then be applied to the speech decoder. Instead, however, the bits can be returned to the BTS transmitter for measurement purposes by means of a switch and thus be received again by the CMD. According to GSM specifications, the transmitter path is assumed to be error-free. With high transmitter levels, the CMD will receive the same data stream that has been sent before. With low transmitter levels, bit errors will occur more often and be evaluated and displayed by the CMD. This RF loopback mode is switched on manually in the BTS.

BER with ABIS interface
The CMD sends a defined pseudo random bit stream with the set level. The BTS receiver demotuldates the bits and evaluates them in the channel decoder. These bits are then applied to the BTS speech decoder via the ABIS interface. At this point, however, they can be tapped off for test purposes using the ABIS card installed in the CMD as an option. For this purpose, the CMD monitors on the set ABIS timeslot, detecting the data received by the BTS. In the case of high levels, the CMD will receive the same data stream that has been sent before. In the case of low levels, bit errors will occur more often than can be evaluated and displayed by the CMD.

This menu provides seven preset measurements TEST1 to TEST7, which can be simply started by means of a keystroke. This allows for measurement series that can easily be reproduced.

The seven different tests offered here differ in their stimuli (RF signals sent by the CMD) and different evaluation criteria. These mainly comprise the number of frames over which the occurred bit errors or the number of erased frames are evaluated. The stimuli and evaluation criteria used in these tests can be set in the CONFIG menu. These tests all have a finite measuring time, do not permit parameter variations during the test and supply a pass/fail result at the end.

The test under softkey CONT. BER MEAS. is excellently suited for permanent measurements, e.g. for adjustments. In this case, parameter variations are possible and the measurement results are displayed continuously (see CONTINUOUS BIT ERROR RATE).

CONT. BER MEAS. Selection of the continuous bit error rate test.

TEST 1 to **TEST 7** Selection and start of a user-specific measurement menu.

Only in remote mode:

BER with IEC bus / RS232
In this case, the CMD transmits a pseudo random bit stream determined with speech mode with the set level. The BTS receiver demodulates the bits and evaluates them in the channel decoder. These bits are then recorded by an external device and combined in speech frames. Using a remote-control command (IEC-bus command / RS232 command), this block is reported to the CMD, which thus recognizes the data received by the BTS. Any number of these blocks can be accumulated in the CMD. With high levels, the CMD will receive the same data stream that has been sent before. With low levels, bit errors will occur more often; they will be evaluated by the CMD and sent to the remote-control computer.

2.4.4.5 BIT ERROR RATE Menu (TEST 1...TEST 7)

One of these menus can be entered by selecting one of the 7 user-specific measurement menus. The illustration shows the screen during the measurement set under TEST1.

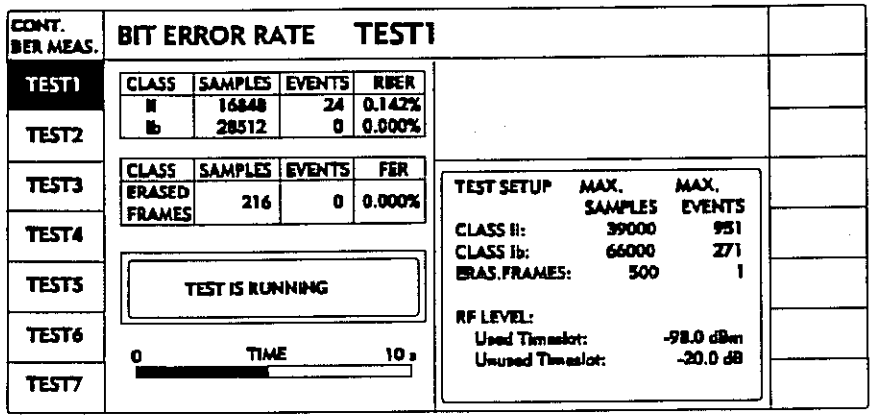


Fig. 2.4-11 Menu BIT ERROR RATE TEST 1

Display

The measurement results are recorded at the top left of the display.

A distinction is made between bit-error-rate measurement (BER) and residual bit error rate measurement (RBER).

A box is displayed here in the bit error rate measurement. It contains a line each for the unprotected bits (class II) and for the protected bits (class Ib). The bits sent by the CMD are referred to as samples and are counted. A bit which has been received wrongly is designated as an event, the events are also counted. The ratio of bits received wrongly related to all received bits is called bit error rate (BER) and indicated in % in the last column, separated according to class II und Ib.

If the test is a residual bit error rate test (RBER), the bits sent are additionally combined in frames. In this case, two boxes containing measured values are visible. The frames sent are again designated as samples and counted as well. The frames that cannot be corrected are referred to as events and also counted. The ratio between erased frames and all frames sent is the frame erasure rate (FER) indicated in % in the last column. In the case of an RBER test, the numbers of the first box must be interpreted in a somewhat different way. The bits belonging to erased frames are neither counted with the samples nor with the events so that the ratio between events and samples with respect to the bits is not concerned by the faulty frames; hence the name residual bit error rate.

The elapsed and remaining test time is indicated at the bottom left. At the end of the test, the result is commented with a pass/fail result. This pass/fail criterion is defined in the CONFIG menu.

2.4.4.6 CONTINUOUS BIT ERROR RATE Menu

Contrary to the 7 bit error rate tests mentioned before, which were limited in duration and supplied a definite result at the end, the continuous bit error rate test is a bit error rate test of arbitrary length. It can be used to observe the dependency of the bit error rate on the stimuli, that is to say on the signals the CMD sends to the mobile station, in an experiment.

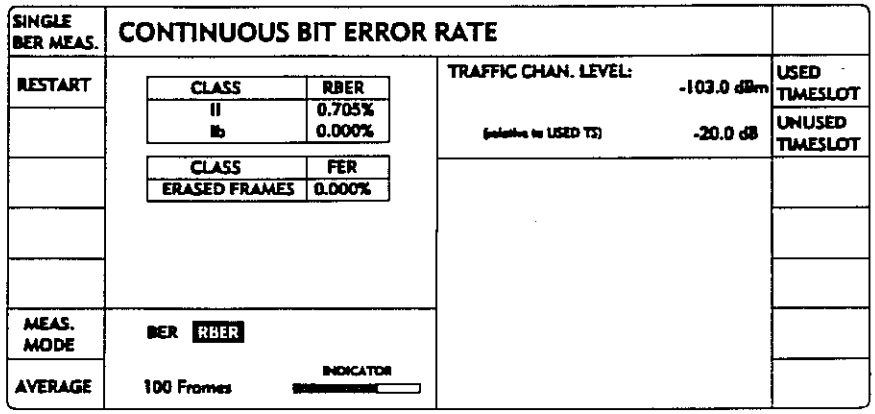


Fig. 2.4-12 CONTINUOUS BIT ERROR RATE Menu

SINGLE BER MEAS.

This softkey permits to return to the selection of a time-limited bit error rate measurement.

RESTART

This softkey can be used to restart a bit error rate test. Due to an averaging period selected using the AVERAGE softkey the measurement results in the result field contain many previous components. On pressing RESTART, the test immediately forgets the previous values and starts anew.

MEAS. MODE

This softkey permits to switch between the two measurement modes BER and RBER.

AVERAGE

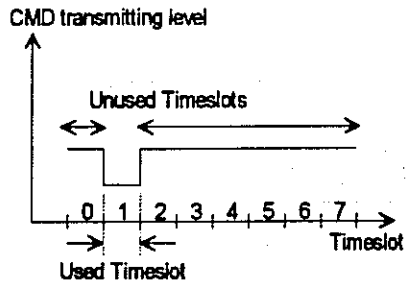
This softkey is used to enter the averaging period in frames.

USED TIMESLOT

Communication with the BTS receiver is effected on one of 8 timeslots (CALL ESTABLISHED menu; TIMESLOT softkey). Using this softkey, the RF level of the CMD in the used timeslot is set to its absolute value.

UNUSED TIMESLOT

This softkey is used to set a uniform level for the remaining timeslots. It is relative and refers to the level of the used timeslot.



Display

The field at the top left contains the measurement results, which are updated continuously. The uppermost box is to be interpreted similarly as in the BER test described before. The only difference is that no samples and events are counted because these measured values are of no interest due to the infinite duration of this test.

The center box only appears if the operating mode residual bit error rate test is running.

The field at the bottom left indicates the operating mode of the test, the number of frames from which the measurement results indicated above are obtained (AVERAGE) and an indicator. The latter has the following meaning: After a start or RESTART, the indicator field is empty and begins to fill. As long as it has not been completely filled, the measured values indicated above do not relate to the full number of frames, the degree to which they are filled approximately indicates how high the number has already become. When the indicator is completely filled, the measurements relate to the full number of frames.

2.4.5 Conventional Measurements

2.4.5.1 ADDITIONAL MEASUREMENTS Menu

The DC voltage result and several DC current results are displayed in this menu. Besides, AF measurements are possible (only with Option CMD-B41). The menu can be entered from different menus (see section 2.2, Menu Structure).

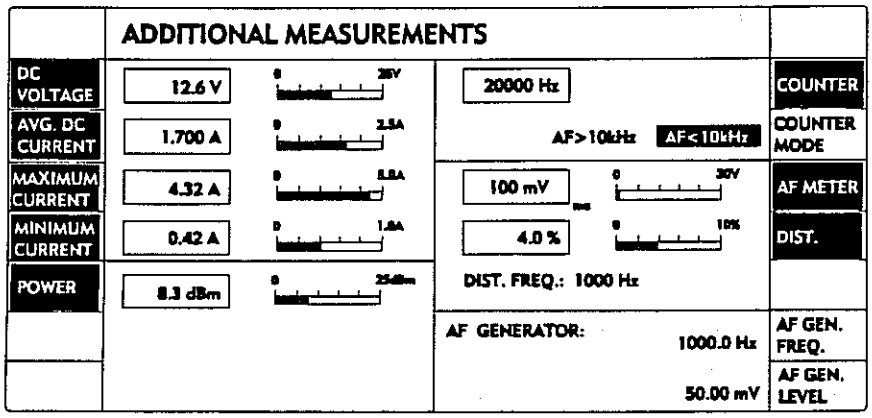


Fig. 2.4-13 ADDITIONAL MEASUREMENTS Menu

The measurement results indicated on the lefthand side of the menu provide information on the current and voltage supply of the test item. As the RF power of the test item usually pulses, the operating current also pulses in general. Therefore, the CMD features specially designed ammeters and voltmeters. The CMD distinguishes beteen max, min and average value. The function AVG. DC CURRENT enables a real measurement of the current consumption. With conventional ammeteres, this type of measurements can only be performed with difficulties or not at all.

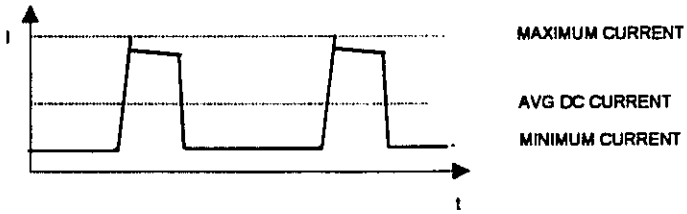
DC VOLTAGE — DC voltage result (permits the measurement of the true (thermal) power consumption together with AVG. DC CURRENT).

AVG. DC CURRENT — Average DC current drain (permits the measurement of the true (thermal) power consumption together with DC VOLTAGE).

MAXIMUM CURRENT — Maximum DC current drain (current consumption during the active burst).

MINIMUM CURRENT — Minimum DC current drain (current consumption while the mobile station is passive).

POWER — Power measurement at the RF IN/OUT socket.



Graphical representation of the DC current measurement results

General notes on the current measurements

The physical minimal value (MIN.DC) or maximal value (MAX.DC) of the measured current is evaluated. As a result of this, the display is inverted when the polarity is reversed.

Example:	AVG.DC	0.5 A	-0.5 A
	MAX.DC	1.5 A	-0.3 A
	MIN.DC	0.3 A	-1.5 A

The average display uses a time constant adapted to the GSM frame clock. Therefore, single unsynchronized current bursts may cause the average measurement to be delayed with respect to the two other measurements. However, this does not result in a faulty statement on the actual current consumption of the test item.

Example:	AVG.DC	0.5 A
	MAX.DC	0.35 A
	MIN.DC	0.31 A

These displays can be seen shortly after a single current consumption peak.

The righthand side of the menu permits to select AF measurements. However, these are only possible with the Option CMD-B41 installed.

COUNTER	Frequency measurement of input signals at the "AF VOLTM" socket.
COUNTER MODE	Switchover of frequency counter mode. Counting of AF signals up to 10 kHz or IF signals up to 60 MHz at the "AF VOLTM" socket.
AF METER	Level measurements of input signals at the "AF VOLTM" socket.
DIST.	Distortion measurement of input signals at the "AF VOLTM" socket.
AF GEN. FREQ.	Setting the frequency of the AF output signal at the "AF GEN" socket.
AF GEN. LEVEL	Setting the level of the AF output signal at the "AF GEN" socket.

Note on the AF measurements (righthand menu side)

Several configuration menus are provided for setting the parameters of the AF measurements.

2.4.6 Module Test

By selecting "MODULE TEST" in the selection menu, the "BURST ANALYSIS" menu can be entered.

2.4.6.1 BURST ANALYSIS Menu

This menu permits to perform GSM-specific measurements on modules or measurements on base stations in service mode.

Input fields:
The operator can enter the input socket, the external attenuation, the expected power, the type of midamble as well as the transmitter channel of the test item.

Result fields:
As soon as the parameters of the test item are entered, the CMD triggers on an incoming power burst and subsequently indicates the average burst power, the peak power, the phase/frequency error values as well as an incorrect/correct power ramp versus time.

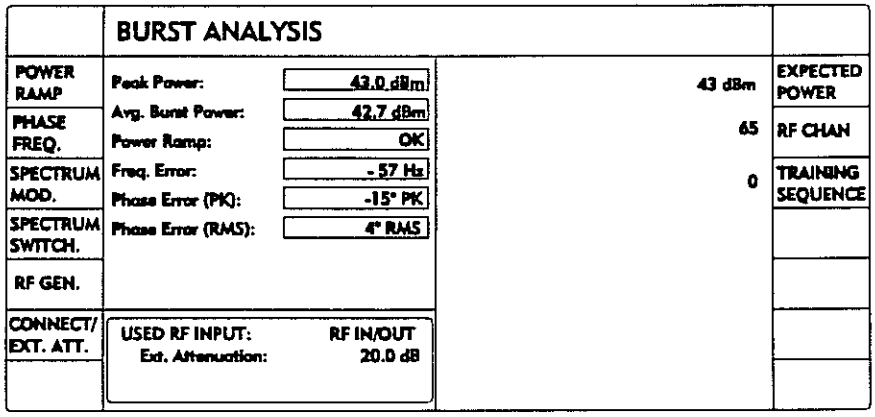


Fig. 2.4-14 BURST ANALYSIS Menu

POWER RAMP	Change to the "POWER RAMP" menu, where the power ramp versus time is indicated (see section 2.4.4.1).
PHASE FREQ.	Change to the "PHASE FREQUENCY" menu, where the phase trajectory versus time is graphically displayed (see section 2.4.4.2).
SPECTRUM MOD.	This softkey permits to change to the menu for the spectrum due to modulation measurement.
SPECTRUM SWITCH.	This softkey permits to change to the menu for the spectrum due to switching measurement.

RF GEN.	Change to the "RF GENERATOR" menu, where the CMD provides an RF signal (modulated/unmodulated or pulsed/unpulsed) (see section 2.4.6.2).
CONNECT/ EXT. ATT.	This softkey is used to call a configuration menu which permits selection of the RF inputs and outputs on the CMD. If external attenuator pads are used or a path attenuation is included in the test setup, the values for the attenuation can be entered here (see section 2.4.7.8).
EXPECTED POWER	After pressing this key, enter the expected power of your test item on the numerical keypad. To be on the safe side, enter a level that is about 2 to 3 dB higher, e.g. transmitter level -20 dBm --> setting -18 dBm or transmitter level 40 dBm --> setting 42 dBm.
RF CHAN.	Input of the transmitter channel of the test item. The module test assumes that only one RF carrier is applied to the measuring instrument.
TRAINING SEQUENCE	Selection of the various types of midamble. This is required to enable the CMD to determine the middle of a burst and the correct time reference.
DECODE	Type of decoding for the phase/frequency error measurement: STANDARD: according to GSM specifications WITH GUARD AND TAILBITS: The guard and tail bits are not assumed to be fixed as specified by GSM, but they are received, decoded and considered accordingly.
PEAK POWER	*(only with input RF IN/OUT selected)* Use of the broadband RF power meter or the narrowband IF power meter.

2.4.6.2 RF SIGNAL GENERATOR Menu

The CMD provides an RF signal. The parameters of this RF signal as well as the desired RF output socket can be set in this menu (lefthand side of menu).

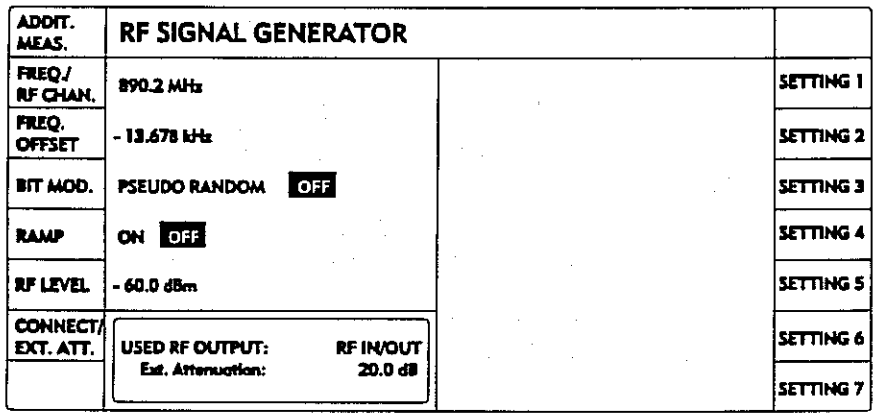


Fig. 2.4-15 RF SIGNAL GENERATOR menu

ADDIT. MEAS.

Selection of the ADDITIONAL MEASUREMENTS menu. It permits to perform DC voltage measurements, several DC current measurements and AF measurements (only with Option CMD-B41) (see section 2.4.5.1).

FREQ./ RF CHAN.

Input of RF frequency or RF channel. The resolution is 200 kHz (GSM/PCN channel spacing). The conversion of frequencies into channels is effected by means of the unit keys (channel corresponds to "dB"). Possible frequencies are 800 to 1000 MHz (GSM mode) or 1697.6 to 1897.6 MHz (only PCN/DCS-1800-model). When converting frequencies that lie outside the defined GSM or PCN/DCS-1800 bands, fictitious channel numbers are indicated. Due to the large frequency range, measurements can also be performed in the extended GSM band (E-GSM).

FREQ. OFFSET

For achieving a more accurate fine frequency resolution, the frequency offset can be set here (resolution 33 Hz, max. ± 100 kHz).

BIT MOD.

Selection of bit modulation.
OFF: No modulation.
PSEUDO RANDOM: Modulation with a pseudo random bit sequence.

RAMP

Selection between burst or no burst of RF signal.

RF LEVEL

Input of RF level.

CONNECT/ EXT. ATT.

Change to the configuration menu for selecting the connectors and entering the external attenuations (see section 2.4.7.8).

SETTING 1(7)

These softkeys on the righthand side of the menu permit to activate complete preset RF signal generator parameter setups by pressing only one key. These sets of parameters are preset in the configuration menus of the RF generator menu.

2.4.7 Configuration Menus

There are two ways to enter the configuration menus:

- From the selection menu via the "CONFIG menu tree".
- From the different menus by pressing the CONFIG hardkey. Then the configuration menus relevant to this menu can be selected via softkeys.

2.4.7.1 Configuration Selection Menu

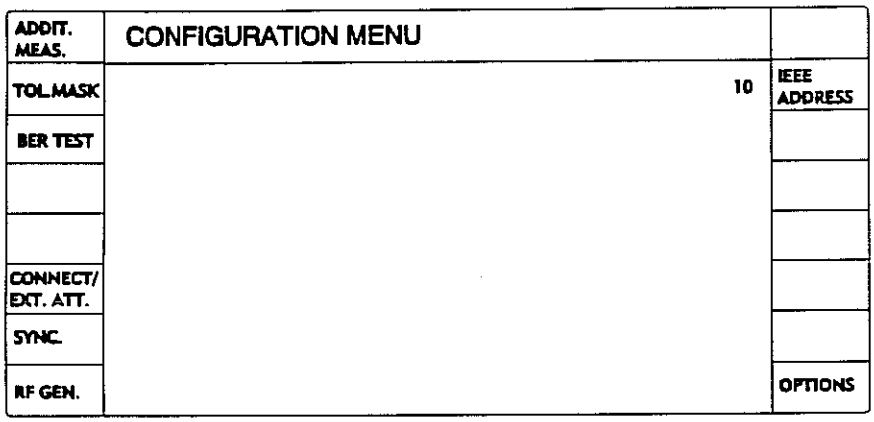


Fig. 2.4-16 CONFIGURATION Menu

ADDIT. MEAS. Change to the configuration menu for the conventional AF measurements (Option CMD-B41).

TOL. MASK Change to the configuration menus for entering the tolerance values for power ramp and phase/frequency error measurement and for spectrum analysis.

BER TEST Change to the configuration menus for the different BER tests (TEST 1 to 7).

CONNECT/ EXT. ATT. Change to the configuration menu for selection of the connectors and input of the external attenuations (see section 2.4.7.8).

SYNC. Change to the configuration menu for selecting the synchronization of the CMD with the test item (only with Option CMD-B3 installed), (see section 2.4.7.9).

RF GEN. Change to the configuration menus for entering the various parameter sets (setting 1 to 7) of the RF generator.

IEEE ADDRESS Input of the IEC-bus remote address (with installed Option CMD-B6 and CMD-B61).

OPTIONS Display of the installed options and the software version number.

2.4.7.2 Configuration Menus for ADDITIONAL MEASUREMENTS

For configuration of the AF measurements (Option CMD-B41) three menus are provided:

2.4.7.2.1 Configuration Menu AF METER

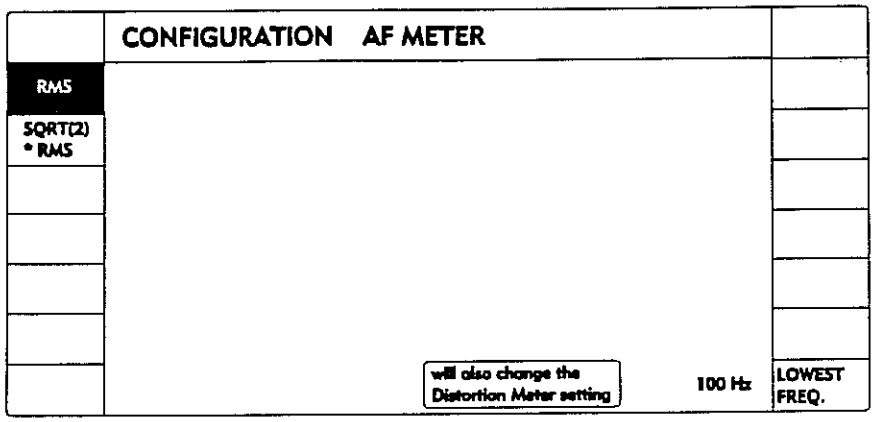


Fig. 2.4-17 CONFIGURATION AF METER menu

RMS

The AF voltmeter measures RMS values.

SQRT (2) * RMS

The AF voltmeter measures RMS values. However, the display is weighted with factor 1.41 (corresponds to peak value in the case of sinusoidal signal).

LOWEST FREQ.

Input of the lowest AF frequency that is weighted without measuring error. High values reduce the measuring time.
Note:
This setting also changes the limit frequency with the distortion measurement.

2.4.7.2.2 Configuration Menu DISTORTION METER

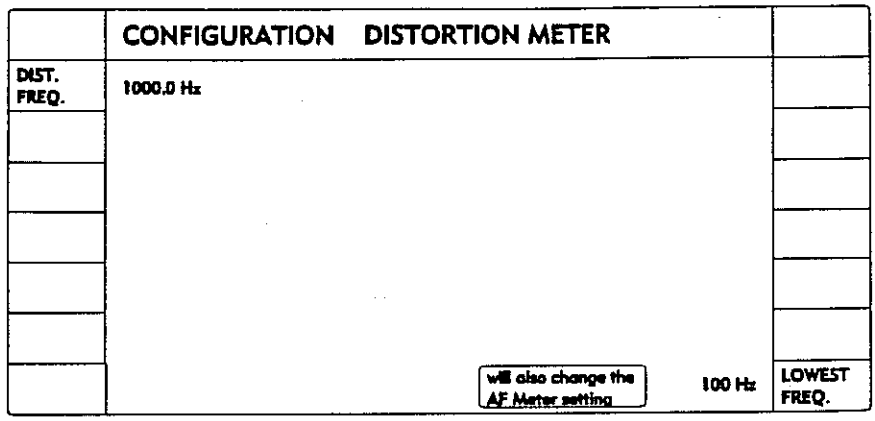


Fig. 2.4-18 CONFIGURATION DISTORTION METER menu

DIST. FREQ. Input of operating frequency of distortion meter (centre frequency of notch filter).

LOWEST FREQ. Input of lowest AF frequency that is weighted without measuring error. High values reduce the measuring time.
Note:
This setting also changes the limit frequency in the case of the AF voltmeter measurement.

2.4.7.2.3 Configuration Menu AF GENERATOR

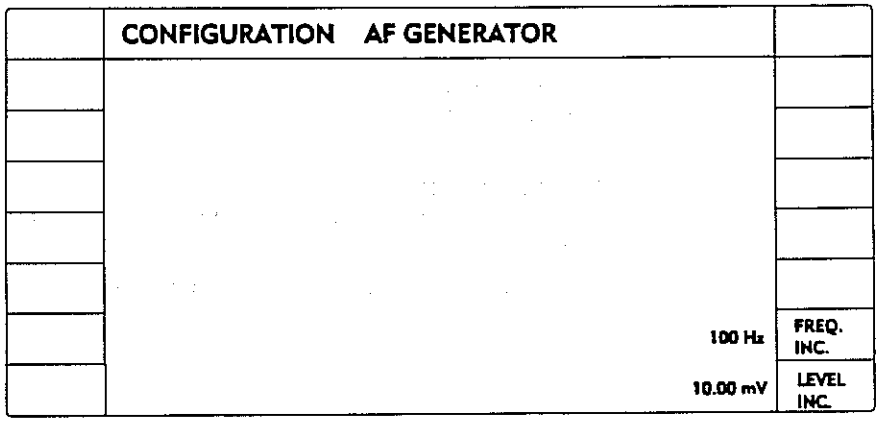


Fig. 2.4-19 CONFIGURATION AF GENERATOR menu

FREQ. INC. Input of increment for variation of the AF generator frequency using the rotary knob.

LEVEL INC. Input of increment for varation of the AF generator level using the rotary knob.

2.4.7.3 Configuration Menu TOLERANCE POWER RAMP

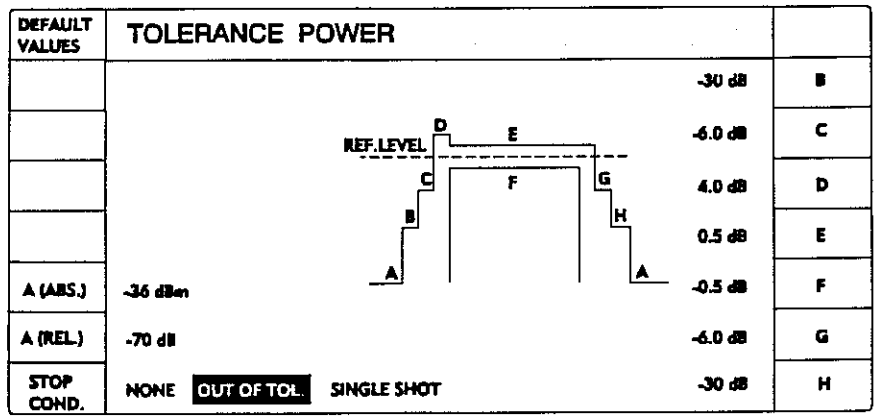


Fig. 2.4-20 TOLERANCE POWER RAMP menu

DEFAULT VALUES

The default values complying with the GSM specifications are used as tolerance values.

A(ABS.)

to

H

The tolerance values of the power time template can be specified for the different ranges A to H.

Depending on the transmitter power of the BTS either the relative or the absolute value is used as max. tolerance limit for segment A. The greater level value is to be used.

Example 1:
Ref. Level = 40 dBm, value for A = - 30 dBm
(da 40 dBm - 70 dB = -30 dBm)

Example 2:
Ref. Level = 20 dBm value for A = -36 dBm
(as 20 dBm - 70 dB = -50 dBm and the greater value is to be entered --> A(ABS) here - 36 dBm)

The values for segments B to H are always entered relatively to the Ref. Level.

STOP COND.

This softkey permits to change between the operating modes continuous measurement, stop after exceeded tolerance and single measurement.

2.4.7.4 Configuration Menu TOLERANCE PHASE FREQUENCY

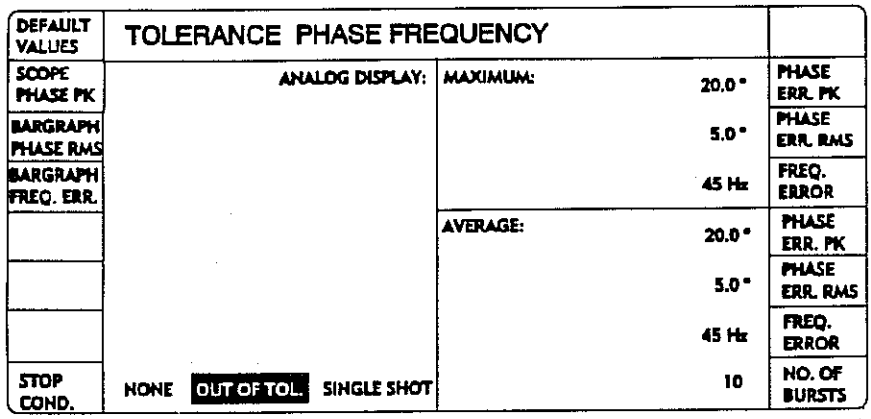


Fig. 2.4-21 TOLERANCE PHASE FREQUENCY menu

DEFAULT VALUES

The default values complying with GSM regulations are used as the tolerance values.

SCOPE PHASE PK

The phase error of the transmitter is graphically displayed during the measurement (oscilloscope mode).

BARGRAPH PHASE RMS

The phase error of the transmitter (RMS-weighted) is indicated in a bar display during the measurement.

BARGRAPH FREQ. ERR.

The frequency error of the transmitter is indicated in a bar display during the measurement.

STOP COND.

This softkey permits to change between the operating mode continuous measurement, stop after exceeded tolerance and single measurement.

PHASE ERR. PK

The user-specific maximum tolerance values of the phase error (peak value and RMS value) and the frequency error can be entered in the upper field.

to

FREQ. ERROR

The user-specific tolerance values of the phase error (peak value and RMS value) and the frequency error for the average weighting can be entered in the lower field.

NO. OF BURSTS

Number of bursts for averaging and average weighting.

2.4.7.5 Configuration Menu TOLERANCE SPECTRUM MOD.

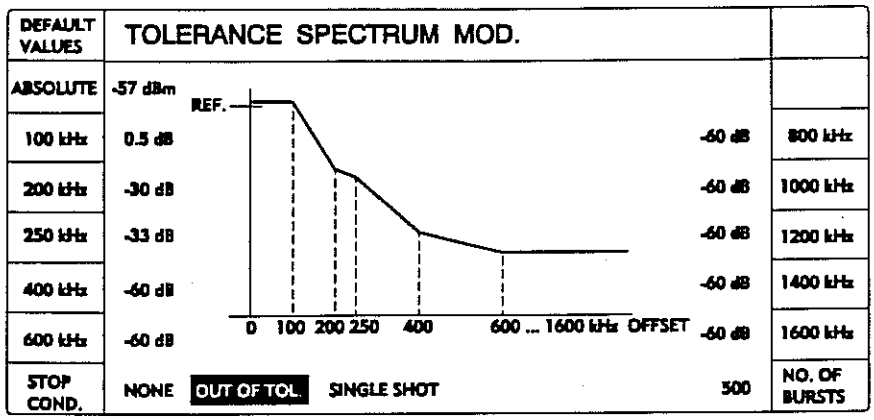


Fig. 2.4-22 TOLERANCE SPECTRUM MOD. menu

DEFAULT VALUES

By pressing this softkey the default values for the tolerances are set.

ABSOLUTE

Setting of the lowest absolute tolerance level for the offset frequencies 100 to 600 kHz. The weaker requirement from absolute and relative limit value is the tolerance limit, ie if the relative values are smaller than the value set here, they are not considered.

100 kHz... 1600 kHz

Setting of the relative tolerance levels per measured offset frequency referred to the carrier. The weaker requirement from absolute and relative limit value is the tolerance limit, ie the values set here are only considered if the measured values are greater than the absolute limit value.

STOP COND.

Selection of the operating modes:

Repeating non-interrupted operation.
Stop as soon as a tolerance is exceeded.
Single recording, restart of the measurement by pressing the softkeys SPECTRUM MOD.

NO. OF BURSTS

Number of bursts recorded per offset frequency and to be considered in the calculation.

2.4.7.6 Configuration Menu TOLERANCE SPECTRUM SWITCH.

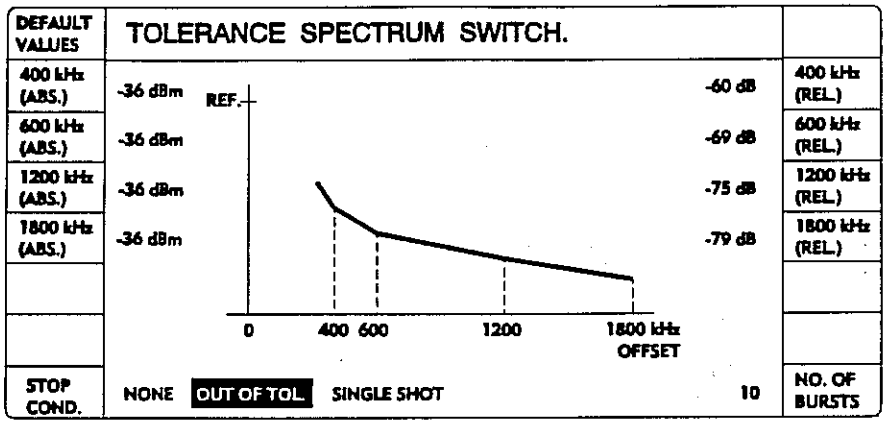


Fig. 2.4-23 TOLERANCE SPECTRUM SWITCH. menu

DEFAULT VALUES

By pressing this softkey the default values for the tolerances are set.

400..1800 kHz (ABS.)

Setting of the lowest absolute tolerance level. The weaker requirement from absolute and relative limit value is the tolerance limit, ie if the relative values are smaller than the value set here, they are not considered.

400..1800 kHz (REL.)

Setting of the relative tolerance levels per measured offset frequency referred to the carrier. The weaker requirement from absolute and relative limit value is the tolerance limit, ie the values set here are only considered if the measured values are greater than the absolute limit value.

STOP COND.

Selection of operating modes:

Repeating uninterrupted operation.
Stop as soon as the tolerance is exceeded.
Single recording, restart of the measurement by pressing the softkeys SPECTRUM SWITCH.

NO. OF BURSTS

Number of bursts recorded per offset frequency and to be considered in the calculation.

2.4.7.7 Configuration Menu BER TEST DEFINITION

The seven tests are identical with respect to their structure. They may differ in the stimuli and evaluation criteria by different user configurations.

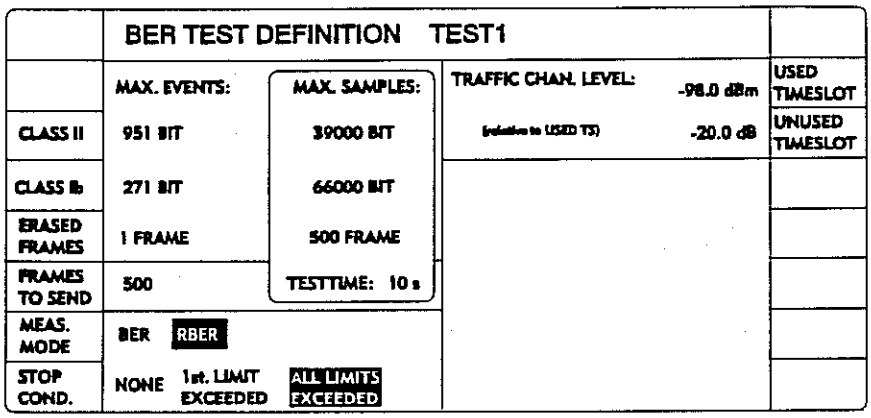


Fig. 2.4-24 BER TEST DEFINITION menu

Fig. 2.4-24 shows a bit error rate test of individual configuration. The stimuli generated by the CMD for this test are to be seen on the right side of the screen, the evaluation criteria on the left side.

The two modes of measurement Bit Error Rate (BER) and Residual Bit Error Rate (RBER) are to be explained first. In the case of the BER test, errors with the unprotectd bits (class II) and with the protected bits (class Ib) are counted. The bits sent by the CMD are designated as samles and also counted, a wrongly received bit is referred to as event and also counted. The ratio of bits received wrongly with respect to all bits sent is designated as Bit Error Rate (BER).

In the case of the residual bit error rate test (RBER), the bits sent are additionally combined in frames. The frames sent are again designated as samples and counted, the erased frames are designated as events and counted as well. The ratio between erased frames and all frames sent is the frame erasure rate (FER). In the case of an RBER test, the Class I and Class II events have to be interpreted in a somewhat different way as well. The bits belonging to erased frames are neither counted with the samples nor with the events, so that the ratio between events and samples with respect to the bits is not concerned by the faulty frames.

CLASS II

CLASS Ib

These softkeys are used to enter the maximum number of permissible bit errors according to classes. The bits sent in this test are indicated on the right for comparison. They represent the reference value for the bit error rate with the BER test. If there are erased frames in an RBER test, they are no reference for the residual bit error rate, as bits from erased frames are not counted, but listed here.

ERASED FRAMES

This softkey is only significant if the residual bit error rate is measured. An entry here describes the maximum number of erased frames in this test. The total number of frames is shown next to the entry for comparison. It is the reference value for the frame erasure rate (FER).

FRAMES TO SEND

This softkey determines over how many frames the test extends. This requires a certain test time that the CMD calculates and indicates as well. As every frame contains exactly 132 Class Ib bits and 78 Class II bits, the total number of bits concerned is also displayed, separated according to classes.

MEAS. MODE

This softkey permits to switch between the two measurement modes BER and RBER.

STOP COND.

This softkey determines when the test is to be aborted before reaching the required number of frames. There are three possibilities:

NONE
The test runs over the specified number of frames, irrespective of how many errors occur. However, it can be manually aborted using the STOP/BREAK key.

1st LIMIT EXCEEDED
The test is aborted when the first of the error limits indicated is reached. These are, alternatively, two different upper limits in the BER test (test runs until Max Events Class Ib or Max Events Class II has been reached) and three in the RBER test (Max Events with respect to frames in addition).

ALL LIMITS EXCEEDED
The test is only aborted before the end of all error limits have been exceeded at an early point of time.

The stimuli generated by the CMD are programmed for the test using the following softkeys.

USED TIMESLOT

Communication with the test item is performed on one of eight timeslots (CALL ESTABLISHED menu, TIMESLOT softkey). This softkey is used to set the RF level of the CMD in the used timeslot to its absolute value.

UNUSED TIMESLOT

This softkey permits to set a uniform level for the remaining timeslots. It is relative and refers to the level of the used timeslot. There are certain dependencies for the setting of the levels of the used timeslot and the unused timeslot.

2.4.7.8 Configuration Menu RF CONNECTOR/EXT. ATTENUATION

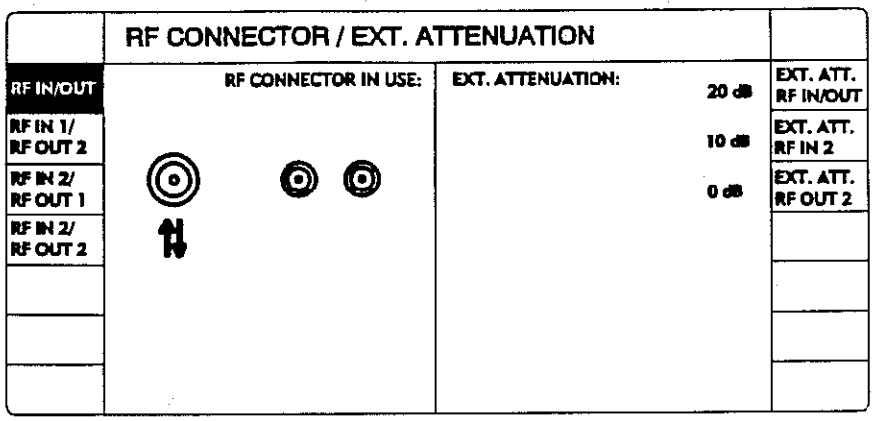


Fig. 2.4-25 RF CONNECTOR/EXT. ATTENUATION menu

The CMD is equipped with 3 RF connectors:

- A bidirectional input/output (RF IN/OUT)
- A sensitive input (RF IN2)
- A unidirectional output (RF OUT2)

These three connectors cannot only be used alternatively, but also in combinations. There are four combinations. For each of the connectors, an attenuation value can be entered on the CMD to be taken into account in the case of level settings and level measurements; negative attenuation values are gains.

RF IN/OUT

to

RF IN2/ RF OUT2

These four softkeys permit to select one of the four input/output combinations.

EXT. ATT RF IN/OUT

to

EXT. ATT. RF OUT2

These softkeys permit to inform the instrument on external attenuation values in dB to be considered in level outputs and level measurements; negative attenuation values are gains. There is only one uniform attenuation or gain for the bidirectional input/output.

2.4.7.9 Configuration Menu SYNCHRONIZATION

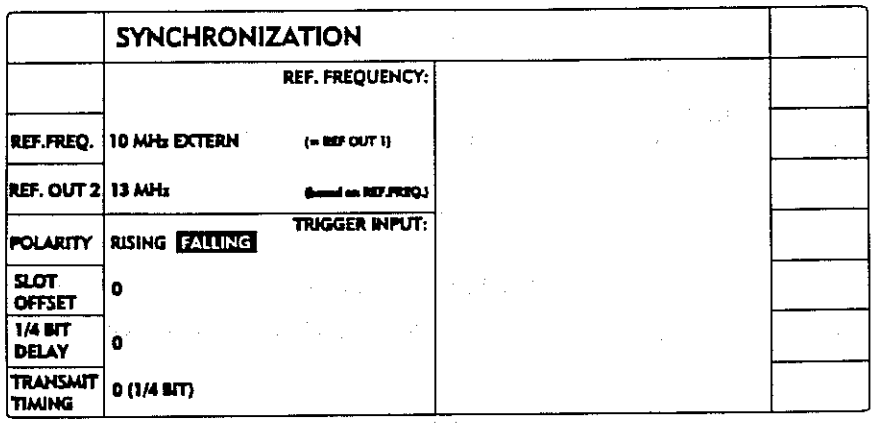


Fig. 2.4-26 SYNCHRONIZATION menu

REF. FREQ.

Selection of external synchronization with different reference frequencies at the reference frequency input or internal synchronization with 10 MHz (TCXO or OCXO CMD-B1). This frequency is then applied to the reference frequency output 1. Please wait approx. 1-2 minutes after switching external → internal.

REF. OUT 2

Selection of the frequency for reference frequency output 2.
The following frequencies are possible:
Bitclock, 2xBitclock, 4xBitclock, 16xBitclock, 1, 2, 4, 13 MHz.

POLARITY

Polarity of the trigger signal at pin 27 of the multifunction port. (Superframeclock).

SLOT OFFSET

Setting the slot offset at pin 27 of the multifunction port.

1/4 BIT DELAY

Setting the bit delay at pin 27 of the multifunction port.

TRANSMIT TIMING

The transmit time is exactly referred to the timeslot limit (simulation of timing advance)

Explanation on setting the slot offset and the1/4-bit delay

In the operating mode "Synchronized Mode", the CMD can receive the time information via an external trigger signal. Both a single trigger signal and a clock signal can be applied. The CMD evaluates an edge only once. A frequency synchronization (e.g. 10 MHz external) is absolutely necessary. The transmitter measurements require a frame clock or a multiple, the bit error rate measurement requires a 26-multiframe clock or a multiple (SACCH and IDLE burst are thus exactly defined).

The edge of the trigger signal set using the "POLARITY" softkey must mark the beginning of the timeslot 0 of the RF signal to be tested with an accuracy of ± 4 bits. Due to delays in the test item, a greater delay between RF and trigger signal may also occur.

This can be compensated for by setting a respective delay using the softkeys "SLOT OFFSET" and "1/4 BIT DELAY".

The following text explains how the correct values can be determined using a dual-channel oscilloscope. The values found are usually typical for the respective type of test item and need not be repeatedly remeasured.

Settings for measuring the trigger delay

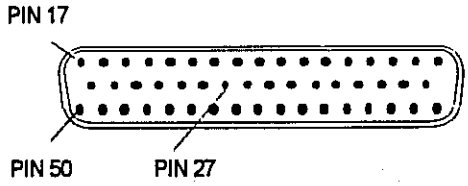
If possible, only one timeslot should be activated on the test item so that the exact time relationships can be clearly recognized. If this is not possible, be very careful to make sure that the correct timeslot to be measured is actually examined.

The RF signal of the test item is applied to the CMD, synchronized mode is selected (manual test) and the channel number of the RF carrier to be measured is set. The CMD will demodulate this signal and internally generate baseband signals.

One of these signals is applied to the multifunction connector at pin 17 and is connected to channel 1 of the oscilloscope.

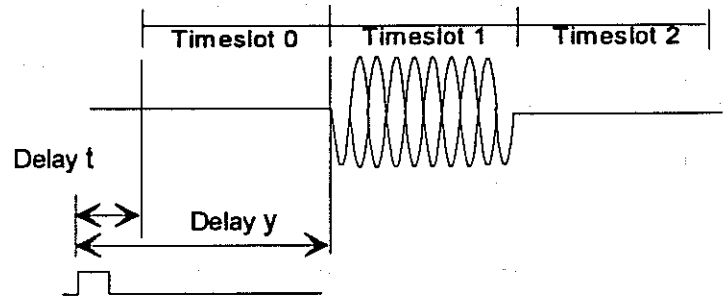
The trigger signal that is to be applied to pin 27 later is connected to channel 2 of the oscilloscope.

The ground connection (GND) of the CMD is to be found at pin 50 of the multifunction connector.



Assumptions for the following illustration:

1) The rising edge of the trigger signal is evaluated.
2) Timeslot 1 is activated on the test item.



Signals similar to those shown must be displayed.
--> The delay of the trigger signal with respect to the transmit signal can be read off.

Delay y corresponds to the measured delay at the oscilloscope in µsec.
Delay t corresponds to the delay to be set on the CMD.
This value must be specified for the respective softkeys "SLOT OFFSET" and "1/4 BIT DELAY".

The values can be determined as follows:

Example:

No. activated timeslot = 1 ---> [SLOT OFFSET] = 1.

1) Delay t $_{(\mu sec)}$ = Delay y $_{(\mu sec)}$ - (No. activated timeslot) * 577 µsec

2) Delay t $_{(1/4\ Bits)}$ = Delay t $_{(\mu sec)}$ * 4 / 3.69 µsec. ---> [1/4 BIT DELAY] = Delay t $_{(1/4\ Bits)}$

(3.69 µsec = Bit duration, 577µsec = Frame duration)

2.4.7.10 Configuration Menu RF SIGNAL GENERATOR

Seven complete parameter sets for the RF signal generator can be configured.

	RF SIGNAL GENERATOR SETTING <nummer>	
FREQ./ RF CHAN.	70	
FREQ. OFFSET	- 13.678 kHz	
BIT MOD.	PSEUDO RANDOM OFF	
RAMP	ON OFF	
RF LEVEL	- 60.0 dBm	

Fig. 2.4-27 RF SIGNAL GENERATOR SETTING menu

FREQ./ RF CHAN.	Input of RF frequency or RF channel.
FREQ. OFFSET	Input of frequency offset (fine frequency resolution).
BIT MOD.	Selection of operating mode modulated/unmodulated.
RAMP	Selection of operating mode burst/no burst.
RF LEVEL	Input of RF output level. **Note:** For details on input see section 2.4.6.2, RF GENERATOR.

Page

Page

3 Remote Control

3.1 Introduction

The instrument is equipped with a serial interface (RS 232-C) as standard and, optionally, with an IEC-bus interface according to standard IEC 625.1/IEEE 488.2. The connector is located at the rear of the instrument and permits to connect a controller for remote control. The instrument supports the SCPI version 1992.0 (Standard Commands for Programmable Instruments). The SCPI standard is based on standard IEEE 488.2 and aims at the standardization of device-specific commands, error handling and the status registers (see Section 3.5.1).

This section assumes basic knowledge of IEC-bus programming and operation of the controller. A description of the interface commands is to be obtained from the relevant manuals.
The requirements of the SCPI standard placed on command syntax, error handling and configuration of the status registers are explained in detail in the respective sections. Tables provide a fast overview of the commands implemented in the instrument and the bit assignment in the status registers. The tables are supplemented by a comprehensive description of every command and the status registers.

3.2 Brief Instructions

The short and simple operating sequence given below permits fast putting into operation of the instrument and setting of its basic functions. Remote control via IEC bus assumes that the IEC-bus address, which is factory-set to 1, has not been changed.

1. Connect instrument and controller using IEC-bus cable.

2. Write and start the following program on the controller:

```
 CALL IBFIND("DEV1", device%)          Open channel to the instrument
 CALL IBPAD(device%, 28)               Inform controller about instrument
address
 CALL IBWRT(device%, "*RST;*CLS")      Reset instrument
 CALL IBWRT(device%, "CONF:CHAN:ARFC 50")  Set channel 50
 CALL IBWRT(device%, "PROC:SEL MAN")   Set MS or BS test
```

The CMD then performs a location update if a mobile is connected and is ready to set up a call with this mobile.

3. To return to manual control, press the [LOCAL] key at the front panel.

The CMD can also be addressed via the serial interface using the same commands. To this end, the terminal emulation of Microsoft Windows, for example, can be used on the controller.

3.3 Switchover to Remote Control

On power-on, the instrument is always in the manual operating state ("LOCAL" state) and can be operated via the front panel. It is switched to remote control ("REMOTE" state) as soon as it receives a command from a controller. During remote control, operation via the front panel is disabled. The instrument remains in the remote state until it is reset to the manual state via the front panel or via remote control (see Section 3.3.3). Switching from manual operation to remote control and vice versa does not affect the instrument settings.

3.3.1 Setting the Device Address

The IEC-bus address of the instrument is factory-set to 1. It can be changed manually in the CONFIG-MENU/IEEE-ADDRESS menu or via the remote control interfaces. Addresses 0 to 30 are permissible.

Manually:

- Call CONFIG-MENU/IEEE-ADDRESS menu
- Enter desired address
- Terminate input using the [1x/ENTER] key

Via IEC bus (or via the serial interface):

```
CALL IBFIND("DEV1", device%)
CALL IBPAD(device%, 1)

CALL IBWRT(device%, "SYST:COMM:GPIB:ADDR 20")
CALL IBPAD(device%, 20)
```

Open channel to the instrument
Inform controller about old address
Set instrument to new address
Inform controller about new address

3.3.2 Indications during Remote Control

In the REMOTE state, no menus but only the keyword REMOTE and, unless configured otherwise, the input and output strings of the remote-control interface are indicated on the display.

3.3.3 Return to Manual Operation

Return to manual operation is possible via the front panel or the IEC bus.

Manually: ➢ Press the [LOCAL] key.

Notes: Before switchover, command processing must be completed as otherwise switchover to remote control is effected immediately.

The [LOCAL] key can be disabled by the universal command LLO (see annex 3) in order to prevent unintentional switchover. In this case, switchover to manual mode is only possible via the IEC bus.

The [LOCAL] key can be enabled again by deactivating the REN line of the IEC bus (see annex A 3).

-Switchover to LOCAL is not possible via the serial interface.

Via IEC bus:

```
...
CALL IBLOC(device%)          Set instrument to manual operation
...
```

3.4 IEC-bus Messages

The messages transferred via the data lines of the IEC bus (see annex A3) can be divided into two groups:

- **interface messages and**
- **device messages.**

The serial interface only recognizes device messages.

3.4.1 Interface Messages

Interface messages are transferred on the data lines of the IEC bus, the "ATN" control line being active. They are used for communication between controller and instrument and can only be sent by a controller which has the IEC-bus control. Interface commands can be subdivided into

- **universal commands and**
- **addressed commands.**

Universal commands act on all devices connected to the IEC bus without previous addressing, addressed commands only act on devices previously addressed as listeners. The interface messages relevant to the instrument are listed in annex A3.

3.4.2 Device Messages (Commands and Device Responses)

Device messages are transferred on the data lines of the remote-control interface, the "ATN" control line not being active. ASCII code is used. A distinction is made according to the direction in which they are sent on the remote-control interface:

- **Commands** are messages the controller sends to the instrument. They operate the device functions and request information.
  The commands are subdivided according to two criteria:

  1. According to the effect they have on the instrument:

     Setting commands cause instrument settings such as reset of the instrument or setting the output level to 1 volt.

     Queries cause data to be provided for output on the remote-control interface, e.g. for identification of the device or polling the active input.

  2. According to their definition in standard IEEE 488.2:

     Common Commands are exactly defined as to their function and notation in standard IEEE 488.2. They refer to functions such as management of the standar-dized status registers, reset and selftest.

     Device-specific commands refer to functions depending on the features of the instrument such as frequency setting. A majority of these commands has also been standar-dized by the SCPI committee (cf. Section 3.5.1).

- **Device responses** are messages the instrument sends to the controller after a query. They can contain measurement results, instrument settings and information on the instrument status (cf. Section 3.5.4).

Structure and syntax of the device messages are described in Section 3.5. The commands are listed and explained in detail in Section 3.6.

3.5 Structure and Syntax of the Device Messages

3.5.1 SCPI Introduction

SCPI (Standard Commands for Programmable Instruments) describes a standard command set for programming instruments, irrespective of the type of instrument or manufacturer. The goal of the SCPI consortium is to standardize the device-specific commands to a large extent. For this purpose, a model was developed which defines the same functions inside a device or for different devices. Command systems were generated which are assigned to these functions. Thus it is possible to address the same functions with identical commands. The command systems are of a hierarchical structure. Fig. 3-1 illustrates this tree structure using a section of command system SOURce, which operates the signal sources of the devices. The other examples concerning syntax and structure of the commands are derived from this command system.
SCPI is based on standard IEEE 488.2, i.e. it uses the same syntactic basic elements as well as the common commands defined in this standard. Part of the syntax of the device responses is defined with greater restrictions than in standard IEEE 488.2 (see Section 3.5.4, Responses to Queries).

3.5.2 Structure of a Command

The commands consist of a so-called header and, in most cases, one or more parameters. Header and parameter are separated by a "white space" (ASCII code 0 to 9, 11 to 32 decimal, e.g. blank). The headers may consist of several key words. Queries are formed by directly appending a question mark to the header.

Note: *The commands of the SOURCE system used in the following examples are not implemented in the CMD.*

Common commands

Common commands consist of a header preceded by an asterisk "*" and one or several parameters, if any.

Examples:
- `*RST` RESET, resets the device
- `*ESE 253` EVENT STATUS ENABLE, sets the bits of the event status enable register
- `*ESR?` EVENT STATUS QUERY, queries the contents of the event status register.

Device-specific commands

Hierarchy:

Device-specific commands are of hierarchical structure (see Fig. 3-1). The different levels are represented by combined headers. Headers of the highest level (root level) have only one key word. This key word denotes a complete command system.

Example: `SOURce` This key word denotes the command system `SOURce`.

For commands of lower levels, the complete path has to be specified, starting on the left with the highest level, the individual key words being separated by a colon ":".

Example: `SOURce:FM:EXTernal:COUPling AC`

This command lies in the fourth level of the SOURce system. It sets the coupling of the external signal source to AC.

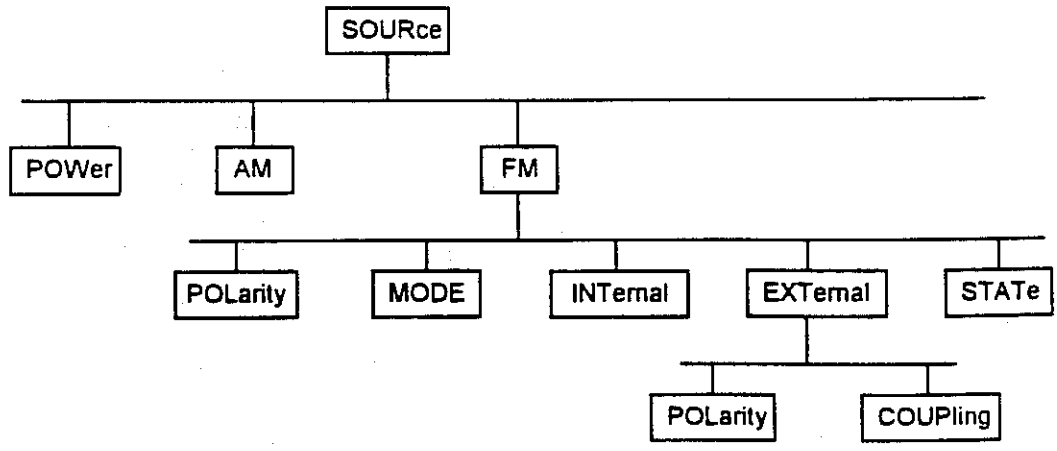


Fig. 3-1 Tree structure of the SCPI command systems using the SOURce system by way of example

Some key words occur in several levels within one command system. Their effect depends on the structure of the command, that is to say, at which position in the header of a command they are inserted.

Example: `SOURce:FM:POLarity NORMal`
This command contains key word POLarity in the third command level. It defines the polarity between modulator and modulation signal.

`SOURce:FM:EXTernal:POLarity NORMal`
This command contains key word POLarity in the fourth command level. It defines the polarity between modulation voltage and the resulting direction of the modulation only for the external signal source indicated.

Optional key words: Some command systems permit certain key words to be optionally inserted into the header or omitted. These key words are marked by square brackets in the description. The full command length must be recognized by the instrument for reasons of compatibility with the SCPI standard. Some commands are considerably shortened by these optional key words.

Example: `[SOURce]:POWer[:LEVel][:IMMediate]:OFFSet 1`
This command immediately sets the offset of the signal to 1 volt. The following command has the same effect:
`POWer:OFFSet 1`

Note: *An optional key word must not be omitted if its effect is specified in detail by a numeric suffix.*

Long and short form: The key words feature a long form and a short form. Either the short form or the long form can be entered, other abbreviations are not permissible.

Example: `STATus:QUEStionable:ENABle 1= STAT:QUES:ENAB 1`

Note: *The short form is marked by upper-case letters, the long form corresponds to the complete word. Upper-case and lower-case notation only serve the above purpose, the instrument itself does not make any difference between upper-case and lower-case letters.*

Parameter: The parameter must be separated from the header by a "white space". If several parameters are specified in a command, they are separated by a comma ",". A few queries permit the parameters MINimum, MAXimum and DEFault to be entered. For a description of the types of parameter, refer to Section 3.5.5.

Example: `SOURce:POWer:ATTenuation? MAXimum` Response: `60`
This query requests the maximal value for the attenuation.

Numeric suffix: If a device features several functions or features of the same kind, e.g. inputs, the desired function can be selected by a suffix added to the command. Entries without suffix are interpreted like entries with the suffix 1.

Example:. `SOURce:FM:EXTernal2:COUPling AC`
This command sets the coupling of the second external signal source.

3.5.3 Structure of a Command Line

A command line may consist of one or several commands. It is terminated by a <New Line>, a <New Line> with EOI or an EOI together with the last data byte. Quick BASIC automatically produces an EOI together with the last data byte.

Several commands in a command line are separated by a semicolon ";". If the next command belongs to a different command system, the semicolon is followed by a colon.

Example:
```
CALL IBWRT(device%, "SOURce:POWer:CENTer MINimum;:OUTPut:ATTenuation 10")
```

This command line contains two commands. The first command is part of the SOURce system and is used to specify the center frequency of the output signal. The second command is part of the OUTPut system and sets the attenuation of the output signal.

If the successive commands belong to the same system, having one or several levels in common, the command line can be abbreviated. To this end, the second command after the semicolon starts with the level that lies below the common levels (see also Fig. 3-1). The colon following the semicolon must be omitted in this case.

Example:
```
CALL IBWRT(device%, "SOURce:FM:MODE LOCKed;:SOURce:FM:INT:FREQuency 1kHz")
```

This command line is represented in its full length and contains two commands separated from each other by the semicolon. Both commands are part of the SOURce command system, subsystem FM, i.e. they have two common levels.
When abbreviating the command line, the second command begins with the level below SOURce:FM. The colon after the semicolon is omitted.

The abbreviated form of the command line reads as follows:

```
CALL IBWRT(device%, "SOURce:FM:MODE LOCKed;INT:FREQuency 1kHz")
```

However, a new command line always begins with the complete path.

Example:
```
CALL IBWRT(device%, "SOURce:FM:MODE LOCKed")
CALL IBWRT(device%, "SOURce:FM:INT:FREQuency 1kHz")
```

3.5.4 Responses to Queries

A query is defined for each setting command unless explicitly specified otherwise. It is formed by adding a question mark to the associated setting command. According to SCPI, the responses to queries are partly subject to stricter rules than in standard IEEE 488.2.

1 The requested parameter is transmitted without header.
Example: `SOURce:EXTernal:COUPling?` Response: `AC`

2. Maximum values, minimum values and all further quantities, which are requested via a special text parameter are returned as numerical values.
Example: `FREQuency? MAX` Response: `10E3`

3. Numerical values are output without a unit. Physical quantities are referred to the basic units or to the units set using the Unit command.
Example: `FREQuency?` Response: `1E6` for 1 MHz

4. Truth values <Boolean values> are returned as 0 (for OFF) and 1 (for ON).
Example: `OUTPut:STATe?` Response: `1`

5. Text (character data) is returned in a short form (see also Section 3.5.5).
Example: `SOURce:FM:SOURce?` Response: `INT1`

3.5.5 Parameters

Most commands require a parameter to be specified. The parameters must be separated from the header by a "white space". Permissible parameters are numerical values, Boolean parameters, text, character strings and block data. The type of parameter required for the respective command and the permissible range of values are specified in the command description (see Section 3.6).

Numerical values

Numerical values can be entered in any form, i.e. with sign, decimal point and exponent. Values exceeding the resolution of the instrument are rounded up or down. The mantissa may comprise up to 255 characters, the exponent must lie inside the value range -32000 to 32000. The exponent is introduced by an "E" or "e". Entry of the exponent alone is not permissible. In the case of physical quantities, the unit can be entered. Permissible unit prefixes are G (giga), MA (mega), MOHM and MHZ are also permissible), K (kilo), M (milli), U (micro) and N (nano). It the unit is missing, the basic unit is used.

Example:
`SOURce:FREQuency 1.5 kHz = SOURce:FREQuency 1.5E3`

Special numerical values

The texts MINimum, MAXimum, DEFault, UP and DOWN are interpreted as special numerical values.

In the case of a query, the numerical value is provided.

Example: Setting command: `SOURce:VOLTage MAXimum`
Query: `SOURce:VOLTage?` Response: `15`

MIN/MAX — MINimum and MAXimum denote the minimum and maximum value.

DEF — DEFault denotes a preset value which has been stored in the EPROM. This value conforms to the default setting, as it is called by the *RST command

UP/DOWN — UP, DOWN increases or reduces the numerical value by one step. The step width can be specified via an allocated step command (see annex C3, List of Commands) for each parameter which can be set via UP, DOWN.

INF/NINF — INFinity, Negative INFinity (NINF) Negative INFinity (NINF) represent the numerical values -9.9E37 or 9.9E37, respectively. INF and NINF are only sent as device reponses.

NAN — Not A Number (NAN) represents the value 9.91E37. NAN is only sent as device response. This value is not defined. Possible causes are the division of zero by zero, the subtraction of infinite from infinite and the representation of missing values.

Boolean Parameters

Boolean parameters represent two states. The ON state (logically true) is represented by ON or a numerical value unequal to 0. The OFF state (logically untrue) is represented by OFF or the numerical value 0. 0 or 1 is provided in a query.

Example: Setting command: `SOURce:FM:STATe ON`
Query: `SOURce:FM:STATe?` Response: `1`

Text

Text parameters observe the syntactic rules for key words, i.e. they can be entered using a short or long form. Like any parameter, they have to be separated from the header by a white space. In the case of a query, the short form of the text is provided.

Example: Setting command: `OUTPut:FILTer:TYPE EXTernal`
Query: `OUTPut:FILTer:TYPE?` Response `EXT`

Strings

Strings must always be entered in quotation marks (' or ").

Example: `SYSTem:LANGuage "English"` or
`SYSTem:LANGuage 'English'`

Block data

Block data are a transmission format which is suitable for the transmission of large amounts of data. A command using a block data parameter has the following structure:

Example: `HEADer:HEADer #45168xxxxxxxx`

ASCII character # introduces the data block. The next number indicates how many of the following digits describe the length of the data block. In the example the 4 following digits indicate the length to be 5168 bytes. The data bytes follow. During the transmission of these data bytes all End or other control signs are ignored until all bytes are transmitted. Data elements comprising more than one byte are transmitted with the byte being the first which was specified by SCPI command "FORMat:BORDer".

3.5.6 Overview of Syntax Elements

The following survey offers an overview of the syntax elements.

:	The colon separates the key words of a command. In a command line the colon after the separating semicolon marks the uppermost command level.
;	The semicolon separates two commands of a command line. It does not alter the path.
,	The comma separates several parameters of a command.
?	The question mark forms a query.
*	The asterix marks a common command.
"	Quotation marks introduce a string and terminate it.
#	ASCII character # introduces block data.
	A 'white space (ASCII-Code 0 to 9, 11 to 32 decimal, e.g.blank) separates header and parameter.

3.6 Description of Commands

3.6.1 Notation

In the following sections, all commands implemented in the instrument are first listed in tables and then described in detail, separated according to the command system. The notation corresponds to the one of the SCPI standards to a large extent. The SCPI conformity information can be taken from the list of commands in annex C3.

Note: *The commands indicated by way of example are not implemented in the CMD.*

Table of Commands

Command: In the command column, the table provides an overview of the commands and their hierarchical arrangement (see indentations).

Parameter: In the parameter column the requested parameters are indicated together with their specified range.

Unit: The unit column indicates the basic unit of the physical parameters.

Remark: In the remark column an indication is made on:
- whether the command does not have a query form,
- whether the command has only one query form ,
- whether this command is implemented only with a certain option of the instrument.

Indentations

The different levels of the SCPI command hierarchy are represented in the table by means of indentations to the right. The lower the level is, the farther the indentation to the right is. Please observe that the complete notation of the command always includes the higher levels as well.

Example: `SOURce:FM:MODE` iis represented in the table as follows:

SOURce	first level
:FM	second level
:MODE	third level

In the individual description, the hierarchy is represented in the corresponding way. That is to say, for each command all key words above up to the left-hand margin must be considered. An example for each command is written out at the end of the individual description.

Upper/lower case notation

Upper/lower case letters serve to mark the long or short form of the key words of a command in the description (see Section 3.5.2). The instrument itself does not distinguish between upper and lower case letters.

Special characters

| A selection of key words with an identical effect exists for several commands. These key words are indicated in the same line, they are separated by a vertical stroke. Only one of these key words has to be indicated in the header of the command. The effect of the command is independent of which of the key words is indicated.

Example: SOURce
:FREQuency
:CW|:FIXed

The two following commands of identical meaning can be formed. They set the frequency of the constantly frequent signal to 1 kHz:

```
SOURce:FREQuency:CW 1E3 = SOURce:FREQuency:FIXed 1E3
```

A vertical stroke in indicating the parameters marks alternative possibilities in the sense of "or". The effect of the command is different, depending on which parameter is entered.

Example: Selection of the parameters for the command

```
SOURce:COUPling  AC | DC
```

If parameter AC is selected, only the AC content is fed through, in the case of DC, the DC as well as the AC content.

[ ] Key words in square brackets can be omitted when composing the header (cf. Section 3.5.2, Optional Keywords). The full command length must be accepted by the instrument for reasons of compatibility with the SCPI standards.
Parameters in square brackets can optionally be incorporated in the command or omitted as well.

{ } Parameters in braces can optionally be incorporated in the command either not at all, once or several times.

3.6.2 Common Commands

The common commands are taken from the IEEE 488.2 (IEC 625-2) standard. Same commands have the same effect on different devices. The headers of these commands consist of "*" followed by three letters. Many common commands refer to the status reporting system which is described in detail in Section 3.8.

Table 3-1 Common Commands

Command	Parameter	Unit	Remark
*CLS			no query
*ESE	0...255		
*ESR?			only query
*IDN?			only query
*IST?			only query
*OPC			
*OPT?			only query
*PRE	0...255		
*PSC	0 | 1		
*RST			no query
*SRE	0...255		
*STB?			only query
*TST?			only query
*WAI			

***CLS**
CLEAR STATUS sets the status byte (STB), the standard event register (ESR) and the EVENt-part of the QUEStionable and the OPERation register to zero. The command does not alter the mask and transition parts of the registers. It clears the output buffer.

***ESE 0...255**
EVENT STATUS ENABLE sets the event status enable register to the value indicated. Query *ESE? returns the contents of the event status enable register in decimal form.

***ESR?**
STANDARD EVENT STATUS QUERY returns the contents of the event status register in decimal form (0 to 255) and subsequently sets the register to zero.

***IDN?**
IDENTIFICATION QUERY queries the instrument identification.
The device response is for example: "Rohde&Schwarz, CMD,0, 1.00 18.10.93"
0= serial number
1.0 18.10.93 = Firmware version number and date of delivery

***IST?**

INDIVIDUAL STATUS QUERY returns the contents of the IST flag in decimal form (0 | 1). The IST-flag is the status bit which is sent during a parallel poll (see section 3.8.3.2).

***OPC**

OPERATION COMPLETE sets bit 0 in the event status register when all preceding commands have been executed. This bit can be used to initiate a service request (cf. Section 3.7).

***OPC?**

OPERATION COMPLETE QUERY writes message "1" into the output buffer as soon as all preceding commands have been executed (cf. Section 3.7).

***OPT?**

OPTION IDENTIFICATION QUERY queries the options included in the instrument and returns a list of the options installed. The options are separated from each other by means of commas.

The responses have the following meaning:

B1	OCXO Reference
B3	Ref. Frequency In/Out
B4	DSP
B41	AF Unit
B42	IF Log. Amplifier
B43	Spectrum Measurements
B5	Speech Codec
B6	Option Basic Board
B61	IEEE Bus
B62	Memcard Interface
B63	Flashdisk
B64	EMMI/DAI
B65	Control In/Out
B7	A-Bis
B8	Coprocessor
B9	Second RF Synthesizer

Example of a device response: B1,,B4,,,,,B6,B61,,,,,,,B9

***PRE 0...255**
PARALLEL POLL REGISTER ENABLE sets parallel poll enable register to the value indicated. Query *PRE? returns the contents of the parallel poll enable register in decimal form.

***PSC 0 | 1**
POWER ON STATUS CLEAR determines whether the contents of the ENABle registers is maintained or reset in switching on.

*PSC = 0 causes the contents of the status registers to be maintained. Thus a service request can be triggered in switching on in the case of a corresponding configuration of status registers ESE and SRE.

*PSC ≠ 0 resets the registers.

Query *PSC? reads out the contents of the power-on-status-clear flag. The response can be 0 or 1.

***RST**
RESET sets the instrument to a defined default status. The command essentially corresponds to pressing the [RESET] key. The default setting is indicated in the description of commands.

***SRE 0...255**
SERVICE REQUEST ENABLE sets the service request enable register to the value indicated. Bit 6 (MSS mask bit) remains 0. This command determines under which conditions a service request is triggered. Query *SRE? reads the contents of the service request enable register in decimal form. Bit 6 is always 0.

***STB?**
READ STATUS BYTE QUERY reads the contents of the status byte in decimal form.

***TST?**
SELF TEST QUERY triggers selftests of the instrument and outputs an error code in decimal form.

WAI
WAIT-to-CONTINUE only permits the servicing of the subsequent commands after all preceding commands have been executed and all signals have settled (see also section 3.7 and "*OPC").

3.7 Instrument Model and Command Processing

The instrument model shown in Fig. 3.2 has been made viewed from the standpoint of the servicing of remote-control commands. The individual components work independently of each other and simultaneously. They communicate by means of so-called "messages".

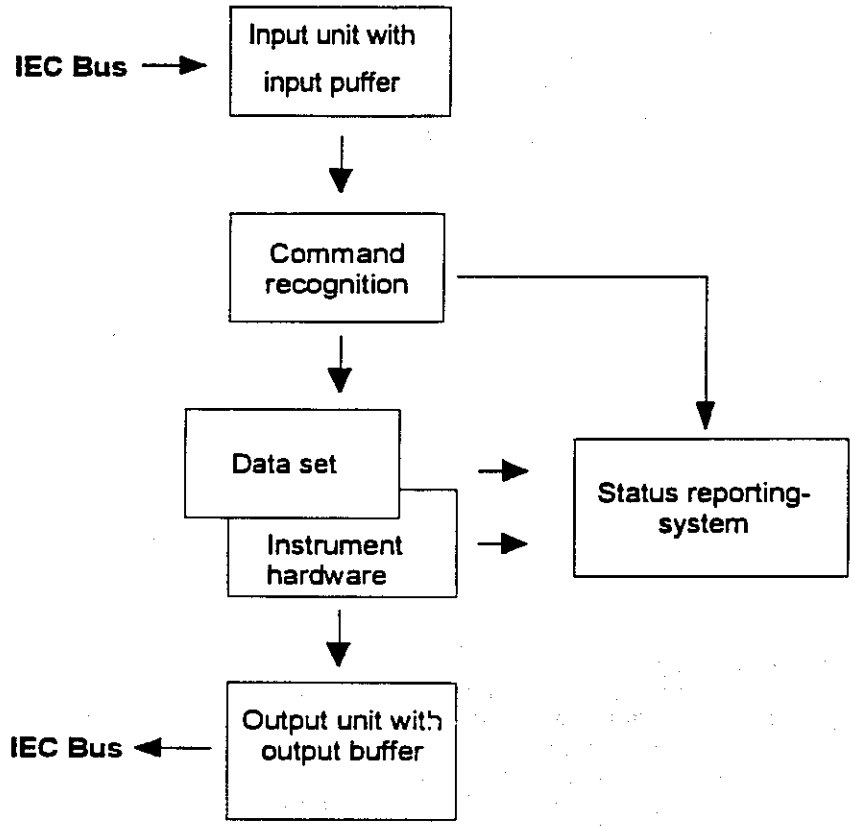


Fig. 3-2 Instrument model in the case of remote control

3.7.1 Input Unit

The input unit receives commands character by character from the remote-control interface and collects them in the input buffer. The input buffer has a size of 256 characters. The input unit sends a message to the command recognition as soon as the input buffer is full or as soon as it receives a delimiter, <PROGRAM MESSAGE TERMINATOR>, as defined in IEEE 488.2, or the interface message DCL.
If the input buffer is full, the remote-control traffic is stopped and the data received up to then are processed. Subsequently the remote-control traffic is continued. If, however, the buffer is not yet full when receiving the delimiter, the input unit can already receive the next command during command recognition and execution. The reception of a DCL clears the input buffer and immediately initiates a message to the command recognition.

3.7.2 Command Recognition

The command recognition analyses the data received from the input unit. It proceeds in the order in which it receives the data. Only a DCL is serviced with priority, a GET (Group Execute Trigger), e.g., is only executed after the commands received before as well. Each recognized command is immediately transferred to the data set but without being executed there at once.
Syntactical errors in the command are recognized here and supplied to the status reporting system. The rest of a command line after a syntax error is analysed further if possible and serviced.
If the command recognition recognizes a delimiter or a DCL, it requests the data set to set the commands in the instrument hardware as well now. Subsequently it is immediately prepared to process commands again. This means for the command servicing that further commands can already be serviced while the hardware is still being set ("overlapping execution").

3.7.3 Data Set and Instrument Hardware

Here the expression "instrument hardware" denotes the part of the instrument fulfilling the actual instrument function - signal generation, measurement etc. The controller is not included.

The data set is a detailed reproduction of the instrument hardware in the software.

Remote-control setting commands lead to an alteration in the data set. The data set management enters the new values (e.g. frequency) into the data set, however, only passes them on to the hardware when requested by the command recognition. As this is always only effected at the end of a command line, the order of the setting commands in the command line is not relevant.

The data are only checked for their compatibility among each other and with the instrument hardware immediately before they are transmitted to the instrument hardware. If the detection is made that an execution is not possible, an "execution error" is signalled to the status reporting system. All alterations of the data set are cancelled, the instrument hardware is not reset. Due to the delayed checking and hardware setting, however, it is permissible to set impermissible instrument states within one command line for a short period of time without this leading to an error message (example: simultaneous activation of FM and PM). At the end of the command line, however, a permissible instrument state must have been reached again.

Remote-control queries induce the data set management to send the desired data to the output unit.

3.7.4 Status Reporting System

The status reporting system collects information on the instrument state and makes it available to the output unit on request. The exact structure and function are described in Section 3.8

3.7.5 Output Unit

The output unit collects the information requested by the controller, which it receives from the data set management. It processes it according to the SCPI rules and makes it available in the output buffer. The output buffer has a size of 256 characters. If the information requested is longer, it is made available "in portions" without this being recognized by the controller.
If the instrument is addressed as a talker without the output buffer containing data or awaiting data from the data set management, the output unit sends error message "Query UNTERMINATED" to the status reporting system. No data are sent on the remote-control interface, the controller waits until it has reached its time limit. This behaviour is specified by SCPI.

3.7.6 Command Sequence and Command Synchronization

What has been said above makes clear that all commands can potentially be carried out overlapping. Equally, setting commands within one command line are not absolutely serviced in the order in which they have been received.

In order to make sure that commands are actually carried out in a certain order, each command must be sent in a separate command line, that is to say, with a separate IBWRT()-call.
In order to prevent an overlapping execution of commands, one of commands *OPC, *OPC? or *WAI must be used. All three commands cause a certain action only to be carried out after the hardware has been set and has settled. By a suitable programming, the contoller can be forced to wait for the respective action to occur (cf. table 3-2).

Table 3-2 Synchronisation using *OPC *OPC? and *WAI

Commnd	Action after the hardware has settled	Programming the controller
*OPC	Setting the operation-complete bit in the ESR	- Setting bit 0 in the ESE - Setting bit 5 in the SRE - Waiting for service request (SRQ)
*OPC?	Writing a "1" into the output buffer	Addressing the instrument as a talker
*WAI	Continuing the IEC-bus handshake	Sending the next command

3.8 Status Reporting System

The status reporting system (cf. Fig. 3-4) stores all information on the present operating state of the instrument and on errors which have occurred. This information is stored in the status registers and in the error queue. The status registers and the error queue can be queried via the remote-control interface.

The information is of a hierarchical structure. The register status byte (STB) defined in IEEE 488.2 and its associated mask register service request enable (SRE) form the uppermost level. The STB receives its information from the standard event status register (ESR) which is also defined in IEEE 488.2 with the associated mask register standard event status enable (ESE) and registers STATus:OPERation and STATus:QUEStionable which are defined by SCPI and contain detailed information on the instrument.

The IST flag ("Individual STatus") and the parallel poll enable register (PPE) allocated to it are also part of the status reporting system. The IST flag, like the SRQ, combines the entire instrument status in a single bit. The PPE fulfills an analog function for the IST flag as the SRE for the service request.

The output buffer contains the messages the instrument returns to the controller. It is not part of the status reporting system but determines the value of the MAV bit in the STB and thus is represented in Fig. 3.4.

3.8.1 Structure of an SCPI Status Register

Each SCPI register consists of 5 parts which each have a width of 16 bits and have different functions (cf. Fig. 3-3). The individual bits are independent of each other, i.e. each hardware status is assigned a bit number which is valid for all five parts. For example, bit 3 of the STATus:OPERation register is assigned to the hardware status "wait for trigger" in all five parts. Bit 15 (the most significant bit) is set to zero for all parts. Thus the contents of the register parts can be processed by the controller as positive integer.

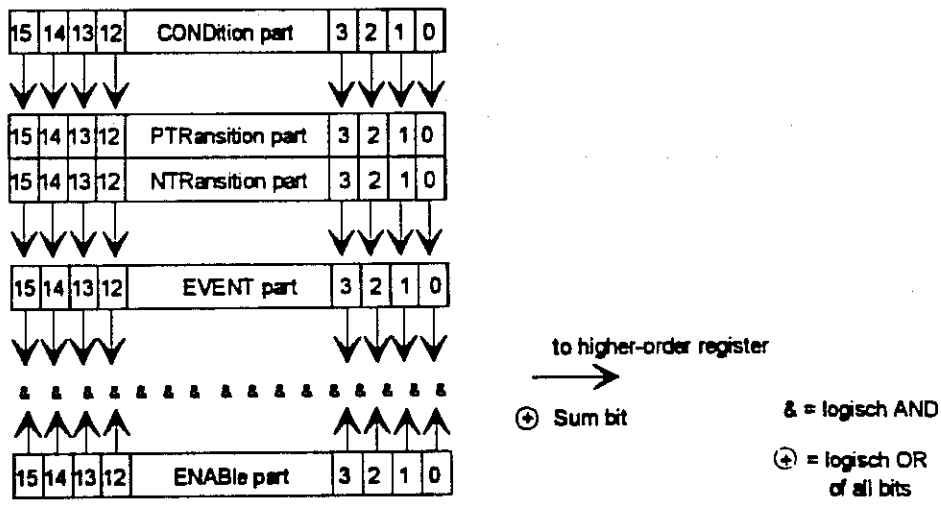


Fig. 3-3 The status-register model

CONDition part

The CONDition part is directly written into by the hardware or the sum bit of the next lower register. Its contents reflects the current instrument status. This register part can only be read, but not written into or cleared. Its contents is not affected by reading.

PTRansition part

The Positive-TRansition part acts as an edge detector. When a bit of the CONDition part is changed from 0 to 1, the associated PTR bit decides whether the EVENt bit is set to 1.
PTR bit =1: the EVENt bit is set.
PTR bit =0: the EVENt bit is not set.
This part can be written into and read at will. Its contents is not affected by reading.

NTRansition part

The Negative-TRansition part also acts as an edge detector. When a bit of the CONDition part is changed from 1 to 0, the associated NTR bit decides whether the EVENt bit is set to 1.
NTR-Bit = 1: the EVENt bit is set.
NTR-Bit = 0: the EVENt bit is not set.
This part can be written into and read at will. Its contents is not affected by reading.

With these two edge register parts the user can define which state transition of the condition part (none, 0 to 1, 1 to 0 or both) is stored in the EVENt part.

EVENt part

The EVENt part indicates whether an event has occurred since the last reading, it is the "memory" of the condition part. It only indicates events passed on by the edge filters. It is permanently updated by the instrument. This part can only be read by the user. During reading, its contents is set to zero. In linguistic usage this part is often equated with the entire register.

ENABle part

The ENABle part determines whether the associated EVENt bit contributes to the sum bit (cf. below). Each bit of the EVENt part is ANDed with the associated ENABle bit (symbol '&'). The results of all logical operations of this part are passed on to the sum bit via an OR function (symbol '+').
ENAB-Bit = 1: the associated EVENt bit does not contribute to the sum bit
ENAB-Bit = 0: if the associated EVENT bit is "1", the sum bit is set to "1" as well.
This part can be written into and read by the user at will. Its contents is not affected by reading.

Sum bit

As indicated above, the sum bit is obtained from the EVENt and ENABle part for each register. The result is then entered into a bit of the CONDition part of the higher-order register.
The instrument automatically generates the sum bit for each register. Thus an event, e.g. a PLL that has not locked, can lead to a service request throughout all levels of the hierarchy.

Note: *The service request enable register SRE defined in IEEE 488.2 can be taken as ENABle part of the STB if the STB is structured according to SCPI. By analogy, the ESE can be taken as the ENABle part of the ESR.*

3.8.2 Overview of the Status Registers

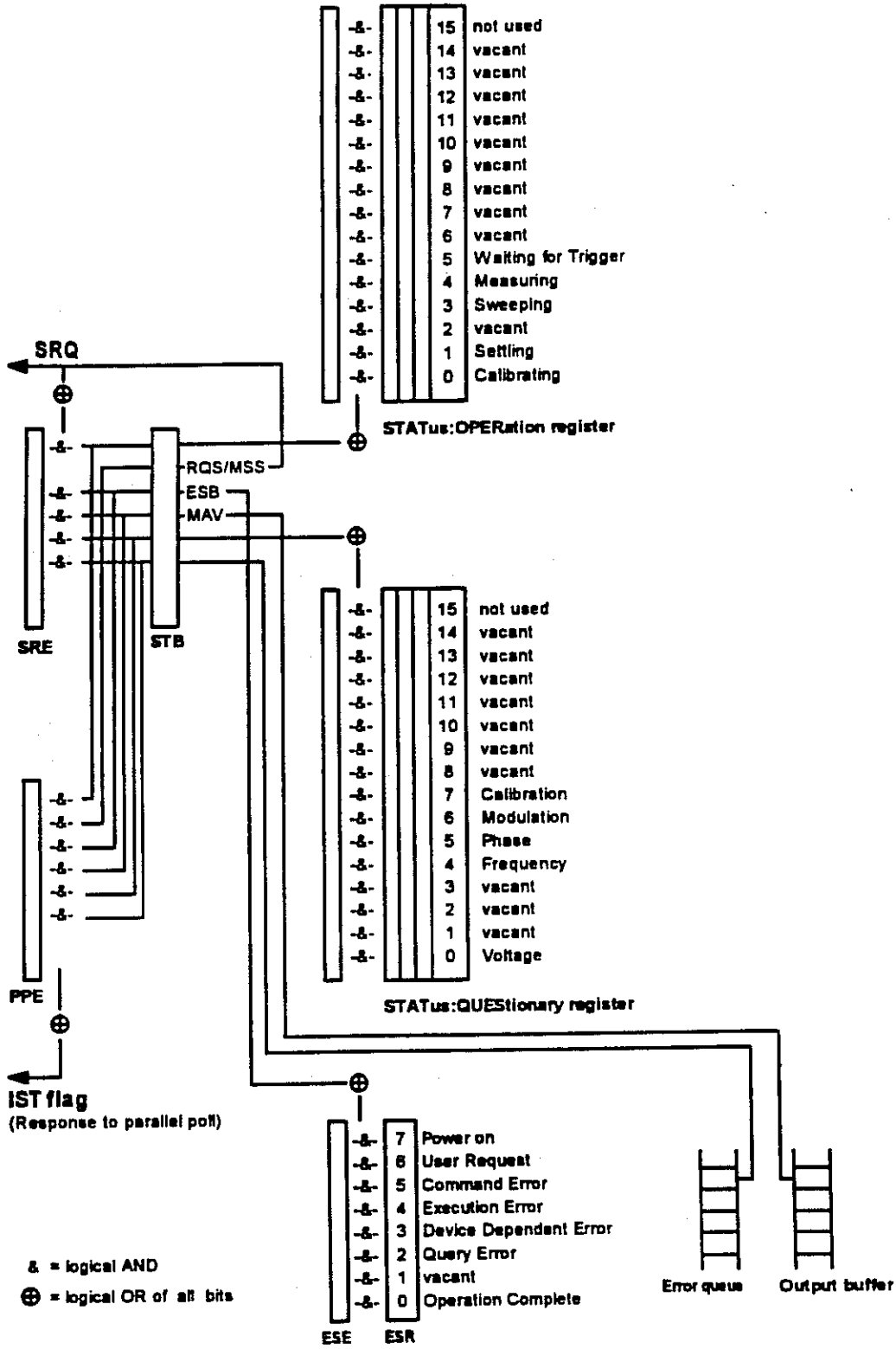


Fig. 3-4 Overview of status registers

3.8.3 Description of the Status Registers

3.8.3.1 Status Byte (STB) and Service Request Enable Register (SRE)

The STB is already defined in IEEE 488.2. It provides a rough overview of the instrument status by collecting the pieces of information of the lower registers. It can thus be compared with the CONDition part of an SCPI register and assumes the highest level within the SCPI hierarchy. A special feature is that bit 6 acts as the sum bit of the remaining bits of the status byte.
The STATUS BYTE is read out using the command "*STB?" or a serial poll.

The STB includes the SRE. It corresponds to the ENABle part of the SCPI registers as to its function. Each bit of the STB is assigned a bit in the SRE. Bit 6 of the SRE is ignored. If a bit is set in the SRE and the associated bit in the STB changes from 0 to 1, a Service Request (SRQ) is generated on the IEC bus, which triggers an interrupt in the controller if this is appropriately configured and can be further processed there. (An SRQ cannot be triggered on the serial interface, since no appropriate hardware lines are provided there).
The SRE can be set using command "*SRE" and read using "*SRE?".

Table 3-3 Meaning of the bits used in the satus byte

Bit No.	Meaning
2	**Error Queue not empty** The bit is set when an entry is made in the error queue. If this bit is enabled by the SRE, each entry of the error queue generates a Service Request. Thus an error can be recognized and specified in greater detail by polling the error queue. The poll provides an informative error message. This procedure is to be recommended since it considerably reduces the problems involved with remote control.
3	**QUEStionable status sum bit** The bit is set if an EVENt bit is set in the QUEStionable-Status register and the associated ENABle bit is set to 1. A set bit indicates a questionable instrument status, which can be specified in greater detail by polling the QUEStionable-Status register.
4	**MAV bit (message available)** The bit is set if a message is available in the output buffer which can be read. This bit can be used to enable data to be automatically read from the instrument to the controller (cf. annex D3, program examples).
5	**ESB bit** Sum bit of the event status register. It is set if one of the bits in the event status register is set and enabled in the event status enable register. Setting of this bit implies a serious error which can be specified in greater detail by polling the event status register.
6	**MSS bit (master status smmary bit)** The bit is set if the instrument triggers a service request. This is the case if one of the other bits of this registers is set together with its mask bit in the service request enable register SRE.
7	**OPERation status register sum bit** The bit is set if an EVENt bit is set in the OPERation-Status register and the associated ENABle bit is set to 1. A set bit indicates that the instrument is just performing an action. The type of action can be determined by polling the QUEStionable -Status register.

3.8.3.2 IST Flag and Parallel Poll Enable Register (PPE)

By analogy with the SRQ, the IST flag combines the entire status information in a single bit. It can be queried by means of a parallel poll (cf. Section 3.8.4.3) or using command ""IST?".

The parallel poll enable register (PPE) determines which bits of the STB contribute to the IST flag. The bits of the STB are ANDed with the corresponding bits of the PPE, with bit 6 being used as well in contrast to the SRE. The Ist flag results from the ORing of all results. The PPE can be set using commands ""PRE" and read using command ""PRE?".

3.8.3.3 Event-Status-Register (ESR) und Event-Status-Enable-Register (ESE)

The ESR is already defined in IEEE 488.2. It can be compared with the EVENt part of an SCPI register. The event status register can be read out using command ""ESR?".
The ESE is the associated ENABle part. It can be set using command ""ESE" and read using command ""ESE?".

Table 3-4 Meaning of the bits used in the event status register

Bit No.	Meaning
0	**Operation Complete** This bit is set on reception of the command *OPC exactly when all previous commands have been executed.
2	**Query Error** This bit is set if either the controller wants to read data from the instrument without having sent a query, or if it does not fetch requested data and sends new instructions to the instrument instead. The cause is often a query which is faulty and hence cannot be executed.
3	**Device-dependent Error** This bit is set if a device-dependent error occurs. An error message with a number between -300 and -399 or a positive error number, which denotes the error in greater detail, is entered into the error queue (cf. annex B3, Error Messages).
4	**Execution Error** This bit is set if a received command is syntactically correct, however, cannot be performed for other reasons. An error message with a number between -200 and -300, which denotes the error in greater detail, is entered into the error queue (cf. annex B3, Error Messages).
5	**Command Error** This bit is set if a command which is undefined or syntactically incorrect is received. An error message with a number between -100 and -200, which denotes the error in greater detail, is entered into the rror queue (cf. annex B3, -Error Messages).
6	**User Request** This bit is set on pressing the LOCAL key, i. e., when the instrument is switched over to manual control.
7	**Power On (supply voltage on)** This bit is set on switching on the instrument.

3.8.3.4 STATus:OPERation Register

In the CONDition part, this register contains information on which actions the instrument is being executing or, in the EVENt part, information on which actions the instrument has executed since the last reading. It can be read using the commands `STATus:OPERation:CONDition?` bzw. `STATus:OPERation[:EVENt]?`.

Table 3-5 Meaning of the bits used in the STATus:OPERation register

Bit No.	Meaning
8	**CMD Event** This bit is set if one of the events specified in the CMD event register has occurred.

The CMD only uses bit 8 of this register.

3.8.3.5 STATus:QUEStionable Register

This register contains information on questionable instrument states. They can occur, e.g. if the instrument is operated out of its specifications. It can be queried using the commands `STATus:QUEStionable:CONDition?` or `STATus:QUEStionable[:EVENt]?`.

The CMD does not use this register.

3.8.4 Application of the Status Reporting System

In order to be able to effectively use the status reporting system, the information contained there must be transmitted to the controller and further processed there. There are several methods which are represented in the following.

3.8.4.1 Service Request, Making Use of the Hierarchy Structure

Under certain circumstances, the instrument can send a service request (SRQ) to the controller. Usually this service request initiates an interrupt at the controller, to which the control program can react with corresponding actions. As evident from Fig. 3.4 (Section 3.8.2), an SRQ is always initiated if one or several of bits 2, 3, 4, 5 or 7 of the status byte are set and enabled in the SRE. Each of these bits combines the information of a further register, the error queue or the output buffer. The corresponding setting of the ENABle parts of the status registers can achieve that arbitrary bits in an arbitrary status register initiate an SRQ. In order to make use of the possibilities of the service request, all bits should be set to "1" in enable registers SRE and ESE.

Examples (cf. Fig. 3.4, Section 3.8.2):

Use of command "*OPC" to generate an SRQ

- Set bit 0 in the ESE (Operation Complete)
- Set bit 5 in the SRE (ESB)?

  After its settings have been completed, the instrument generates an SRQ.

Indication of the end of a call setup from the mobile by means of an SRQ with the controller

- Set bit 7 in the SRE (sum bit of the STATus:OPERation register)
- Set bit 8 (CMD event) in the STATus:OPERation:ENABle.

  After a call setup has been completed, the instrument generates an SRQ.

The SRQ is the only possibility for the instrument to become active on its own. Each controller program should set the instrument such that a service request is initiated in the case of malfunction. The program should react appropriately to the service request.

3.8.4.2 Serial Poll

In a serial poll, as with command "*STB", the status byte of an instrument is queried. However, the query is implemented via interface messages and is thus clearly faster. The serial-poll method has already been defined in IEEE 488.1 and used to be the only standard possibility for different instruments to poll the status byte. The method also works with instruments which do not adhere to SCPI or IEEE 488.2.

The quick-BASIC command for executing a serial poll is "IBRSP()". Serial poll is mainly used to obtain a fast overview of the state of several instruments connected to the IEC bus.

3.8.4.3 Parallel Poll

In a parallel poll, up to eight instruments are simultaneously requested by the controller by means of a single command to transmit 1 bit of information each on the data lines, i.e., to set the data line allocated to each instrument to logically "0" or "1". By analogy to the SRE register which determines under which conditions an SRQ is generated, there is a parallel poll enable register (PPE) which is ANDed with the STB bit by bit as well considering bit 6. The results are ORed, the result is then sent (possibly inverted) as a response in the parallel poll of the controller. The result can also be queried without parallel poll by means of command "*IST".

The instrument first has to be set for the parallel poll using quick-BASIC command "IBPPC()". This command allocates a data line to the instrument and determines whether the response is to be inverted. The parallel poll itself is executed using "IBRPP()".

The parallel-poll method is mainly used in order to quickly find out after an SRQ which instrument has sent the service request if there are many instruments connected to the IEC bus. To this effect, SRE and PPE must be set to the same value.

3.8.4.4 Query by Means of Commands

Each part of every status register can be read by means of queries. The individual commands are indicated in the detailed description of the registers in Section 3.8.3. What is returned is always a number which represents the bit pattern of the register queried. Evaluating this number is effected by the controller program.

Queries are usually used after an SRQ in order to obtain more detailed information on the cause of the SRQ

3.8.4.5 Error-Queue Query

Each error state in the instrument leads to an entry in the error queue. The entries of the error queue are detailed plain-text error messages which can be queried via the remote control using command "SYSTem:ERRor?". Each call of "SYSTem:ERRor?" provides an entry from the error queue. If no error messages are stored there any more, the instrument responds with 0, "No error".

The error queue should be queried after every SRQ in the controller program as the entries describe the cause of an error more precisely than the status registers. Especially in the test phase of a controller program the error queue should be queried regularly since faulty commands from the controller to the instrument are recorded there as well.

3.8.5 Resetting Values of the Status Reporting System

Table 3-6 comprises the different commands and events causing the status reporting system to be reset. None of the commands, except for *RST and SYSTem:PRESet influences the functional instrument settings. In particular, DCL does not change the instrument settings.

Table 3-6 Resettting instrument functions

Event / Effect	Switching on supply voltage: Power-On-Status-Clear 0	Switching on supply voltage: Power-On-Status-Clear 1	DCL,SDC (Device Clear, Selected Device Clear)	*RST or SYSTem:PRESet	STATus:PRESet	*CLS
Clear STB,ESR	—	yes	—	—	—	yes
Clear SRE,ESE	—	yes	—	—	—	—
Clear PPE	—	yes	—	—	—	—
Clear EVENTt parts of the registers	—	yes	—	—	—	yes
Clear Enable parts of all OPERation and QUEStionable registers, Fill Enable parts of all other registers with "1".	—	yes	—	—	yes	—
Clear error queue	yes	yes	—	—	—	yes
Clear output buffer	yes	yes	yes	1)	1)	1)
Clear command processing and input buffer	yes	yes	yes	—	—	yes

1) Every command being the first in a command line, i.e., immediately following a <PROGRAM MESSAGE TERMINATOR> clears the output buffer.

Annex A3

IEC-Bus Interface

The instrument is equipped with an optional IEC/IEEE-bus connector. The mating connector according to IEEE 488 is at the rear of the instrument. A controller for remote control can be connected via the interface. The connection is effected using a shielded cable.

Characteristics of the Interface

- 8-bit parallel data transfer
- bidirectional data transfer
- three-line handshake
- high data transfer rate of max. 350 kByte/s
- up to 15 devices can be connected
- maximal length of the connecting cables 15 m (single connection 2m)
- wired OR if several instruments are connected in parallel.

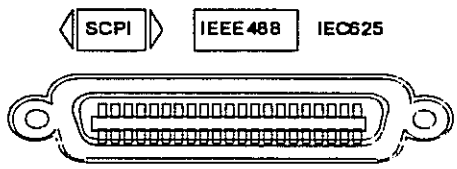


Fig. A3-1 IEC-Bus-Interface

Bus Lines

1. **Data bus with 8 lines DIO 1 to DIO 8.**
   The transmission is bit-parallel and byte-serial in the ASCII/ISO code. DIO1 is the least significant, DIO8 the most significant bit.

2. **Control bus with 5 lines.**
   IFC (Interface Clear),
   active low resets the interfaces of the instruments connected to the default setting.

   ATN (Attention),
   active low signals the transmission of interface messages
   inactive high signals the transmission of device-dependent messages.

SRQ (Service Request),
active low enables a device connected to send a service request to the controller.

REN (Remote Enable),
active low permits the switchover to remote control.

EOI (End or Identify),
has two functions in connection with ATN:
active low marks the end of data transmission with ATN=high
active low triggers a parallel poll with ATN=low.

3. **Handshake bus with three lines.**
DAV (Data Valid),
active low signals a valid data byte on the data bus.

NRFD (Not Ready For Data),
active low signals that one of the devices connected is not ready for data transfer .

NDAC (Not Data Accepted),
active low as long as the instrument connected is accepting the data present on the data bus.

Interface Functions

Instruments which can be remote-controlled via IEC bus can be equipped with different interface functions. Table A3-1 lists the interface functions appropriate for the instrument.

Table A3-1 Interface functions

Control character	Interface function
SH1	Handshake source function (source handshake)
AH1	Handshake drain function (acceptor handshake)
L4	Listener function.
T6	Talker function, ability to respond to serial poll
SR1	Service request function (Service Request)
PP1	Parallel poll function
RL1	Remote/Local switchover function
DC1	Resetting function (Device Clear)
DT1	Trigger function (Device Trigger)
C0	Controller function

Interface Messages

Interface messages are transmitted to the instrument on the data lines, with the attention line being active (LOW). They serve to communicate between instrument and controller.

Universal Commands

The universal commands are encoded in the range 10 through 1F hex. They act on all instruments connected to the bus without addressing them before.

Table A3-2 Universal Commands

Command	QuickBASIC command	Effect on the instrument
DCL (Device Clear)	IBCMD (controller%, CHR$(20))	Aborts the processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument setting.
IFC (Interface Clear)	IBSIC (controller%)	Resets the interfaces to the default setting.
LLO (Local Lockout)	IBCMD (controller%, CHR$(17))	The LOC/IEC ADDR key is disabled.
SPE (Serial Poll Enable)	IBCMD (controller%, CHR$(24))	Ready for seriall poll.
SPD (Serial Poll Disable)	IBCMD (controller%, CHR$(25))	End of seriall poll.
PPU (Parallel Poll Unconfigure)	IBCMD (controller%, CHR$(21))	End of the parallel-poll state.

Addressed Commands

The addressed commands are encoded in the range 00 through 0F hex. They are only effective for instruments addressed as listeners.

Table A3-3 Addressed Commands

Command	QuickBASIC command	Effect on the instrument
SDC (Selected Device Clear)	IBCLR (device%)	Aborts the processing of the commands just received and sets the command processing software to a defined initial state. Does not change the instrument setting.
GTL (Go to Local)	IBLOC (device%)	Transition to the "Local" state (manual control).
PPC (Parallel Poll Configure)	IBPPC (device%, data%)	Configure instrument for parallel poll. The QuickBASIC command additionally executes PPE/PPD.

Serial Interface

The instrument is equipped with a serial interface (RS-232-C) as standard. The 9-pin connector is located at the rear of the instrument. A controller for remote control can be connected via the interface. The connection is effected using a zero modem cable.

For remote control via the serial interface, an important aspect is to be noted:
Some controllers already send characters on the serial interface during booting, causing the instrument to switch to the REMOTE state as soon as it receives these characters (since no explicit addressing is possible with the serial remote control).

Characteristics of the Interface

- serial data transfer
- bidirectional data transfer
- Software or hardware handshake
- Data transfer rate between 110 baud and 115200 baud
- Possible length of connecting cable > 20 m

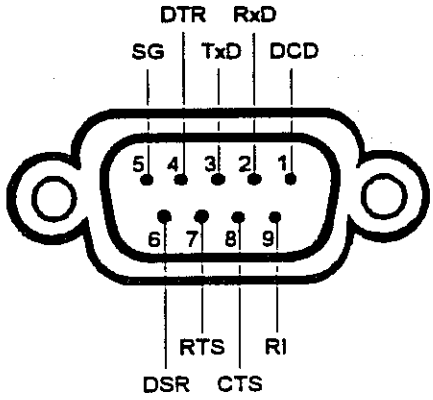


Fig. A3-2 RS232 interface

Designation		Pin (9-pin)	Pin (25-pin)
Data Carrier Detect	DCD	1	8
Receive Data	RxD	2	3
Transmit Data	TxD	3	2
Data Terminal Ready	DTR	4	20
Signal Ground	SG	5	7
Data Set Ready	DSR	6	6
Request To Send	RTS	7	4
Clear To Send	CTS	8	5
Ring Indicator	RI	9	21

Lines

1. Data lines
RxD (receive data) and **TxD** (transmit data)
The transmission is bit-serial in the ASCII code starting with the LSB.
The two lines are necessary as the minimum requirement for a transmission; however, no hardware handshake is possible, but only the XON/XOFF protocol.

2. Control lines
DCD (Data Carrier Detect),
active LOW.
Input; using this signal, the data terminal recognizes that the modem of the remote station receives valid signals with sufficient level. DCD is used to disable the receiver in the data terminal and prevent reading of false data if the modem cannot interpret the signals of the remote station.

DTR (Data Terminal Ready),
active LOW,
Output indicating that the data terminal is ready to receive data.

DSR (Data Set Ready),
active LOW,
Input indicating that the external device is ready to receive data.

RTS (Request To Send),
active LOW.
Output that can be used to indicate the readiness to receive data.

CTS (Clear To Send),
active LOW.
Input used to enable the transmission of data.

RI (Ring Indicator),
active LOW.
Input; RI is used by a modem to indicate that a remote station wants to set up a connection.

Default settings

The serial interface is set to the following values:

Table A3-4 Default setting

Parameter	Setting value
Baud rate	2400 baud
Data bits	8 bits
Stop bits	1 bits
Parity	none

Handshake

Software handshake

In the case of the software handshake, the data transfer is controlled using the two control characters XON / XOFF.
The CMD uses the control character XON to indicate that it is ready to receive data.
If the receive buffer is full, it sends the XOFF character via the interface to the controller. The controller then interrupts the data output until it receives another XON from the CMD.
The controller indicates to the CMD that it is ready to receive data in the same way.

Cable for local controller coupling in the case of software handshake

The connection of the CMD with a controller in the case of software handshake is effected by crossing the data lines. The following wiring diagram applies to a controller with 9-pin or 25-pin configuration.

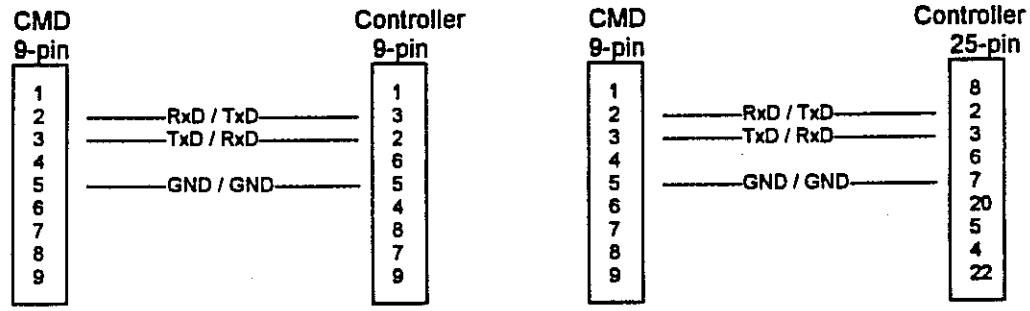


Fig. A3-3 Wiring of the data lines for software handshake

Hardware handshake

In the case of the hardware handshake, the CMD indicates that it is ready to receive data via the lines DTR and RTS. A logic '0' on both lines means "ready" and a logic '1' means "not ready". The RTS line is always active (logic '0') as long as the serial interface is switched on. The DTR line thus controls the readiness of the CMD to receive data.

The readiness of the remote station to receive data is reported to the CMD via the CTS and DSR line. A logic '0' on both lines activates the data output and a logic '1' on both lines stops the data output of the CMD. The data output is effected via the TxD line.

Annex B3

List of Error Messages

The following list contains all error messages for errors occurring in the instrument. The meaning of negative error codes is defined in SCPI, positive error codes mark errors specific of the instrument.

The table contains the error code in the left-hand column. In the right-hand column the error text being entered into the error/event queue or being displayed is printed in bold face. Below the error text, there is an explanation as to the respective error.

SCPI-Specific Error Messages

No Error

Error code	Error text in the case of queue poll Error explanation
0	**No error** This message is output if the error queue does not contain any entries.

Command Error - Faulty command; sets bit 5 in the ESR register.

Error code	Error text in the case of queue poll Error explanation
-100	**Command Error** The command is faulty or invalid.
-101	**Invalid Character** The command contains an invalid sign. Example: A header contains an ampersand, "SOURCE &".
-102	**Syntax error** The command is invalid. Example: The command contains block data the instrument does not accept.
-103	**Invalid separator** The command contains an impermissible sign instead of a separator. Example: A semicolon is missing after the command.
-104	**Data type error** The command contains an invalid value indication. Example: ON is indicated instead of a numeric value for frequency setting.
-105	**GET not allowed** A Group Execute Trigger (GET) is within a command line.
-108	**Parameter not allowed** The command contains too many parameters. Example: Command `CONFigure:REGen:FREQency` permits only one fraquency indication.

Contiuation: Command Error

Error code	Error text in the case of queue poll Error explanation
-109	**Missing parameter** The command contains too few parameters. Example: The command `CONFigure:RFGen:FREQuency` requires a frequency indication.
-111	**Header separator error** The header contains an impermissible separator. Example: the header is not followed by a "White Space", "`*ESE255`"
-112	**Program mnemonic too long** The header contains more than 12 characters.
-113	**Undefined header** The header is not defined for the instrument. Example: `*XYZ` is undefined for every instrument.
-114	**Header suffix out of range** The header contains an impermissible numeric suffix. Example: `SOURce3` does not exist in the instrument.
-120	**Numeric data error** The command contains a faulty numeric parameter.
-121	**Invalid character in number** A number contains an invalid character. Example: An "A" in a decimal number or a "9" in an octal number.
-123	**Exponent too large** The absolute value of the exponent is greater than 32000.
-124	**Too many digits** The number includes too many digits.
-128	**Numeric data not allowed** The command includes a number which is not allowed at this position. Example: The command `SOURce:RFGen:SELect` requires indication of a text parameter.
-131	**Invalid suffix** The suffix is invalid for this instrument. Example: nHz is not defined.
-134	**Suffix too long** The suffix contains more than 12 characters.
-138	**Suffix not allowed** A suffix is not allowed for this command or at this position of the command. Example: The command `*RCL` does not permit a suffix to be indicated.
-141	**Invalid character data** The text parameter either contains an invalid character or it is invalid for this command. Example: write error with parameter indication; `SOURce:RFGen:SELect STT1.`
-144	**Character data too long** The text parameter contains more than 12 characters.
-148	**Character data not allowed** The text parameter is not allowed for this command or at this position of the command. Example: The command `*RCL` requires a number to be indicated.

Continuation: Command Error

Error code	Error text in the case of queue poll Error explanation
-151	**Invalid string data** The command contains a faulty string. Example:An END message has been received prior to the terminating apostrophe.
-158	**String data not allowed** The command contains a valid string at a position which is not allowed. Example: A text parameter is set in quotation marks, `SOURce:RFGen:SELect "SETting1"`
-161	**Invalid block data** The command contains faulty block data. Example: An END message was received prior to reception of the expected number of data.
-168	**Block data not allowed** The command contains valid block data at an impermissible position. Example:
-171	**Invalid expression** The command contains an invalid mathematical expression. Example: the expression contains mismatching parentheses.
-178	**Expression data not allowed** The command contains a mathematical expression at an impermissible position. Example:
-180	**Macro error** A faulty macro has been defined, or an error has occurred during execution of a macro.

Execution Error - Error on execution of a command; sets bit 4 in the ESR register

Error code	Error text in the case of queue poll Error explanation
-200	**Execution error** Error on execution of the command.
-221	**Settings conflict** There is a conflict between setting of parameter value and instrument state. Example: External attenuation has been set in a state other than IDLE.
-222	**Data out of range** The parameter value lies out of the permissible range of the instrument. Eample: The command *RCL only permits entries in the range from 0 to 50.
-223	**Too much data** The command contains too many data. Example: The instrument does not have sufficient storage space.
-241	**Hardware missing** The command cannot be executed due to missing hardware. Example: An option is not fitted.

Device Specific Error; sets bit 3 in the ESR register

Error code	Error text in the case of queue poll Error explanation
-300	**Device-specific error** SM3-specific error not defined in greater detail.
-350	**Queue overflow** This error code is entered in the queue instead of the actual error code if the queue is full. It indicates that an error has occurred but not been accepted. The queue can accept 5 entries.

Query Error - Error in data request; sets bit 2 in the ESR register

Error code	Error text in the case of queue poll Error explanation
-400	**Query error** General error occurring when data are requested by a query.
-410	**Query INTERRUPTED** The query has been interrupted. Example: After a query, the instrument receives new data before the response has been sent completely.
-420	**Query UNTERMINATED** The query is incomplete. Example: The instrument is addressed as a talker and receives incomplete data.
-430	**Query DEADLOCKED** The query cannot be processed. Example: The input and output buffers are full, the instrument cannot continue operation.
-440	**Query UNTERMINATED after indefinite response** A query is in the same command line after a query which requests an indefinite response.

Page

Annex C3

Page

Annex C3

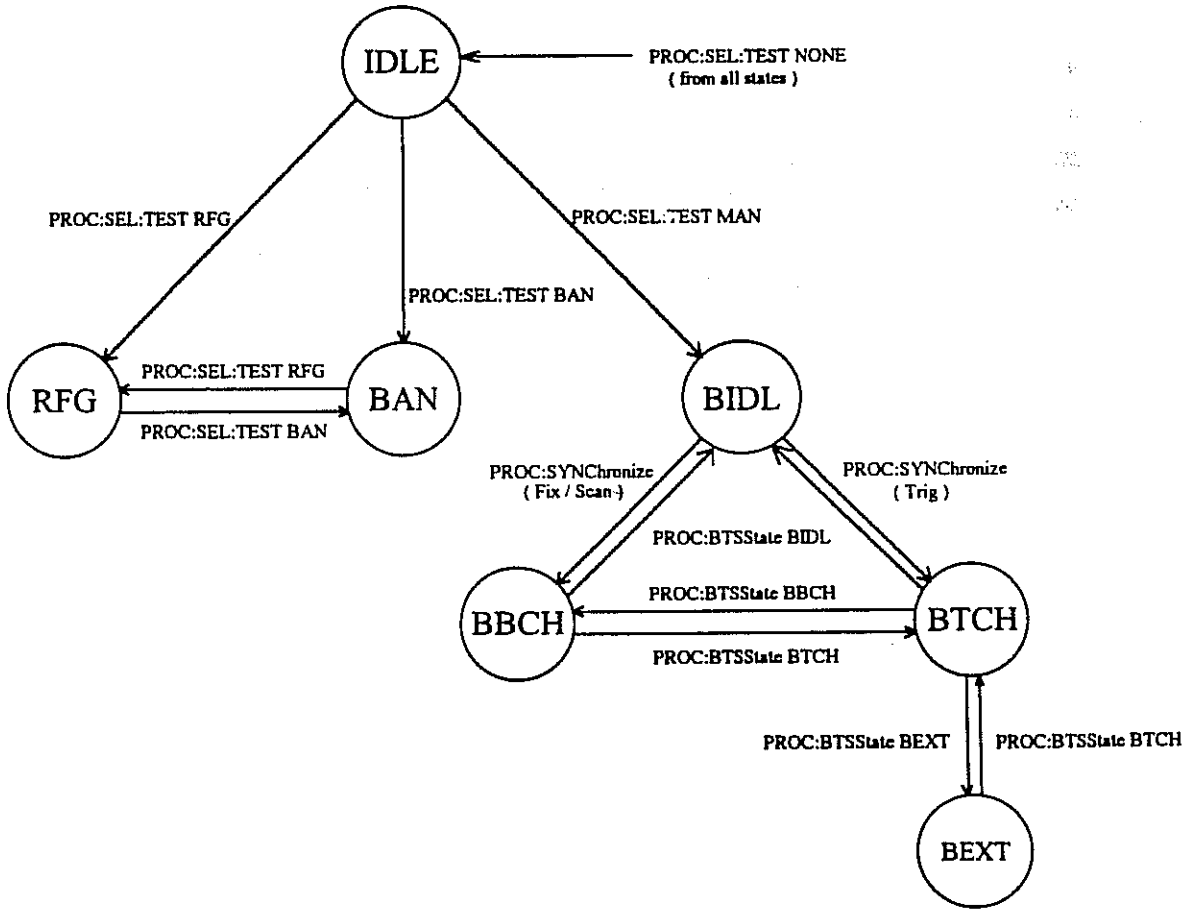
1. General Information

1.1. States

In the description of the commands, the following abbreviations are used for indication of the permissible states:

IDLE: Initial state of the CMD; is also achieved by means of PROCedure:SELect[:TEST] NONE.
BAN: Burst analysis active
BIDL: BTS test / Idle Mode
BBCH: BTS test / Measurement of the BCCH parameters
BTCH: BTS test / Measurement of the TCH parameters
BEXT: BTS test / BER measurement via RS 232 / IEEE 488
RFG: RF generator active
ALL: All states (IDLE, BAN, BIDL, BBCH, BTCH, BEXT or RFG)

The following diagram explains the individual transitions of states:



1.2. DCS1800

The settings for DCS1800 are only provided for the CMD57; the CMD54 outputs an error message when the attempt is made to set DCS1800 values.

If DCS1800 is desired as type of network, the switchover must be made by means of CONFigure:NETWork:TYPE DCS1800 before settings are changed. After the switchover, all commands act on the DCS1800 data set, without switchover the GSM data set is used.

1.3. Note

<numeric_value> denotes a numeric value; MAXimum or MINimum can be indicated as well unless stated otherwise.
If <numeric_value> may contain a unit, indicating the unit is optional. The value is always returned without a unit.

<value> denotes a character date from a list; only list entries are permissible.

All commands are structured analogously to the SCPI description, i.e. the upper-case letters indicate the short form of the command; the CMD only accepts this short form as an abbreviation (according to SCPI), otherwise the long form is to be used.

1.4. Error Recovery

If no value is existing with queries or the value is invalid, NAN is returned instead of the value. An overflow of the value is indicated by INF, a missing input signal by means of NINF.

If the CMD is not in the right state to be able to carry out the command, SCPI error -221, "Settings conflict" is generated. No value is returned in the case of queries.
The permissible state is indicated in the following table in the column "state".

If, however, an option to execute a command is missing, SCPI error -241, "Hardware missing" is displayed. No result is returned either in the case of a query.
The option necessary to execute the command is entered in the tables under "option".

2. Settings

2.1. Input and Output

External attenuation at RF In Out

Syntax:	SENSe1:CORRection:LOSS[:INPut][:MAGNitude] <numeric_value> or SOURce1:CORRection:LOSS[:OUTPut][:MAGNitude] <numeric_value>			
Value range:	-40.0 ... +50.0 dB			**Default:** 0.0 dB
State: IDLE	**Option:** none	with query	**Note:** Positive values refer to an attenuation; (N2a)	

External attenuation at RF In 2

Syntax:	SENSe2:CORRection:LOSS[:INPut][:MAGNitude] <numeric_value>			
Value range:	-40.0 ... +90.0 dB			**Default:** 0.0 dB
State: IDLE	**Option:** none	with query	**Note:** Positive values refer to an attenuation, (N2a)	

External attenuation at RF Out 2

Syntax:	SOURce2:CORRection:LOSS[:OUTPut][:MAGNitude] <numeric_value>			
Value range:	-40.0 ... +90.0 dB			**Default:** 0.0 dB
State: IDLE	**Option:** none	with query	**Note:** Positive values refer to an attenuation, (N2a)	

Inputs and outputs used

Syntax:	ROUTe:IOConnector <value>			
Value range	I1O1 | I1O2 | I2O1 | I2O2	Input: RF In Out; Input: RF In Out; Input: RF In 2; Input: RF In 2;	Output: RF In Out Output: RF In 2 Output: RF In Out Output: RF In 2	**Default:** I1O1
State: IDLE	**Option:** none	with query	**Note:** (N2b)	

Reference frequency (input)

Syntax:	CONFigure:FREQuency:REFerence <value>		
Value range:	BC | External, bit clock BC2 | External, 2 * bit clock BC4 | External, 4 * bit clock BC16 | External, 16 * bit clock E1M | External, 1 MHz E2M | External, 2 MHz E204 | External, 2.048 MHz E3M | External, 3 MHz E4M | External, 4 MHz E5M | External, 5 MHz E6M | External, 6 MHz E7M | External, 7 MHz E8M | Extern, 8 MHz E9M | External, 9 MHz E10M | External, 10 MHz E11M | External, 11 MHz E12M | External, 12 MHz E13M | External, 26 MHz E39M | External, 39 MHz E52M | External, 52 MHz I10M Internal, 10 MHz	**Default:** I10M
State: IDLE	**Option:** B3	With query	

Reference frequency (Output)

Syntax:	CONFigure:FREQuency:OUTPut:REFerence <value>		
Value range:	BC | Bit clock BC2 | 2 * Bit clock BC4 | 4 * Bit clock BC16 | 16 * Bit clock F1M | Clock signal with 1 MHz F2M | Clock signal with 2 MHz F4M | Clock signal with 4 MHz F13M Clock signal with 13 MHz	**Default:** F13M
State: IDLE	**Option:** B3	With query	

2.2. Signalling and RF Parameters

2.2.1. Signalling Parameters of the BTS

Reading MCC

Syntax:	SENSE:SIGNalling:IDENtity:MCC?			
Return:	0 ... 999	<Integer>		
State: BBCH		**Option:** none	only query	**Note:**

Reading MNC

Syntax:	SENSE:SIGNalling:IDENtity:MNC?			
Return:	0 ... 99	<Integer>		
State: BBCH		**Option:** none	only query	**Note:**

Reading Location Area

Syntax:	SENSE:SIGNalling:IDENtity:LAC?			
Return:	0 ... 65535	<Integer>		
State: BBCH		**Option:** none	only query	**Note:**

Reading Superframe

Syntax:	SENSE:SIGNalling:SUPerframe?			
Return:	0 ...1325	<Integer>		
State: BBCH		**Option:** none	only query	**Note:**

Reading multiframe

Syntax:	SENSE:SIGNalling:MULTiframe?			
Return:	0 ...50	<Integer>		
State: BBCH		**Option:** none	only query	**Note:**

2.2.2. Signalling Parameters for CMD

Channel number (ARFCN)

Syntax:	CCCH: CONFigure:CHANnel:BTS:CCCH:ARFCn <numeric_value> TCH: CONFigure:CHANnel:BTS[:TCH]:ARFCn <numeric_value>			
Value range:	GSM: 1 ... 124 / 0, 975 ... 1023 (E-GSM) DCS1800: 512 ... 885 PCS1900: 512 ... 810		**Default:** GSM: CCCH 20 TCH 105 DCS1800: CCCH 550 TCH 715 PCS1900: CCCH 550 TCH 610	
State: Set : IDLE, BIDL, TCH in addition: BBCH, BTCH Query : ALL	**Option:** none	With query		

Timeslot of the TCH

Syntax:	CONFigure:CHANnel:BTS[:TCH]:SLOT <numeric_value>		
Value range:	0 ... 7		**Default:** 0
State: IDLE, BIDL, BBCH, BTCH	**Option:** none	With query	

Setting the Training Sequence

Syntax:	CONFigure:CHANnel:BTS:TSC <numeric value>		
Value range:	0 ... 7		**Default:** 0
State: IDLE, BIDL	**Option:** none	with Query	

Setting the Expected Power

Syntax:	CONFigure:BTS:POWer:EXPected		
Value range:	RF In Out : 0 .. 47 dBm RF In 2 : -37 .. 0 dBm		**Default:** 43 dBm
State: IDLE, BIDL, BBCH,BTCH	**Option:** none	with query	

Transmitter power of the TCH in the used timeslot

Syntax:	CONFigure:CHANnel:BTS[:TCH][:POWer][:USED] <numeric_value>			
Value range	(N2d)			**Default:** -50.0 dBm
State: ALL	**Option:** none	with query		

Selection of modulation contents on the TCH

Syntax:	CONFigure:SPEech:MODE <value>			
Value range	ECHO | Loop back in the CMD with delay LOOP | Loop back in the CMD with minimum possible delay PR9 | 2E9 - 1 PSR bit pattern PR11 | 2E11 - 1 PSR bit pattern PR15 | 2E15 - 1 PSR bit pattern PR16 | 2E16 - 1 PSR bit pattern			**Default:** ECHO
State: All except BEXT	**Option:** none	with query		

Transmit Timing

Syntax:	CONFigure:BTS:TRANsmit:TIMing <numeric_value>			
Value range:	-64 ... +64			**Default:** 0
State: IDLE, BIDL, BBCH	**Option:** none	With query		

2.3. Burst Analysis

Channel number (ARFCN)

Syntax:	CONFigure:CHANnel:BANalysis:ARFCn <numeric_value>			
Value range:	GSM: 1 ... 124 0, 975 ... 1023 DCS1800: 512 ... 885 PCS1900: 512 ... 810		**Default:**	GSM: 65 DCS1800: 700 PCS1900: 600
State: ALL	**Option:** B4	With query		

Training Sequence Codes

Syntax:	CONFigure:CHANnel:BANalysis:TSC <numeric_value>		
Value range:	0 ... 7		**Default:** 0
State: ALL	**Option:** B4	With query	

Expected power (of BTS)

Syntax:	CONFigure:BANalysis:POWer:EXPected <numeric_value>			
Value range:	-60.0 ... +47.0 dBm			**Default:** +43.0 dBm
State: ALL	**Option:** B4	With Query	**Note:** (N2d)	

Input bandwidth for measurement of peak power

Syntax:	CONFigure:BANalysis:POWer:BANDwidth:INPut1 <value>			
Value range:	NARRow | Narrowband input WIDE Broadband input			**Default:** WIDE
State: BAN	**Option:** none	With query		

2.4. Network and Test Mode

Network

Syntax:	CONFigure:NETWork[:TYPE] <value>			
Value range:	GSM | Dcs1800			**Default:** GSM
State: IDLE	**Option:** none	with query		

Test mode

Syntax:	PROCedure:SELect[:TEST] <value>				
Value range:	NONE | No test mode (switch-on state) BANalysis | Burst analysis MANual | BTS test RFGenerator RF generator				**Default:** NONE
State:	(NONE): ALL (BANalysis): IDLE, RFG (MANual): IDLE (RFGenerator): IDLE, BAN	**Option:**	none B4 none none	with Query	

Notes:

(N2a)
-) The transmitter power is adapted, if necessary (see also (N2d)).

-) The input may be overloaded if an external amplifier is connected.

(N2b)
-) The level is automatically adapted (see N2d).

-) Only one input and output may be active at a time, i.e. the one not selected becomes inactive.

Example:
If I1O1 is selected, RF In Out is selected as input and output, RF In 2 and RF Out 2 are not available then.

(N2d)
-) The value applies irrespective of the output and is automatically adapted to the output on transition to the BIDL state, which may cause the value range to be shifted.

-) The value applies to the currently set timeslot of the TCH.

-) For the value range, compare Manual Operation, Section 2.

(N2e)
The level for the unused timeslots is to be indicated relative to the level in the used timeslot. However, it cannot exceed the absolute limit values (see (N2d).

3. Synchronization / Selection of Operating Mode

Selecting the measurement state

Syntax:	PROCedure:BTSState			
Value range:	BIDL BBCH BTCH BEXTernal	BS test: - Idle BS test: - BCCH measurements BS test: - TCH measurements BS test: - BER measurement via RS 232 / IEEE488		**Default:**
State: BBCH, BTCH, BEXT		**Option:** none	with query	

Perform synchronization with BCCH / or Wired Sync

Syntax:	PROCedure:SYNChronize		
State: BIDL	**Option:** none	no Query	**Note:** leads to the state BBCH or. BTCH depending on "Configure:Timing:Ref"

Setting Timing Ref Mode

Syntax:	CONFigure:TIMing:REFerence <value>			
Value range:	TRIGger Trigger an additional external line FIXed Synchronization with the BCCH on a fixed channel SCAN Synchronization with the BCCH searched before			**Default:** FIXed
State: IDLE,BIDL		**Option:** none	with query	

Selection of polarity at synchronization input (multifunction connector/pin27)

Syntax:	CONFigure:SYNChronize:POLarity <value>			
Value range:	FALLing | falling edge RISing | rising edge			**Default:** RISing
State: IDLE		**Option:** none	with Query	

Setting the slot offset at the synchronization input (multifunction connector/pin 27)

Syntax:	CONFigure:SYNChronize:SLOT:OFFSet <value>			
Value range:	0 ... 256			**Default:** 0
State: IDLE		**Option:** none	with query	

Setting the 1/4 bit delay at the synchronization input (multifunction connector/pin 27)

Syntax:	CONFigure:SYNChronize:QBIT:DELay <value>			
Value range:	0 ... 624			**Default:** 0
State: IDLE	**Option:** none	with query		

4. RF Generator

4.1. Configuration of a Generator Parameter Set

CONFigure:RFGen:SELect is used to select a parameter set on which the changes with CONFigure:RFGen:... are to act. These changes are maintained even if a diferent parameter set is selected.

Selection of the generator configuration

Syntax:	CONFigure:RFGen:SELect			
Value range:	SETting1 | SETting2 | SETting3 | SETting4 | SETting5 | SETting6 | SETting7			**Default:** SET1
State: ALL	**Option:** none	with query	**Note:** (N4)	

Frequency

Syntax:	CONFigure:RFGen:FREQuency[:CW|:FIXed]			
Value range:	GSM: 800.0 ... 1000.0 MHz (in steps of 0.2 MHz) DCS1800: 1697.6 ... 1897.6 MHz (in steps of 0.2 MHz) PCS1900: 1816 ..... 2016 MHz (in steps of 0.2 MHz)			**Default:** GSM: 900.0 MHz DCS1800: 1750.0 MHz PCS1900 1950.0 MHz
State: ALL	**Option:** none	with query	**Note:** The input value is adapted to the step size indicated when the parameter set is set, (N4)	

Frequency offset

Syntax:	CONFigure:RFGen:FREQuency:OFFSet			
Value range:	-100.009 ... 100.009 kHz (in steps of approx. 33.061 Hz)			**Default:** 0.0 Hz
State: ALL	**Option:** none	with query	**Note:** The input value is adapted to the step size indicated when setting the parameter set, (N4)	

Type of modulation

Syntax:	CONFigure:RFGen:DM:FORMat			
Value range:	DUMmy0 | Dummy burst with TSC 0 DUMmy1 | Dummy burst with TSC 1 DUMmy2 | Dummy burst with TSC 2 DUMmy3 | Dummy burst with TSC 3 DUMmy4 | Dummy burst with TSC 4 DUMmy5 | Dummy burst with TSC 5 DUMmy6 | Dummy burst with TSC 6 DUMmy7 | Dummyburst with TSC 7 PRS | Pseudo random sequence NONE No modulation			**Default:** NONE
State: ALL	**Option:** none	with query	**Note:** (N4)	

Ramping Mode

Syntax:	CONFigure:RFGen:RAMPing:STATe			
Value range:	ON | Signal with Power Ramping OFF Permanent signal			**Default:** OFF
State: ALL	**Option:** none	with Query	**Note:** (N4)	

Output level

Syntax:	CONFigure:RFGen:POWer			
Value range:	(-120.0 - ext. att.) ... (+13.0 - ext. att.) dBm			**Default:** -80.0 dBm
State: ALL	**Option:** none	with query	**Note:** The level is automatically adapted to the output and output connection when selecting the parameter set, (N4)	

4.2. Setting the Current Generator Parameter Set

Setting a generator configuration

Transfers the values of the selected configuration and correspondingly sets the RF generator. These values can be changed using the following commands. By calling SOURce:RFGen:SELect again, the modifications are lost.

Syntax:	SOURce:RFGen:SELect			
Value range:	SETting1 | SETting2 | SETting3 | SETting4 | SETting5 | SETting6 | SETting7 | NONE (only for query if selected configuration has been varied))			**Default:** SET1
State: RFG	**Option:** none	with query	**Note:** Power level is automatically adapted to the output and output connection, (N4)	

Frequency

Syntax:	SOURce:RFGen:FREQuency[:CW|:FIXed]			
Value range:	GSM: 800.0 ... 1000.0 MHz (in steps of 0.2 MHz) DCS1800: 1697.6 ... 1897.6 MHz (in steps of 0.2 MHz) PCS1900: 1816.0 ... 2016.0 MHz (in steps of 0.2 MHz)			**Default:** GSM: 900.0 MHz DCS1800: 1750.0 MHz PCS1900: 1950.0 MHz
State: RFG	**Option:** none	with query	**Note:** The input value is adapted to the step size indicated (N4)	

Frequency offset

Syntax:	SOURce:RFGen:FREQuency:OFFSet			
Value range:	-100.009 ... 100.009 kHz (in steps of approx: 33.061 Hz)			**Default:** 0.0 Hz
State: RFG	**Option:** none	with query	**Note:** The input value is adapted to the step size indicated, (N4)	

Type of modulation

Syntax:	SOURce:RFGen:DM:FORMat			
Value range:	DUMmy0 | Dummy burst with TSC 0 DUMmy1 | Dummy burst with TSC 1 DUMmy2 | Dummyburst with TSC 2 DUMmy3 | Dummy burst with TSC 3 DUMmy4 | Dummy burst with TSC 4 DUMmy5 | Dummy burst with TSC 5 DUMmy6 | Dummy burst with TSC 6 DUMmy7 | Dummy burst with TSC 7 PRS | Pseudo random sequence NONE No modulation			**Default:** NONE
State: RFG	**Option:** none	with query	**Note:** (N4)	

Ramping Mode

Syntax:	SOURce:RFGen:RAMPing:STATe			
Value range:	ON | Signal with power ramping OFF Permanent signal			**Default:** OFF
State: RFG	**Option:** none	with query	**Note:** (N4)	

Output level

Syntax:	SOURce:RFGen:POWer			
Value range:	(-120.0 - ext. att.) ... (+13.0 - ext. att.) dBm			**Default:** -80.0 dBm
State: RFG	**Option:** none	with query	**Note.:** Level is automatically adapted to the output and output connection when selecting the parameter set, (N4)	

Notes:

(N4)
CONFigure:RFGen:SELect is used to select a generator setting in which the values can be configured (with CONFigure:RFGen:...).
SOURce:RFGen:SELect permits to load the values of the selected setting (adapt them to the output or output connection, if necessary). Using SOURce:RFGen:... the values of the selected generator setting can be changed (they are lost when a different setting is selected).

5. AF Generator Setting

Frequency

Syntax:	CONFigure:AFGen:FREQuency[:CW|:FIXed]		
Value range:	20.0 ... 10000.0 Hz		**Default:** 1000.0 Hz
State: ALL	**Option:** B41	with query	

Level

Syntax:	CONFigure:AFGen:VOLTage		
Value range:	10.0 µV ... 5.0 V (in steps of 10 µV)		**Default:** 1.0 V
State: ALL	**Option:** B41	With query	

Switching generator on and off

Syntax:	SOURce:AFGen:STATe		
Value range:	ON | Switch generator on OFF Switch generator off		**Default:** OFF
State: ALL	**Option:** B41	with query	**Note:** The generator is automatically switched off with burst and BER measurements.

6. AF Setting

Distortion frequency

Syntax:	CONFigure:AFMeas:FREQuency:DISTortion		
Value range:	50.0 ... 5000.0 Hz		**Default:** 1000.0 Hz
State: IDLE	**Option:** B41	with query	

Lower limit frequency (for distortion meter and voltmeter)

Syntax:	CONFigure:AFMeas:FREQuency:MINimum		
Value range:	10 ... 1000 Hz		**Default:** 100 Hz
State: ALL	**Option:** B41	With Query	**Note:** This setting also affects the duration of measurement

7. Measurement, Analysis and Result Query

7.1. AF Measurement

Display format of AF counter

Syntax:	CONFigure:AFMeas:COUNter:FORMat		
Value range:	LT10kHz | GT10kHz		**Default:** LT10
State: ALL	**Option:** B41	With query	

Display format of voltmeter

Syntax:	CONFigure:AFMeas:VOLTage:FORMat		
Value range:	RMS | SQRTrms		**Default:** RMS
State: ALL	**Option:** B41	With query	

AF counter

Syntax: Execute new measurement and signal result Only read result	READ[:SCALar]:AFMeas:COUNter? FETCh[:SCALar]:AFMeas:COUNter?			
Return:	<Value> (Unit: Hz)			
State: ALL	**Option:** B41	only Query	**Note:** No default value	

AF voltage

Syntax: Perform new measurement and signal result Only read result	READ[:SCALar]:AFMeas:VOLTage? FETCh[:SCALar]:AFMeas:VOLTage?			
Return:	<Value> (Unit: V)			
State: ALL	**Option:** B41	only query	**Note:** No default value	

Distortion

Syntax: Execute new measurement and signal result	READ[:SCALar]:AFMeas:DISTortion?			
Only read result	FETCh[:SCALar]:AFMeas:DISTortion?			
Return:	<Value> (Unit: %)			
State: ALL	**Option:** B41	only query	**Note:** No default value	

7.2. BER

7.2.1. Selection of the BER Measurement Configuration (Parameter Set)

Syntax:	CONFigure:BER:SELect <value>			
Value range:	BER1 | BER2 | BER3 | BER4 | BER5 | BER6 | BER7			**Default:** BER1
State: ALL	**Option:** B4	with query	**Note:** (N6a)	

7.2.2. Measurement Tolerances for the BER Configuration Selected

Maximal values for class-Ib events

Syntax:	CALCulate:LIMit:BER:CLIB:MEVents <numeric_value>		
Value range:	0 ... 100000		
State: ALL	**Option:** B4	With Query	**Note:** No default value, (N6c)

Maximal values for class-II events

Syntax:	CALCulate:LIMit:BER:CLII:MEVents <numeric_value>		
Value range:	0 ... 100000		
State: ALL	**Option:** B4	with Query	**Note:** No default value, (N6c)

Maximal values for erased frames

Syntax:	CALCulate:LIMit:BER:EFRames:MEVents <numeric_value>		
Value range:	0 ... 50000		
State: ALL	**Option:** B4	With Query	**Note:** No default value, (N6c)

7.2.3. Measurement Parameters for the BER Configuration Selected

Level for TCH in the used timeslot

Syntax:	CONFigure:BER:POWer[:USED] <numeric_value>		
Value range:	(N2d)		
State: ALLexcept BEXT	**Option:** B4	With Query	**Note:** No default value, (N6a)

Level for TCH in the unused timeslots

Syntax:	CONFigure:BER:POWer:UNUSed <numeric_value>		
Value range:	-20 ... +30 dB		
State: ALL except BEXT	**Option:** B4	With Query	**Note:** No default value, (N2e), (N6a)

Number of frames to be sent

Syntax:	CONFigure:BER:FRAMestosend <numeric_value>		
Value range:	1 ... 50000		
State: ALL	**Option:** B4	with query	**Note:** No default value

Maximal number of the samples to be sent and test time

The maximaum number of samples sent in the test is derived from the value for "Frames to send" ab. These values are only reached in the test if the errors occurring do not exceed the tolerances or ASAMples is selected as an abort condition (CONFigure:BER:SCONdition).

Syntax:	CONFigure:BER:CLIB:MSAMples? CONFigure:BER:CLII:MSAMples? CONFigure:BER:EFRames:MSAMples? CONFigure:BER:TEST:TIME?		
Return	78 ... 780000 (Class IB) 132 ... 6600000 (Class II) 1 ... 50000 (Erased Frames) 0.02 ... 1000 (Test time, unit: s)		
State: ALL	**Option:** B4	with Query	**Note:** The values have been derived from "Frames to send" and thus cannot be set.

Abort condition for BER measurement

Syntax:	CONFigure:BER:SCONdition <value>		
Value range:	ALIMits | Abort when all limits have been reached ASAMples | Abort when all samples have been transmitted FLIMit Abort on first exceeding of a limit		
State: ALL	**Option:** B4	with Query	**Note:** No default value

7.2.4. Measurement

Measured values of class Ib

Syntax: Execute new measurement and signal result Only read result	READ[:SCALar]:BER:CLIB[:BER]? READ[:SCALar]:BER:CLIB:EVENts? READ[:SCALar]:BER:CLIB:RBER? FETCh[:SCALar]:BER:CLIB[:BER]? FETCh[:SCALar]:BER:CLIB:EVENts? FETCh[:SCALar]:BER:CLIB:RBER?		
Return:	BER and RBER: 0 ... 100 (Unit: %) Events: 0 ... 100000		
State: BTCH	**Option:** B4	Only query	**Note:** No default values, (N6b)

Measured values of class II

Syntax: Execute new measurement and signal result Only read result	READ[:SCALar]:BER:CLII[:BER]? READ[:SCALar]:BER:CLII:EVENts? READ[:SCALar]:BER:CLII:RBER? FETCh[:SCALar]:BER:CLII[:BER]? FETCh[:SCALar]:BER:CLII:EVENts? FETCh[:SCALar]:BER:CLII:RBER?		
Return:	BER and RBER: 0 ... 100 (Unit: %) Events: 0 ... 100000		
State: BTCH	**Option:** B4	Only query	**Note:** No default values, (N6b)

Measured values of erased frames

Syntax: Execute new measurement and signal result Only read result	READ[:SCALar]:BER:EFRames[:FER]? READ[:SCALar]:BER:EFRames:EVENts? FETCh[:SCALar]:BER:EFRames[:FER]? FETCh[:SCALar]:BER:EFRames:EVENts?		
Return:	FER: 0 ... 100 (Unit: %) Events: 0 ... 50000		
State: BTCH	**Option:** B4	Only query	**Note:** No default values, (N6b)

Total result of a BER measurement

Syntax: Execute new measurement and signal result	READ[:SCALar]:BER:TRESult?		
Only read result	FETCh[:SCALar]:BER:TRESult?		
Return:	PASS | Results valid, all configured frames sent; all tolerances observed FAIL | Results valid, but not all frames sent and/or tolerances observed INV | Measurement results are invalid TLOW | BS signal level too low, results are not valid IMP No measurement possible, results are not valid		
State: BTCH	**Option:** B4	only query	**Note:** No default values, (N6b)

7.2.5 Measurement of BER with External Abis Monitor

This measurement can only be performed in the remote mode.

Procedure:

Starting the measurement by "PROCedure:BTSState BEXTernal" after synchronization and setting the RF level in the state BTCH. This command leads to the state BEXT.

With "CALCulate:BER:EXTernal:BITSequence ....", the CMD receives the reference data which are immediately evaluated. The remote control is only enabled again after completion of the evaluation.

As long as the CMD is not requested to reset the results (via "CALCulate:BER:EXTernal:CLEar"), the speech frames received are appended to those received so far and the evaluation is updated for all blocks.

The group of commands "CALCulate:BER:EXTernal:CLIB:...?"
and
"CALCulate:BER:EXTernal:CLI:...?" provides the current results.

Note that the evaluation is made with the pseudo random bit pattern set via "CONFigure:SPEech:MODE.." and that an evaluation is only possible with the pseudo random sequences. The bit pattern cannot be changed in the state BEXTernal.

By abandoning the state BEXTernal the measurement is completed.
("PROCedure:BTSState BTCH " in the state BEXT)

Reinitialization of the bit sequence for BER calculation

Syntax:	CALCulate:BER:EXTernal:CLEar			
State: BEXT		**Option:** B4	no query	

Level for TCH in the used timeslot

Syntax:	CONFigure:BER:EXTernal:POWer[:USED] <numeric_value>			
Value range:	(N2d)			
State: ALL	**Option:** B4	with query	**Note:** no default value, (N6a)	

Level for TCH in the unused timslots

Syntax:	CONFigure:BER:EXTernal:POWer:UNUSed <numeric_value>			
Value range:	-20 ... +30 dB			
State: ALL	**Option:** B4	with query	**Note:** No default value, (N2e), (N6a)	

Transfer of the bit sequence to the CMD (for BER calculation)

Syntax:	CALCulate:BER:EXTernal:BITSequence <string>			
Value range:	<string>: Bits of a speech frame in the form of an ASCII string (260 bits = 65 bytes ASCII), e.g. bit pattern "10001011" is transferred as "8B"			
State: BEXT	**Option:** B4	no query	**Note:** no default values	

Fetching the results of class Ib

Syntax:	CALCulate:BER:EXTernal:CLIB[:BER]? CALCulate:BER:EXTernal:CLIB:EVENts?			
Return:	BER: 0 ... 100 (unit: percent) Events: 0 ... 100000			
State: BEXT		**Option:** B4	only query	**Note:** no default values

Picking up the results of class II

Syntax:	CALCulate:BER:EXTernal:CLII[:BER]? CALCulate:BER:EXTernal:CLII:EVENts?			
Return:	BER: 0 ... 100 (Unit: percent) Events: 0 ... 100000			
State: BEXT		**Option:** B4	only query	**Note:** no default values

Total result of a BER measurement

Syntax:	CALCulate:BER:EXTernal:TRESult?			
Return:	OK INV INVS	| | |	Valid measurement results Invalid measurement results (no result available yet) Invalid measurement results (Invalid String)	
State: BEXT		**Option:** B4	Only query	**Note:** no default value

Notes

- The limits set (CALCulate:LIMit:BER:...:MEVents) are not observed
- CONFigure:SPEech:MODE (for switching over the pseudo random bit pattern) is not possible in the BEXTernal mode; the BEXTernal state must therefore be abandoned before, the switchover made and BEXTernal selectd again.

7.3. Power

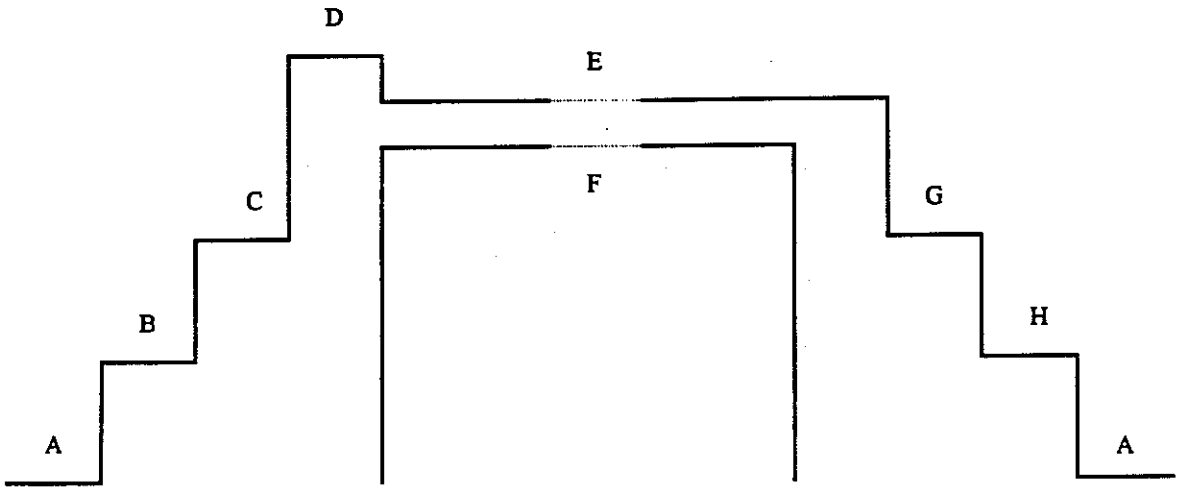
7.3.1. Tolerance Values

Resetting to default values

Syntax:	CALCulate:LIMit:POWer[:TEMPlate]:CLEar		
State: ALL	**Option:** B4	No query	**Note:** Sets the GSM or DCS1800 tolerances

Tolerances for power time template

The level designation in the power time template for the command CALCulate:LIMit:POWer[:TEMPlate][:DATA] can be obtained from the following illustration:



Syntax:	CALCulate:LIMit:POWer[:TEMPlate][:DATA] <numeric_value>, <numeric_value>, <numeric_value>, <numeric_value>, <numeric_value>, <numeric_value>, <numeric_value>, <numeric_value>, <numeric_value>		
Value range:	-100.0 ... 0.0 dBm	Absolute level at A	**Default:** GSM: -36.0 dBm DCS1800: -47.0 dBm
	-100.0 ... 0.0 dB	Relative level at A	-70.0 dB
	-100.0 ... 0.0 dB	Relative level at B	-30.0 dB
	-100.0 ... 0.0 dB	Relative level at C	-6.0 dB
	0.0 ... +20.0 dB	Relative level at D	+4.0 dB
	0.0 ... +5.0 dB	Relative level at E	+1.0 dB
	-5.0 ... 0.0 dB	Relative level at F	-1.0 dB
	-100.0 ... 0.0 dB	Relative level at G	-6.0 dB
	-100.0 ... 0.0 dB	Relative level at H	-30.0 dB
State: ALL	**Option:** B4	With query	

Query for observance of the tolerances of the power/time template

Syntax:	CALCulate:LIMit:POWer[:TEMPlate]:MATChing?		
Return:	MATC | Limit values observed NMAT | Limit values not observed INV | No measurement result provided NRAM | No ramp provided NTSC | No valid TSC contained OUT | Out of dynamic range TEAR | Falling edge of burst too early THIG | Phase or frequency error of burst too great TLAT | Rising edge of burst too late TLON | Burst too long TSH | Burst too short		
State: BTCH, BAN	**Option:** B4	only query	**Note:** Supplies the result for the last measurement, (N6d), (N6f)

7.3.2. Power Measurement

Average power of the burst

Syntax: Execute new measurement and signal result	READ[:SCALar]:BURSt:POWer:AVERage?		
Only read result	FETCh[:SCALar]:BURSt:POWer:AVERage?		
Return:	<value> (unit: dBm)		
State: BTCH, BAN	**Option:** B4	only query	**Note:** no default values, (N6d)

Power values of the entire burst

Syntax: Execute new measurement and signal result	READ:ARRay:BURSt:POWer?		
Only read result	FETCh:ARRay:BURSt:POWer?		
Return:	<value> {, <value>} (unit: dB)		
State: BTCH, BAN	**Option:** B4	only query	**Note:** no default values, (N6d), (N6e)

7.4. Phase and Frequency Errors

7.4.1. Tolerance Values

Resetting to default values

Syntax:	CALCulate:LIMit:PHFR:CLEar		
State: ALL	**Option:** B4	no query	**Note:** Sets the GSM or DCS1800 tolerances

Tolerances for phase and frequency error (single and maximum value measurement)

Syntax:	CALCulate:LIMit:PHFR:TOLerance[:DATA] <numeric_value>, <numeric_value>, <numeric_value>			
Value range:	0.0 ... 100.0 deg 0.0 ... 25.0 deg GSM: 0... 200 Hz DCS1800: 0... 400 Hz PCS1900: 0... 400 Hz	(Peak phase error) (RMS phase error) (Frequency error)		**Default:** 20.0 deg 5.0 deg GSM: 45 Hz DCS1800: 90 Hz PCS1900: 45 Hz
State: ALL	**Option:** B4	with query		

Tolerances for phase and frequency error (average value measurement)

Syntax:	CALCulate:LIMit:PHFR:TOLerance:AVERage[:DATA] <numeric_value>, <numeric_value>, <numeric_value>			
Value range	0.0 ... 100.0 deg 0.0 ... 25.0 deg GSM: 0 ... 200 Hz DCS1800: 0 ... 400 Hz PCS1900: 0 ... 400 Hz	(Peak phase error) (RMS phase error) (Frequency error)		**Default:** 20.0 deg 5.0 deg GSM: 45 Hz DCS1900: 90 Hz PCS1900: 90 Hz
State: ALL	**Option:** B4	with query		

Query for observance of tolerances (single-value measurement)

Syntax:	CALCulate:LIMit:PHFR:TOLerance:MATChing?			
Return:	(MATC | NMAT | INV), (MATC | NMAT | INV), (MATC | NMAT | INV)	(Peak phase error) (RMS phase error) (Frequency error)		
State: BTCH, BAN	**Option:** B4	Only query	**Note:** Supplies the result for the last measurement, (N6d), (N6f)	

Query for observance of the tolerances (average and maximum value measurement)

Syntax:	CALCulate:LIMit:PHFR:TOLerance:MATChing:AVERage? CALCulate:LIMit:PHFR:TOLerance:MATChing:MAXimum?			
Return:	(MATC | NMAT | INV), (MATC | NMAT | INV), (MATC | NMAT | INV)	(Peak phase error) (RMS phase error) (Frequency error)		
State: BTCH, BAN	**Option:** B4	only query	**Note:** Supplies the result for the last measurement (N6d), (N6f)	

7.4.2. Test Parameters for Phase and Frequency Error Measurement

Number of bursts for average and maximum value measurement

Syntax:	CALCulate:LIMit:PHFR:AVERage[:COUNt] <numeric_value>		
Value range:	1 ... 1000		**Default:** 10
State: ALL	**Option:** B4	with query	

Decoding

Syntax:	CONFigure:DECoding:MODE <value>		
Value range:	STANdard | Standard mode GATBits Considering guard and tail bits		**Default:** STANdard
State: BAN	**Option:** B4	With query	Note : Setting applies to all phase measurements, also in the menu BURST ANALYSIS !

7.4.3. Phase Error Measurement

Total phase error of a burst (single-value measurement)

Syntax: Execute new measurement and signal result Only read result	RMS: READ[:SCALar]:BURSt:PHASe:ERRor:RMS? Peak: READ[:SCALar]:BURSt:PHASe:ERRor:PEAK? RMS: FETCh[:SCALar]:BURSt:PHASe:ERRor:RMS? Peak: FETCh[:SCALar]:BURSt:PHASe:ERRor:PEAK?		
Return:	<value> (unit: °)		
State: BTCH, BAN	**Option:** B4	only query	**Note:** no default values, (N6d)

Total phase error of a burst (average and maximum value measurement)

Syntax: Execute new measurement and signal result Only read result	RMS: READ[:SCALar]:BURSt:PHASe:ERRor:RMS:AVERage? READ[:SCALar]:BURSt:PHASe:ERRor:RMS:MAXimum? Peak: READ[:SCALar]:BURSt:PHASe:ERRor:PEAK:AVERage? READ[:SCALar]:BURSt:PHASe:ERRor:PEAK:MAXimum? RMS: FETCh[:SCALar]:BURSt:PHASe:ERRor:RMS:AVERage? FETCh[:SCALar]:BURSt:PHASe:ERRor:RMS:MAXimum? Peak: FETCh[:SCALar]:BURSt:PHASe:ERRor:PEAK:AVERage? FETCh[:SCALar]:BURSt:PHASe:ERRor:PEAK:MAXimum?		
Return:	<value> (unit: °)		
State: BTCH, BAN	**Option:** B4	only Query	**Note:** No default values, (N6d)

Phase error values of the total burst (single-value measurement)

Syntax: Execute new measurement and signal result	READ:ARRay:BURSt:PHASe:ERRor?		
Only read result	FETCh:ARRay:BURSt:PHASe:ERRor?		
Return:	<value> {, <value>} (unit: °)		
State: BTCH, BAN	**Option:** B4	only Query	**Note:** no default values, (N6d), (N6e)

7.4.4. Frequency Error Measurement

Total frequency error of a burst (single-value measurement)

Syntax: Execute new measurement and signal result Only read result	READ[:SCALar]:BURSt:FREQuency:ERRor? FETCh[:SCALar]:BURSt:FREQuency:ERRor?		
Return:	<value> (unit: Hz)		
State: BTCH, BAN	**Option:** B4	only query	**Note:** No default values, (N6d)

Total frequency error of a burst (average and maximum value measurement)

Syntax: Execute new measurement and signal result Only read result	READ[:SCALar]:BURSt:FREQuency:ERRor:AVERage? READ[:SCALar]:BURSt:FREQuency:ERRor:MAXimum? FETCh[:SCALar]:BURSt:FREQuency:ERRor:AVERage? FETCh[:SCALar]:BURSt:FREQuency:ERRor:MAXimum?		
Return:	<value> (unit: Hz)		
State: BTCH, BAN	**Option:** B4	only query	**Note:** no default values, (N6d)

7.5. Spectrum Measurements

7.5.1. Tolerance Values

Resetting to default values

Syntax:	CALCulate:LIMit:SPECtrum:MODulation:CLEar CALCulate:LIMit:SPECtrum:SWITching:CLEar		
State: ALL	**Option:** B43	no query	**Note:** Sets the GSM or DCS1800 tolerances

Absolute tolerances for spectrum (modulation)

Syntax:	CALCulate:LIMit:SPECtrum:MODulation:ABSolute[:DATA] <numeric_value>		
Value range:	-100.0 ... 5.0 dBm		**Default:** -57.0 dBm
State: ALL	**Option:** B43	with Query	

Relative tolerances for spectrum (modulation)

Syntax:	CALCulate:LIMit:SPECtrum:MODulation:RELative[:DATA] <numeric_value>, <numeric_value>, <numeric_value>, <numeric_value>, <numeric_value>, <numeric_value>, <numeric_value>, <numeric_value>, <numeric_value>, <numeric_value>, <numeric_value>		
Value range:	-100.0 ... 5.0 dB -100.0 ... 5.0 dB -100.0 ... 5.0 dB -100.0 ... 5.0 dB -100.0 ... 5.0 dB -100.0 ... 5.0 dB -100.0 ... 5.0 dB -100.0 ... 5.0 dB -100.0 ... 5.0 dB -100.0 ... 5.0 dB	Relative level at 100 kHz Relative level at 200 kHz Relative level at 250 kHz Relative level at 400 kHz Relative level at 600 kHz Relative level at 800 kHz Relative level at 1000 kHz Relative level at 1200 kHz Relative level at 1400 kHz Relative level at 1600 kHz	**Default:** +0.5 dB -30.0 dB -33.0 dB -60.0 dB -60.0 dB -60.0 dB -60.0 dB -60.0 dB -60.0 dB -60.0 dB
State: ALL	**Option:** B43	with query	

Absolute tolerances for spectrum (switching)

Syntax:	CALCulate:LIMit:SPECtrum:SWITching:ABSolute[:DATA] <numeric_value>, <numeric_value>, <numeric_value>, <numeric_value>		
Value range	-100.0 ... 5.0 dBm -100.0 ... 5.0 dBm -100.0 ... 5.0 dBm -100.0 ... 5.0 dBm	Absolute level at 400 kHz Absolute level at 600 kHz Absolute level at 1200 kHz Absolute level at 1800 kHz	**Default:** -23.0 dBm -26.0 dBm -32.0 dBm -36.0 dBm
State: ALL	**Option:** B43	with query	

Relative tolerances for spectrum (switching)

Syntax:	CALCulate:LIMit:SPECtrum:SWITching:RELative[:DATA] <numeric_value>, <numeric_value>, <numeric_value>, <numeric_value>			
Value range:	-100.0 ... 5.0 dB -100.0 ... 5.0 dB -100.0 ... 5.0 dB -100.0 ... 5.0 dB	Relative leel ati 400 kHz Relative level at 600 kHz Relative level at 1200 kHz Relative level at 1800 kHz		**Default:** -60.0 dB -69.0 dB -75.0 dB -79.0 dB
State: ALL	**Option:** B43	with query	**Note:** For the MS test, only the 1st tolerance is checked (with offset 400 kHz); the other tolerances are only evaluated in the BTS test. The query always provides all four values.	

Query for observance of the tolerances of the spectrum (modulation)

Syntax:	CALCulate:LIMit:SPECtrum:MODulation:MATChing?		
Return:	(MATC | NMAT | INV)		
State: BTCH, BAN	**Option:** B43	only query	**Note:** Supplies the result for the last measurement

Query for observance of the tolerances of the spectrum (switching)

Syntax:	CALCulate:LIMit:SPECtrum:BTS:SWITching:MATChing?		
Return:	(MATC | NMAT | INV)		
State: BTCH, BAN	**Option:** B43	only query	**Note:** Supplies the result for the last measurement

7.5.2. Test Parameters for Spectrum Measurement

Number of bursts to be measured

Syntax:	CONFigure:SPECtrum:MODulation:AVERage[:COUNt] <numeric_value> CONFigure:SPECtrum:SWITching:AVERage[:COUNt] <numeric_value>			
Value range:	1 ... 2000			**Default:** Modulation: 500 Switching: 10
State: IDLE	**Option:** B43	with query		

7.5.3. Measurements

Measuring the absolute power of the spectrum (modulation und switching)

Syntax: Execute new measurement and signal result Only read result	READ[:SCALar]:SPECtrum:MODulation:POWer? READ[:SCALar]:SPECtrum:SWITching:POWer? FETCh[:SCALar]:SPECtrum:MODulation:POWer? FETCh[:SCALar]:SPECtrum:SWITching:POWer?		
Return:	<value> (unit: dBm)		
State: BTCH, BAN	**Option:** B43	only query	**Note:** no default value

Executing spectrum measurement (modulation)

Syntax: Execute new measurement and signal result Only read result	READ:ARRay:SPECtrum:MODulation? FETCh:ARRay:SPECtrum:MODulation?		
Return:	<value> {, <value>} (unit: dBc)		
State: BTCH, BAN	**Option:** B43	only Query	**Note:** no default values; the values returned are the spectral lines in the following order: -11 ... 0 ... +11 (23 values)

Executing spectrum measurement (switching)

Syntax: Execute new measurement and signal result	READ:ARRay:SPECtrum:BTS:SWITching?		
Only read result	FETCh:ARRay:SPECtrum:BTS:SWITching?		
Return:	<value> {, <value>} (unit: dBc)		
State: BTCH, BAN	**Option:** B43	only query	**Note:** no default values; the values returned are the spectral lines in the following order: -4 ... 0 ... (9 values)

7.6. Other Measurements

Current measurement

Syntax: Execute new measurement and signal result	READ[:SCALar]:CURRent[:DC]? (Average) READ[:SCALar]:CURRent[:DC]:MAXimum? (Maximum) READ[:SCALar]:CURRent[:DC]:MINimum? (Minimum)		
Only read result	FETCh[:SCALar]:CURRent[:DC]? (Average) FETCh[:SCALar]:CURRent[:DC]:MAXimum? (Maximum) FETCh[:SCALar]:CURRent[:DC]:MINimum? (Minimum)		
Return:	<value> (unit: A)		
State: ALL	**Option:** none	only query	**Note:** no default values

Voltage measurement

Syntax: Execute new measurement and signal result	READ[:SCALar]:VOLTage[:DC]?		
Only read result	FETCh[:SCALar]:VOLTage[:DC]?		
Return:	<Value> (unit: V)		
State: ALL	**Option:** none	only query	**Note:** no default value

Frequency for measurement of peak power

Syntax:	CONFigure:POWer:PEAK:FREQuency <numeric_value>				
Value range:	GSM: DCS1800: PCS1900:	800.0 ... 1000.0 MHz 1697.6 ... 1897.6 MHz 1816.0 ... 2016.0 MHz	(in steps of 0.2 MHz) (in steps of 0.2 MHz) (in steps of 0.2 MHz)	**Default:** GSM: DCS1800: PCS1900:	890.2 MHz 1710.2 MHz 1930.2 MHz
State: BIDL, IDLE	**Option:** none	With query			

Peak power measurement

Syntax: Execute new measurement and report result	READ[:SCALar]:POWer?			
Only read result	FETCh[:SCALar]:POWer?			
Return:	<Value> (Unit: dBm)			
State: ALL	**Option:** none	Only query	**Note:** No default value	

Notes:

(N6a)
CONFigure:BER:SELect permits to select a BER measurement; the settings can be changed and a measurement executed for the selected measurement.
If a new BER measurement is selected, the measured values of the previous measurement are maintained (and can still be fetched using FETCh). However, the total result (FETCh:BER:TRESult) is set to INValid.
When the new measurement is started, the measured values are updated (which means that the results of the previous measurement are lost)

(N6b)
A new measurement is started and the desired value returned by means of any READ command. Then all results of this measurement can be read one after the other by means of FETCh queries without a new measurement being performed (FETCh[:SCALar]:BER:TRESult? provides a statement on the validity of the measured values).

(N6c)
The tolerances are only taken into account if the abort condition for the BER measurement is set to FLIMit or ALIMits (CONFigure:BER:SCONdition).

(N6d)
When a READ command is selected, all scalar measurement results (average power, RMS and peak phase error and frequency error) are calculated and the desired value is returned; the remaining measurement results can be fetched using FETCh or CALCulate. The field values cannot be obtained. However, if the measurement is made via READ:ARRay, all scalar values are provided in addition to the selected field values. The measurement of the field values of the power (READ:ARRay:BURSt:POWer?) and of the phase error (READ:ARRay:BURSt:PHASe:ERRor?) exclude one another, i.e. it is **not** possible to fetch the phase error using FETCh:ARRay:BURSt:PHASe:ERRor? after READ:ARRay:BURSt:POWer?.

(N6e)
The values are calculated in ¼-bit steps and are supplied in the range from bit index -10.0 to bit index +157.0 (power) or +0.5 to +147.5 (phase error) (referred to the useful part of the burst); this results in 669 power values and 588 phase error values.

(N6f)
The results in the tolerance query have the following meaning:

MATC:	The measurement results observes the limits configured
NMAT:	The measurement result does not observe the limits configured
INV:	There is no measurement result

8. Miscellaneous

8.1. Internal Instrument State

Current instrument state

Syntax:	STATus:DEVice?		
Return:	IDLE | Idle (initial state) BAN | Burst analysis BIDL | BTS test: Idle BBCH | BTS test: measurements of the BCCH channel BTCH | BTS test: measurements of the TCH channel BEXT | BTS test: BER measurements via RS 232 / IEEE 488 RFG RF generator		**Default:** IDLE
State: ALL	**Option:** none	only query	

8.2. Signalling Asynchronous Events

The CMD event register is used to signal events the CMD executes without having explicitly received a request via remote control. The controller can query the events via the remote control.

The CMD enters the following events by setting the respective bit in the CMD event register:

Event	CMD event register
Synchronisation Lost	bit 2

Setting a bit in the CMD event register leads to setting of a bit in the operation status register and then in the status byte and thus - with the IEC bus - to a service request (provided that the respective enable registers permit the events).

A more detailed explanation of the connections in the hierarchy of the SCPI registers can be found in the SCPI manual 1993.0, volume 1 on page 9-4.

CMD Event Register

Syntax:	STATus:OPERation:CMD[:EVENt]?		
Return:	0 ... 15		**Default:** 0
State: ALL	**Option:** none	only query	

CMD Operation Condition Register

Syntax:	STATus:OPERation:CMD:CONDition?		
Return:	0 ... 15		**Default:** 0
State: ALL	**Option:** none	only query	

CMD Event Register Enable

Syntax:	STATus:OPERation:CMD:ENABle <numeric_value>			
Value range:	0 ... 32767			**Default:** 32767
State: ALL	**Option:** none	with query	**Note:** MAXimum and MINimum impermissible	

8.3. Operating Mode

Autorange

Syntax:	CONFigure:AUTorange:STATe <value>			
Value range:	ON | OFF	Autoranging active Autoranging not active		**Default:** ON
Zustand: IDLE	**Option:** none	With query		

8.4. Query of Options

Syntax:	SYSTem:OPTions?		
Return:	List of all existing options (as Bx, with x as number of the option), separated by means of commas; not existing options are not indicated. Example:Options B1, B4, B41, B6, B61 and B9 exist, then the output is: B1,,B4,B41,,,,B6,B61,,,,,,,B9		
State: ALL	**Option:** none	only query	**Note:** No default value

8.5. Remote Control

Screen display of the remote-control commands and responses

Syntax:	DISPlay:ENABle			
Value range:	ON | OFF	Remote-control commands and responses appear on the screen No screen outputs		**Default:** ON
State: ALL	**Option:** none	with query	**Note:**	

IEC-bus address

Syntax:	SYSTem:COMMunicate:GPIB[:SELF]:ADDRess <numeric_value>			
Value range:	0 ... 30			**Default:** 1
State: ALL	**Option:** none	with query		

9. Specified Commands

9.1. Mandatory Commands

Clear Status

Syntax:	*CLS		
State: ALL	**Option:** none	no query	

Standard Event Status Enable

Syntax:	*ESE <numeric_value>			
Value range:	0 ... 255			**Default:** 0
State: ALL	**Option:** none	with query	**Note:** MAXimum and MINimum impermissible	

Standard Event Status Register

Syntax:	*ESR?		
Return:	0 ... 255		
State: ALL	**Option:** none	only query	

Identification Query

Syntax:	*IDN?		
Return:	Rohde&Schwarz,CMD,0,x.xx yy.yy.yy		(x.xx is SW version, e.g. V 1.00 yy.yy.yy is the date, e.g. 18.10.93)
State: ALL	**Option:** none	only query	

Individual Status Query

Syntax:	*IST?		
Return	0 | 1		
State	**Option:** none	Only query	

Operation Complete

Syntax:	*OPC		
Return:	1 (return only in the case of query)		
State: ALL	**Option:** none	with query	**Note:** Also influences the OPC bit in the event status register.

Parallel Poll Enable Register Enable

Syntax:	*PRE <numeric_value>			
Value range:	0 ... 255			**Default:** 0
State: ALL	**Option:** none	with query	**Note:** MAXimum and MINimum impermissible	

Power-on Status Clear

Syntax:	*PSC <numeric_value>			
Value range:	-32767 ... 32767			**Default:** 1
State: ALL	**Option:** none	with query	**Note:** MAXimum and MINimum impermissible	

Reset

Syntax:	*RST		
State: ALL	**Option:** none	no query	**Note:** Sets the instrument to the default state(without taking into account a connection set up)

Service Request Enable

Syntax:	*SRE <numeric_value>			
Value range	0 ... 255			**Default:** 0
State:	**Option:** none	with query	**Note:** MAXimum and MINimum impermissible	

Status Byte Query

Syntax:	*STB?		
Return:	0 ... 255		
State: ALL	**Option:** none	only query	

Self-Test

Syntax:	*TST?		
Return:	0 ... 255		
State: ALL	**Option:** none	only query	**Note:** No error in the selftest is indicated by the value 0

Wait-to-Continue

Syntax:	*WAI		
State: ALL	**Option:** none	no query	

9.2. Optional Commands

Query of options

Syntax:	*OPT?		
Return:	Identical with SYSTem:OPTions?		
State: ALL	**Option:** none	only query	**Note:** No default value, identical with SYSTem:OPTions?

9.3. STATus Subsystem

Operation Event Register

Syntax:	STATus:OPERation[:EVENt]?			
Return:	0 ... 32767			**Default:** 0
State: ALL	**Option:** none	only Query	**Note:** Bit 8 is used as summary bit for the CMD event register.	

Operation Condition Register

Syntax:	STATus:OPERation:CONDition?			
Return:	0 ... 32767			**Default:** 0
State: ALL	**Option:** none	only query		

Operation Event Register Enable

Syntax:	STATus:OPERation:ENABle <numeric_value>			
Value range:	0 ... 32767			**Default:** 0
State: ALL	**Option:** none	with query	**Note:** MAXimum and MINimum impermissible; bit 8 is used for the CMD event register.	

Questionable Event Register

Syntax:	STATus:QUEStionable[:EVENt]?			
Return:	0 ... 32767			**Default:** 0
State: ALL	**Option:** none	only Query		

Questionable Condition Register

Syntax:	STATus:QUEStionable:CONDition?			
Return:	0 ... 32767			**Default:** 0
State: ALL	**Option:** none	only query		

Questionable Event Register Enable

Syntax:	STATus:QUEStionable:ENABle <numeric_value>			
Value range:	0 ... 32767			**Default:** 0
State: ALL	**Option:** none	with query	**Note:** MAXimum and MINimum impermissible	

Resetting the instrument

Syntax:	STATus:PRESet		
State: ALL	**Option:** none	no query	

Status Queue

Syntax:	STATus:QUEue[:NEXT]?			
Return:	see SCPI, section 20.8 (p. 20-6)			**Default:** 0, "no error"
State: ALL	**Option:** none	only query		

9.4. SYSTem Subsystem

Next message from error queue

Syntax:	SYSTem:ERRor?		
Return:	see SCPI, section 21.7 (p. 21-10)		**Default:** 0, "no error"
State: ALL	**Option:** none	only query	

SCPI Version

Syntax:	SYSTem:VERSion?		
Rückgabe:	see SCPI, section 21.18 (p. 21-28)		**Default:** 1993.0
State: ALL	**Option:** none	only query	

4 Maintenance

Under normal operating conditions, regular maintenance is not required. However, we recommend to check the lithium battery and the frequency accuracy of the reference oscillator every one to two years.

4.1 Checking the Lithium Battery

A battery-backed CMOS-RAM retains the data of the setup as well as the complete instrument settings after switch-off.

The battery voltage can be measured using the performance-test software (menu item: Performance Test, internal diaganosis and battery).

4.2 Testing and Adjustment of the Frequency Accuracy

If the option CMD-B1 is not fitted, check the TCXO reference oscillator.

If the option CMD-B1 is fitted, check the OCXO reference oscillator (note warm-up period).

The reference frequency can be checked and re-adjusted, if required, using the performance-test software (menu item: Adjustment TCXO 10 MHz, OCXO 10 MHz).

5 Testing the Rated Specifications

5.1 Test Instruments and Utilities

RF frequency counter	up to 2.2 GHz	e.g., FSB
Power meter	up to 2.2 GHz, -37...+13 dBm	e.g., NRVS
RF spectrum analyzer	up to 3.1 GHz	e.g., FSB
RF signal generator	up to 2.2 GHz	e.g., SMHU
Oscilloscope	up to 50 MHz	e.g., BOL
Power supply for lab use	up to 30 V, up to 10 A	e.g., NGPE
AF voltmeter		e.g., UPA
AF distortion meter		e.g., UPA
AF generator		e.g., UPA
GSM mobile telephone		

Note:
The instruments mentioned below are required to completely check,whether the data given in the data sheets are adhered to, however, a limited function and data test can be performed without these instruments.

GMSK generator	GSM frequency range	e.g., CMTA 94
Power generator	Frequency depends on type, up to +47 dBm	

5.2 Test Procedure (using Service Software)

5.2.1 Booting for DOS

All service programs of the CMD are only accessible under DOS. An external keyboard must be connected to the CMD, in order to enter the DOS surface. Upon switching on the CMD, a short signal is audible. The keys <Alt>, <Control> and <E> must now be pressed within 1.5 seconds. Do not press the key <E> until the two other keys are being pressed. Startup messages such as "Testing..." are then displayed by the controller.

If switchover fails, switch off the CMD and repeat.

When the controller-startup has been completed, the DOS prompt is displayed.

Note:
Files must not be modified or deleted. This would impair the validity of data and function of the CMD.

5.2.2 Starting the Program

- Boot the CMD for DOS, if required (see Section 5.2.1).
- Change directory: cd \service <ENTER>.
- Call performance-test program: check <ENTER>.

5.2.3 Operating the Program

The program can be operated either using the CMD keyboard or the external PC keyboard. That key on the external keyboard that corresponds to the softkey is given in brackets "<>". The default key is framed by two lines; it can be selected with any key which is not used, e.g., <SPACE KEY> or < ENTER>. -The <ESC> key can be used to abort the running test or the program.

Subsequent to the start messages, the CMD status is displayed. Check, whether the instrument variation and all options fitted have been exactly identified.

The program then prompts for the desired program status. Select the "SERVICE" mode. It is advisable to used the option "External Reference" (CMD-B3), but is is not absolutely necessary. The test selection menu is then displayed. For selection of a menu item, use the keys <Cursor up>, <Cursor down>, <Page up> and <Page down> to position the cursor next to the menu item, then, press the <ENTER> key.

A test point is entered under the assumption that there is no connection to an external test instrument.

When a test has been selected, the user is prompted step by step to carry out various actions, such as:

connection of external measuring facilties to the CMD, settings and measurements on test instruments as well as reading off CMD-internal test results.

If the requested action has been executed, the test run is continued by pressing the default key. A number of measurements allow for repeating the current or the preceding measurement or to skip the subsequent measurement.

A few instructions are output together with additional information to ease troubleshooting.

The program is left by simply switching off the instrument.

5.2.4 Tests To Be Performed

The test selection menu is divided into two sections:

Adjustments
is used to perform mere adjustments and to check the internal diagnosis facitlity. A few diagnostic voltages have no corresponding trimming facility. If the voltage is out of tolerance, the module must be replaced.

Trimmers and rated values at the associated test points are displayed.

Performance-Test
A complete performance test of the CMD includes all selectable menu entries of the test selection menu under performance test

5.2.4 Tests To Be Performed

The test selection menu is divided into two sections:

Adjustments
is used to perform mere adjustments and to check the internal diagnosis facitlity. A few diagnostic voltages have no corresponding trimming facility. If the voltage is out of tolerance, the module must be replaced.

Trimmers and rated values at the associated test points are displayed.

Performance-Test
A complete performance test of the CMD includes all selectable menu entries of the test selection menu under performance test