STABILOCK 4031 4032

GSM 1800/1900 MS-Test

Software Option 897 912

Operating Instructions

03_GSMMS Doc. Version 0002-500-A

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Supplement to operating manual; file under chapter 10

Contents

☞ **Differences to former software versions: see the timeline at the end of this supplement.**

Introduction

Applicability of this manual

This manual is valid for the option GSM/DCS 1800/1900 MS-Test (Software option 897 912, hardware option 248 274). It describes the testing of mobile stations (mobiles, also referred to as MS) in the following networks:

- GSM 900 (900 MHz)
- DCS 1800 (1800 MHz), also called PCN
- DCS 1900 (1900 MHz), also called PCS

What can the GSM MS-Test option do?

The GSM MS-Test option can perform the following tests:

Transmitter test (TX-Test)	Power/time template with userdefinable cornerpoints Peak power (TX test) and burst length Phase error, frequency error and modulation spectrum Zoomable graphic result display with marker
Receiver test (RX-Test)	Receiver sensitivity Bit error rate (RBER, RBERIb and RBERII) Frame error rate (FER) via GPIB
Call handling	Call establishment and release by MS and BS Emergency Call Measurement report (MS judges level and quality of connection with BS) Channel handover (FEX option required) ☞ Cross-band channel assignment for multi-band mobiles (STABILOCK 4032 from serial number 1788 onwards with FEX)
MS properties	Display of IMSI, IMEI, classmark, power control level, revision level Check of technical capabilities of the MS: extended frequency range, ciphering algorithms and SMS capability (the latter by transmitting the message "WAVETEK 4032 GSM Test - Cell Broadcast Channel Message" on the cell broadcast channel (CBCH, channel 0)
Audio tests	Audio loopback on traffic channel Audio measurement via AF generator A of STABILOCK

Software and hardware requirements

The following table shows the equipment necessary for testing in the three different networks:

Network	Basic device	Software requirement	Hardware requirement
GSM 900 [1]	STABILOCK 4031	Host ≥ 4.10, RF/AF-MCU ≥ 4.10, CRT-MCU ≥ 2.58 (3.03) [2]	Serial number 1188 [3] or greater
	STABILOCK 4032	Host ≥ 6.10, RF/AF-MCU ≥ 6.10, CRT-MCU ≥ 2.58 (3.03) [4]	
DCS 1800 (PCN)	STABILOCK 4031		FEX [5]
	STABILOCK 4032		FEX [5]
DCS 1900 (PCS)	STABILOCK 4031		FEX [5]
	STABILOCK 4032		FEX [5]
GSM/E-GSM/DCS 1800 and GSM/E-GSM/DCS 1900 [6]	STABILOCK 4032	Host ≥ 6.10, RF/AF-MCU ≥ 6.30, CRT-MCU ≥ 2.58 (3.03) [4]	Serial number 1788 [7] or greater and FEX option [8]

1) If STABILOCK is supplied with the RF-Frequency extension 2.3 GHz (FEX [5]), then base channel and traffic channel may be assigned to different frequency channels. The traffic channel may then be changed during the test in progress.

2) Version 3.03 is valid, if the STABILOCK 4031 is supplied with the additional spectrum analyzer 248 290.

3) Earlier STABILOCK 4031 (from serial number 0388 onwards) can be fitted to the state of series 1188 with an upgrade kit (ordering code 248 281). This has to be done in the factory.

4) Version 3.03 is valid, if the STABILOCK 4032 is supplied with the additional spectrum analyzer 248 291.

5) The upgrade to the RF-Frequency extension 2.3 GHz (FEX, ordering code 248 295) has to be done in the factory.

6) Cross-band TCH assignment uses channels of all involved systems.

7) The FEX option of earlier STABILOCK 4032 can be fitted to the state of series 1788 with an upgrade kit (ordering code 248 322[8]).

8) Minimum requirement: FEX RX unit with HW revision ≥ 1, FEX duplex unit with HW revision ≥ 9.

Quick start

You can start testing right away if you stick to the following checklist:

- The GSM MS-Test option must be in place in **slots 5/6**. Socket Bu 103 of the GSM option has to be connected to socket Bu 103 of the IF unit. Use the BNC cable delivered with the GSM kit for that purpose.
- **Connect the test item** as described in the section "Before Testing", "Test setup".
- **Prepare unit under test and STABILOCK** as described in section "Before Testing", "Preparing MS and STABILOCK for testing".
- **Select the system** as described in section "Before testing", "Selecting the system".
- Set the **parameters** of the MS and BS. There are more details of this in the section "Before Testing", "Setting test parameters".
- **Start the test** with the appropriate softkey.

Before Testing

This section tells you about the test setup, presettings, how to start the GSM test software, select the system and set parameters for MS and BS.

☞ You can perform the tests without detailed knowledge about GSM. But if you do want to find out more, there is a brief introduction in the section "Basics".

Test setup

Levels of < –110 dBm appear during tests, so the entire setup must be guarded against stray pickup. The following precautions are recommended:

- Terminate the RF DIRECT socket of the test setup with 50 Ω.
- Make sure that all plug-ins of the test setup (back panel) are screwed in tight.
- Close up vacant slots on the test setup (back panel) with dummy panels.

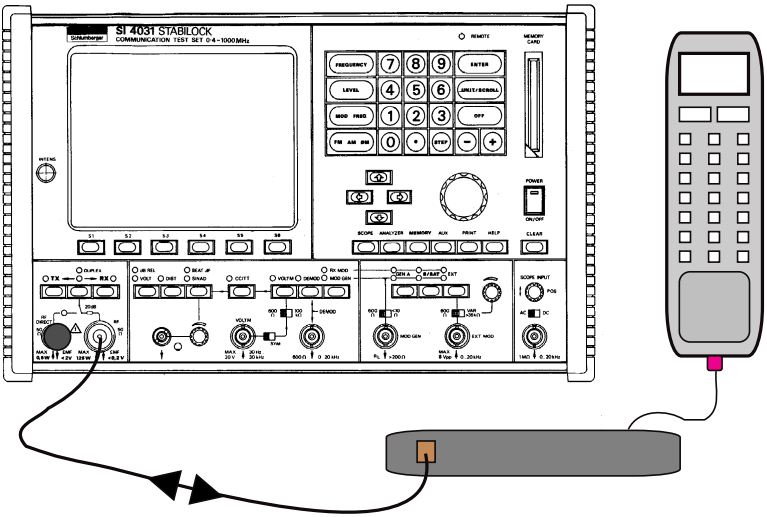


Fig. 10.1: Measurement setup.

Preparing MS and STABILOCK for testing

- Insert SIM card correctly into the mobile. If you want to use other SIM cards than the ones delivered with the GSM/DCS kit, refer to section "Using your own SIM card".
- Switch on STABILOCK.
- Insert the supplied memory card in its slot on the STABILOCK.
- Start test software with (AUX)+(DATA). STABILOCK then shows the test mask on the screen (**Fig. 10.5).**
- Select system with (DEF-PAR). See section "Selecting the system".
- Switch on the MS and enter PIN number of the SIM card (0000 with both Wavetek cards) into MS. After synchronizing to the STABILOCK "network" the MS will display the actual network code, eg like

  `MCC = 001`
  `MNC =  01`
- Set up test parameters as described in the following section.

☞ A locked SIM can be unlocked by entering the personal unblocking key (PUK). The PUK for the SIM cards delivered with the GSM option is `76543210`.

Using your own SIM card

For optimum testing we recommend strongly that you use no other than the SIM cards delivered with the GSM kit. However, you may use any other SIM card as well. In this case, the MS must be 'location-updated' and the STABILOCK must read the IMSI of the SIM card before starting the test. In order to achieve that,

- Prepare unit under test and STABILOCK as described above.
- After entering the PIN, call up MS-CALL.
- As soon as the MS displays the network service (eg like MCC = 001 and MNC = 01), the MS has registered. If the MS does not register, select the correct network on the MS (MCC = 001 and MNC = 01).
- Dial a number on the MS. The call is established and STABILOCK starts saving the MS data. As long as you do not perform a reset or switch off STABILOCK all tests may be performed now.

☞ BER functionality is guaranteed only when using the SIM cards delivered with the GSM kit.

Tests without SIM Card

Quick testing of the MS without SIM card is possible by using the emergency call, as each MS is able to call an ermergency number without SIM card.

- Press softkey (MS-CALL). This is **absolutely necessary** to prevent a real base station from receiving the emergency call.
- Dial the emergency call number with the MS. The call is set up correctly, if the STABILOCK displays `Signaling Status CALL ACTIVE`.

☞ This is the recommended test for mobiles without SIM card in order to set up a proper call. All tests except BER and TX Test in idle mode (access bursts) are then possible.

Selecting the system

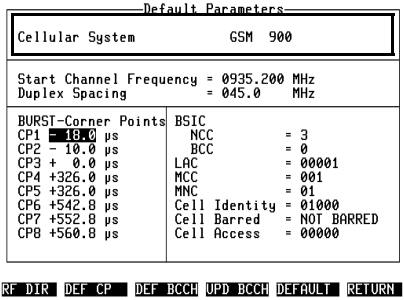


Fig. 10.2: Selecting the system

- Call mask `Default Parameters` (**Fig. 10.2**) by pressing (DEF-PAR) in the test mask.
- Select the system in the scroll field next to `Cellular System` (`GSM 900`, `DCS 1800` or `DCS 1900`). Start channel frequency and duplex spacing are then automatically set to the default values (see "Description of parameters").
- If the system does not meet the standard values (eg if the channel spacing is redefined), then you are free to set start channel frequency and duplex spacing within the valid range. But make sure to keep the system specifications! (DEFAULT) resets to the default values.
- (RF DIR) toggles the RF signal path between the sockets RF DIRECT and RF. Default when starting the GSM/DCS option is socket RF.
- (RETURN) takes you back to the test mask.

☞ Testing the DCS 1800 and DCS 1900 systems requires the RF-Frequency extension 2.3 GHz (FEX). If it is missing, then only `GSM 900` remains selectable in the scroll field next to `Cellular System`.

Description of parameters

Start channel frequency and duplex spacing			
System	**Parameter**	**Valid entry**	**Default**
GSM 900	`Start Channel Frequency`	0 to 1000 MHz	935.2 MHz
	`Duplex Spacing`	0 to 100 MHz	45.0 MHz
DCS 1800	`Start Channel Frequency`	1500 to 2000 MHz	1805.2 MHz
	`Duplex Spacing`	0 to 100 MHz	80.0 MHz
DCS 1900	`Start Channel Frequency`	1500 to 2000 MHz	1930.2 MHz
	`Duplex Spacing`	0 to 100 MHz	95.0 MHz

Start channel frequency

To be set in scroll field `Start Channel Frequency`. Frequency for the first downlink channel of the system (BS → MS). In the system GSM 900 this is channel number 1, in the DCS systems channel number 512. See section "Setting test parameters", table "Channels and frequencies in GSM/DCS" for channel assignment of the systems.

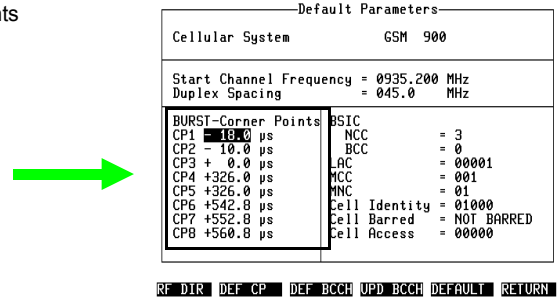
Duplex spacing

To be set in scroll field `Duplex Spacing`. Difference between uplink frequency (MS → BS) and downlink freqeuncy (BS → MS) of a channel. The downlink frequency is always by the duplex spacing higher than the uplink frequency.

Setting corner points for power/time template

When measuring the power/time template (see page 10-21), STABILOCK reads the power level at the so called corner points and displays it below the graph (see **Fig. 10.8).**
If a mobile does not meet the specification, then time and level of the erroneous value can be determined by setting the corner points `CP1` to `CP8` in the `Default Parameters` mask to the appropriate values.

Bild 10.3: Setting corner points



☞ (DEF CP) restores the default values for the corner points.

Setting BCCH (e.g. for Microcell applications)

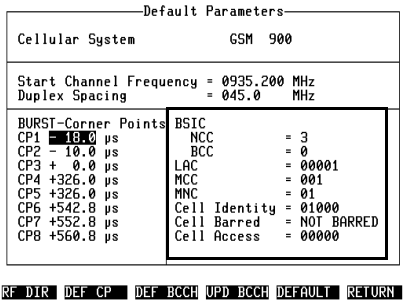


Bild 10.4: Setting BCCH

`BSIC` Base station identification code. Identifies a base station. The BSIC is transmitted on the synchronisation channel SCH and consists of two codes:
`NCC` (network colour code): Identifies the network.
`BCC` (base station colour code): Differs for adjacent base stations.

`LAC` Local area code. Identifies a base station within a network.

`MCC` Mobile country code. Identifies the country the network belongs to.

`MNC` Mobile network code. Identifies the network within a country

`Cell Identity` Identifies a cell within a network.

`Cell Barred` Determines whether a cell may `(NOT BARRED)` or may not `(BARRED)` be accessed by any mobiles.

`Cell Access` Determines what mobile classes are allowed to access the cell. Also determines the way a mobile has to transmit the (always allowed) emergency call.

(DEF BCCH) Restores the BCCH to the default values.

(UPD BCCH) STABILOCK accepts the entered parameters and transmits the BCCH using the new parameters.

Attention for Power measurements below 20 dBm (100 mW)

If you intend to measure power levels below 20 dBm (100 mW), a sample measurement is necessary before getting valid results.
Therefore, during an ongoing test, you change the entry `MS Power CCH` (or `MS Power TCH`, if a call is established) in the GSM MS-Test mask to a value between 20 dBm and 24 dBm (if FEX is not fitted) or between 15 dBm and 18 dBm (if FEX is fitted). As soon as a measurement result is displayed in the `Peak Power` output field, you change the MS Power back to the desired value.

☞ Every time the `Peak Power` field displays --------, this sample measurement has to be performed.

Setting test parameters

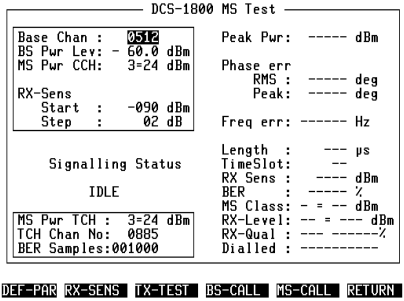


Fig. 10-5:
Setting the test parameters in the system DCS 1800.

`Base Chan` The frequency channel on which the STABILOCK transmits the BCCH (simulated base channel of the BS). See table "Channels and frequencies in GSM/DCS".

`TCH Chan No` Only visible if FEX option is installed.
The frequency channel used by the STABILOCK to transmit the TCH while a call is set up (traffic channel). See table "Channels and frequencies in GSM/DCS".

`BS Pwr.Lev` The transmitted RF power level of the BS. Permissible range: –120 to –15 dBm on RF socket.

Channels and frequencies in GSM/DCS

System	Available Channels	Assigned frequencies	Default in STABILOCK
P-GSM 900	1 to 124	$f_{n,downlink} = 935 + 0.2 \cdot n$ $f_{n,uplink} = f_{n,downlink}$ – Duplex spacing	63 (BCCH) 1 (TCH)
E-GSM 900	0 to 124	$f_{n,downlink} = 935 + 0.2 \cdot n$ $f_{n,uplink} = f_{n,downlink}$ – Duplex spacing	63 (BCCH) 1 (TCH)
	975 to 1023	$f_{n,downlink} = 935 + 0.2 \cdot (n - 1024)$ $f_{n,uplink} = f_{n,downlink}$ – Duplex spacing	
DCS 1800	512 to 885	$f_{n,downlink} = 1805.2 + 0.2 \cdot (n - 512)$ $f_{n,uplink} = f_{n,downlink}$ – Duplex spacing	512 (BCCH) 885 (TCH)
DCS 1900	512 to 810	$f_{n,downlink} = 1930.2 + 0.2 \cdot (n - 512)$ $f_{n,uplink} = f_{n,downlink}$ – Duplex spacing	512 (BCCH) 810 (TCH)

☞ Only select channels supplied by the MS. Otherwise no call setup is possible or the connection will be interrupted. Example: GSM mobiles which are not designed to use the extended frequency range (see "MS-INFO", `Ext Freq`), will supply the channels 1 to 124 only.

`Start` — Starting value for the receiver test (see section "RX test"). Permissible values: –120 dBm to –15 dBm.

`Step` — Decrement for the receiver test (see section "RX test"). Permissible values: 1 dB to 20 dB in steps of 1 dB.

`BER Samples` — Number of bits taken measured during a single measurement at the BER test. See section "BER". Permissible values: 1000 to 100000. The greater the value entered here, the longer a single measurement will take. Reasonable range of values for expressive measurements is 1000 to 50000. Value to achieve one single measurement per second: 3900.

`BER, BERIb, BERII` — Bit class tested during a single measurement at the BER test. Use [↓] to select entry field `BER` and select appropriate bit class with [UNIT/SCROLL] or the spinwheel.

`MS Pwr CCH` — Maximum RF level at which the MS may transmit the access burst. Set level by using the spinwheel or the [+] and [-] keys. The coding, corresponding to GSM Specifications and levels in dBm are displayed together (see table on page 10-19).

`MS Pwr TCH` — The RF level at which the MS must transmit on the traffic channel. Enter level with the spinwheel or the [+] and [-] keys. The coding, corresponding to GSM Specifications and levels in dBm are displayed together (see table on page 10-19).

☞ Only select power levels supplied by the MS. Otherwise no call setup is possible or the connection will be interrupted. Example: Some phase 1 GSM mobiles supply only power levels between 0 and 15.

TX TEST

The TX TEST checks the transmitter characteristics of the MS in any operation mode.

CALL ACTIVE	STABILOCK automatically measures normal bursts. It hereby measures frequency offsets of up to ±12 kHz from the preset channel.
IDLE	STABILOCK measures access bursts. It hereby measures frequency offsets of up to ±100 kHz from the preset channel.
Mobile in service mode	STABILOCK measures bursts transmitted unsynchronously to STABILOCK's base channel and continuous signals. It hereby measures frequency offsets of up to ±100 kHz from the preset channel.

Why?

The transmitter of the MS must have precisely the characteristics defined in GSM Specifications. An MS must not disturb general radiocommunication in the GSM network.

How?

- ❍ Prepare measurement as described in section "Before testing".
- ❍ For tests on the traffic channel (normal bursts): Set up call as described in sections "MS-CALL" or "BS-CALL.
- ❍ For tests in the mobiles test mode: Call up test mode on the MS.
- ❍ Start test with (TX-TEST). The labelling of the softkeys changes (**Fig. 10.6). Continuous measurements are performed and the results are displayed.**

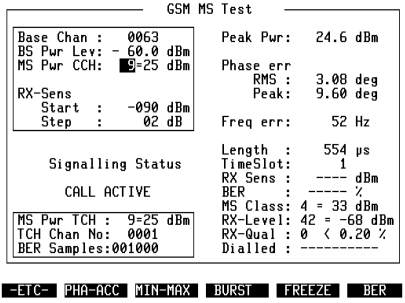


Fig. 10.6: TX test during an active call in the system GSM 900.

- The parameters MS Pwr, MS Pwr TCH, Base Chan, TCH Chan No (if FEX is installed) and BS Pwr.Lev can be altered during an ongoing test. By varying MS Pwr CCH you can check whether the MS correctly adapts to the specified levels. In idle mode, these parameters do not have any influence.
- (PHA-ACC) for measurements below 20 dBm (100 mW): Switches to maximum measuring accuracy for phase error, frequency error and power/time template. (POW-ACC) switches back to maximum accuracy for peak power measuring.
- (MIN-MAX) leads to the MIN-MAX mask. See section "Result display", "MIN-MAX mask"
- (BURST) displays the power/time template. See section "Result display", "Burst and Zoom".
- (FREEZE) freezes the display. The STABILOCK then displays the results of the most recently performed single measurement. (RUN) continues the measuring.
- (STOP) stops the measurements.

Result

The transmitter characteristics of the MS are measured continuously and shown anew after each measurement. In the MIN-MAX mask the results may be traced over many single measurements (see section "Result display", "MIN-MAX mask").

A pass/fail verdict according to GSM specifications is given against the limits stated below. In the BURST and ZOOM masks the results are shown graphically (see section "Result display", "Burst and Zoom"). The following MS properties are measured:

Peak Power — The peak power of the MS transmitter during the burst. The specifications allow a maximum deviation from the figure set in MS Pwr CCH and MS Pwr TCH:: see table on page 10-19.

Phase err — Phase error

RMS — Averaged phase error. This must not exceed 5 °.

Peak — Maximum phase error. This must not exceed 20 °.

Freq.err — Frequency error. This must not be more than ±90 Hz.

Length — Burst duration in µs. Typical duration (at 6 dB below peak level):
access burst: 321 µs to 341 µs
normal burst: 543 µs to 563 µs
continuous signal: Here a ? is displayed

Timeslot — Timeslot in which the MS is transmitting.

`MS Class` Only if a TCH is active. Shows the power class the MS belongs to, ie. the maximum power level it can transmit at.

RF power classes					
Code number	**1**	**2**	**3**	**4**	**5**
GSM/E-GSM	43 dBm	39 dBm	37 dBm	33 dBm	29 dBm
PCN/GSM1800	30 dBm	24 dBm	36 dBm	—	—
PCS/GSM1900	30 dBm	24 dBm	33 dBm	—	—

`RX-Level` Only during an active call. The level at which the MS receives the STABILOCK. See section "MS-INFO".

`Dialled` MS-CALL only: Number dialled on the MS.

☞ The `BER` and `RX Sens` fields are not used with TX Tests. See sections "BER" and "RX Sens".

Power level, transmitted power and tolerance

Level	P-GSM/E-GSM		PCN (GSM1800)		PCS (GSM1900)	
29	—	—	36 dBm	±2 dB	—	—
30	—	—	34 dBm	±3 dB	33 dBm	±2 dB
31	—	—	32 dBm	±3 dB	32 dBm	±3 dB
0	43 dBm	±2 dB	30 dBm	±3 dB	30 dBm	±3 dB
1	41 dBm	±3 dB	28 dBm	±3 dB	28 dBm	±3 dB
2	39 dBm	±3 dB	26 dBm	±3 dB	26 dBm	±3 dB
3	37 dBm	±3 dB	24 dBm	±3 dB	24 dBm	±3 dB
4	35 dBm	±3 dB	22 dBm	±3 dB	22 dBm	±3 dB
5	33 dBm	±3 dB	20 dBm	±3 dB	20 dBm	±3 dB
6	31 dBm	±3 dB	18 dBm	±3 dB	18 dBm	±3 dB
7	29 dBm	±3 dB	16 dBm	±3 dB	16 dBm	±3 dB
8	27 dBm	±3 dB	14 dBm	±3 dB	14 dBm	±3 dB
9	25 dBm	±3 dB	12 dBm	±4 dB	12 dBm	±4 dB
10	23 dBm	±3 dB	10 dBm	±4 dB	10 dBm	±4 dB
11	21 dBm	±3 dB	8 dBm	±4 dB	8 dBm	±4 dB
12	19 dBm	±3 dB	6 dBm	±4 dB	6 dBm	±4 dB
13	17 dBm	±3 dB	4 dBm	±4 dB	4 dBm	±4 dB
14	15 dBm	±3 dB	2 dBm	±5 dB	2 dBm	±5 dB
15	13 dBm	±3 dB	0 dBm	±5 dB	0 dBm	±5 dB
16	11 dBm	±5 dB	—	—	—	—
17	9 dBm	±5 dB	—	—	—	—
18	7 dBm	±5 dB	—	—	—	
19	5 dBm	±5 dB	—	—	—	—

Result display

MIN-MAX mask

In the MIN-MAX mask statistical properties of the MS transmitter are displayed over the whole measuring period. Call-up of the mask with (MIN-MAX) during the ongoing TX test.

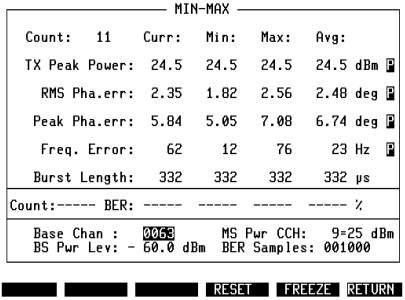


Fig. 10.7: MIN-MAX mask with access bursts in the system GSM 900.

`Count` Number of single measurements performed.

`Curr` Test result of the most recently performed single measurement.

`Min` Minimum value over all single measurements, since count = 0.

`Max` Maximum value over all single measurements, since count = 0.

`Avg` Average value over the approx. 30 most recent single measurements. The value is calculated by using the following formula:

New = (Act – Old) * 0.03 + Old, where

New: New average value
Act: Actual Test result
Old: Old average value

`P, F` Pass/Fail display. If `Curr` is within the permissible range, then `P` is displayed (test passed) otherwise `F`. The results the MS has to achieve in order to pass the single tests are described in the previous section "Result".

(RESET) Resets all output fields to 0 and starts a new series of measurements.

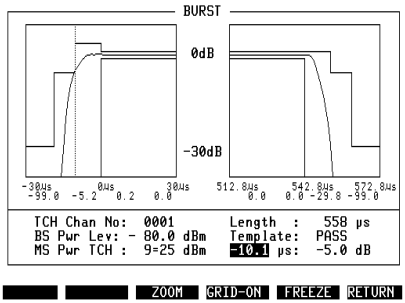
(FREEZE) Freezes the display, until the measuring is continued with (RUN).

(RETURN) Takes you back to the GSM MS-Test mask (**Fig. 10.6).**

Burst and Zoom

In the BURST mask the power/time template is displayed. Call-up of the mask with (BURST) during the ongoing TX test.

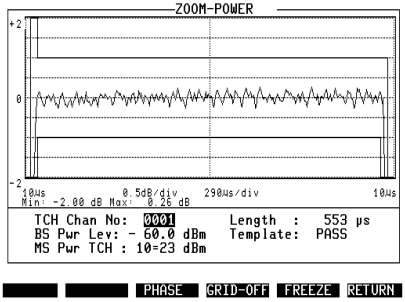
Fig. 10.8:
BURST mask with access bursts in the system GSM 900.



The power/time template shows at a glance, whether the transmitted power of the MS meets the specifications during a burst. If the test has been passed, then PASS is displayed beside Template, otherwise FAIL. STABILOCK displays the corner point levels below the power/time template (see section "Before testing", "Setting corner points for power/time template").
The marker allows to read out the transmitted power at any time in the power/time template. Therefore, select entry field µs and enter the desired time value with the spinwheel (steps of 0.92 µs). The corresponding transmitted power is then displayed beside the µs entry field.

(ZOOM) Zooms into the graphic display of the MS power. The softkey is renamed to (PHASE). If you repeat striking the softkey, then phase error and modulation spectrum (resolution band width RBW = 4 kHz) with current value, peak value and average value will be displayed one after another (see **Figures 10.9** to **10.13**).

Fig. 10.9:
ZOOM-POWER mask with normal bursts in the system GSM 900 (FEX installed).



(GRID-OFF) Blanks out the grid. (GRID-ON) blanks it in again.

(FREEZE) Freezes the display, until the test is continued with (RUN).

(RETURN) Takes you back to the GSM MS-Test mask (**Fig. 10.6).**

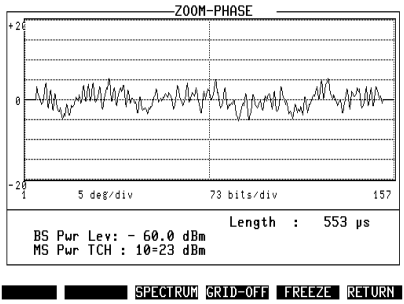


Fig. 10-10:
ZOOM-Phase mask with normal bursts in the system GSM 900 (FEX not installed).

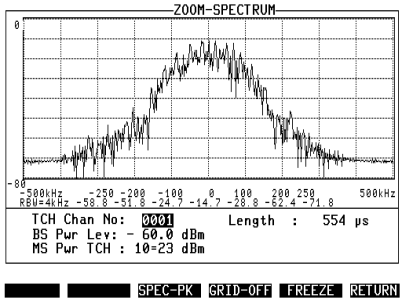


Fig. 10-11:
ZOOM-SPECTRUM mask with normal bursts in the system GSM 900 (FEX installed).

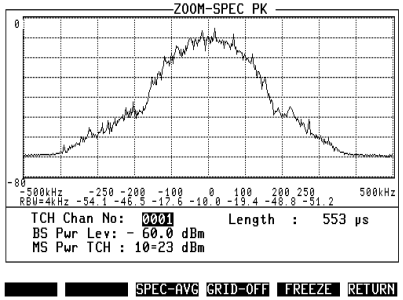


Fig. 10-12:
ZOOM-SPEC PK mask with normal bursts in the system GSM 900 (FEX installed).

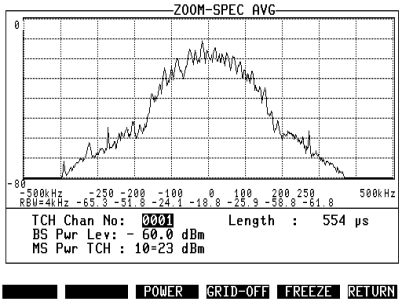


Fig. 10-13:
ZOOM-SPEC AVG mask with normal bursts in the system GSM 900 (FEX installed).

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RX-SENS

The RX-SENS test measures the sensitivity of the MS receiver.

Why?

The sensivity of a radio receiver is the RF level at which it still is able to detect the received signal with a certain degree of quality. In analog radios this quality was determined by Signal to Noise (S/N) measurements. The sensitivity of digital receivers can be determined by Bit Error Ratio or other methods like explained below.

How?

- ❍ Prepare measurement as described in section "Before testing".
- ❍ Start test with (RX-SENS). STABILOCK will begin with the test routine (see box).

Result

Once the test has been completed, the receiver sensitivity of the test item will be shown in the `RX Sens` field of the GSM MS-Test mask (**Fig. 10.14).**

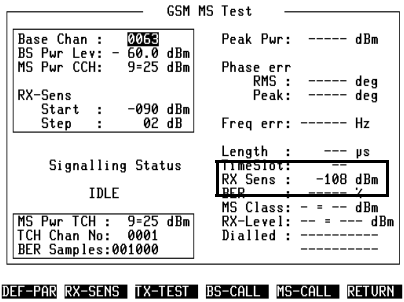


Fig. 10.14:
The measurement result for the receiver sensitivity is displayed in the RX Sens output field. While the test goes on, the display shows `WAIT`.

☞ This tests takes a relatively long time. Therefore, try preset starting level and increment in the best possible way:

- Adjust starting value just above the expected sensitivity (typically approx. –95 dBm).
- Select increment just below the wanted precision of the measurement (typically approx. 2 dB).

Measuring receiver sensitivity

The BS can call on an MS to report back. This is called paging. The test routine in the setup makes use of this. It calls the MS with the RF level set in the GSM MS-Test mask in the entry field `Start`. If the MS then comes in within 30 seconds, STABILOCK will call it again. The level this time is lower by the `Step` in the GSM MS-Test mask. This is repeated until the MS no longer responds (display "no service" or something similar on the display of the MS). The smallest level at which the MS reports back is displayed as the receiver sensitivity.

Another method is the monitoring of the MSs measurement report (see section "MS-Info"). Just compare the reported level with the value in field `BS Pwr Lev`. And last but not least the MS sensitivity can be determined by a Bit Error Ratio (BER) at a certain low RF level (see section "BER").

BS-CALL

In this test STABILOCK sets up a call with the MS.

Why?

Some signaling is necessary in a GSM network to set up a call. In the BS-CALL test the test item must prove that it correctly transmits and receives this signaling. After a call is established, transmitter and receiver tests can be performed.

How?

- Connect test item.
- Prepare measurement as described in section "Before testing".
- Start test with (BS-CALL).
- As soon as the MS "rings" (Signaling Status shows: `ALERTING`), accept the call. The labelling of the softkeys changes (**Fig. 10.15). The call being activated is shown by Signaling Status:** `CALL ACTIVE`**.**
- (-ETC-) changes the labelling of the softkeys. Thus, other functions may be called up during a call in progress (see also sections "TX-TEST" and "BER").
- Audio quality measurements are invoked with (AUDIO) (see section "Audio measurements").
- Internal parameters of the MS and the measurement report can be called up with (MS-INFO) (see section "MS-INFO").
- The parameters `MS Pwr`, `MS Pwr TCH`, `Base Chan`, `TCH Chan No` (if FEX is installed) and `BS Pwr.Lev` can be altered during an ongoing test. By varying MS Pwr CCH you can check whether the MS correctly adapts to the specified levels. In idle mode, these parameters do not have any influence.
- The call can be terminated with (BS-CLEAR) or (MS-CLEAR) (see sections "BS-CLEAR" and "MS-CLEAR"), or you can halt it with (STOP).

Result

The righthand half of the GSM MS-Test mask shows the transmitter characteristics of the MS (**Fig. 10.15). Internal parameters of the MS appear in the mask GSM MS-Info (called up by** (MS-INFO)) (**Fig. 10.16).**

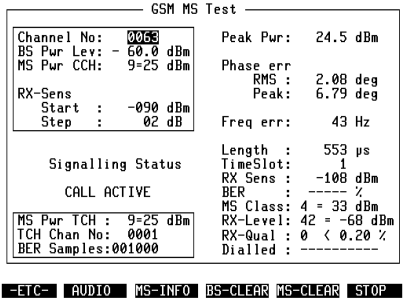


Fig. 10.15: CALL ACTIVE.
The call between STABILOCK and the test item is set up.
System: GSM 900.

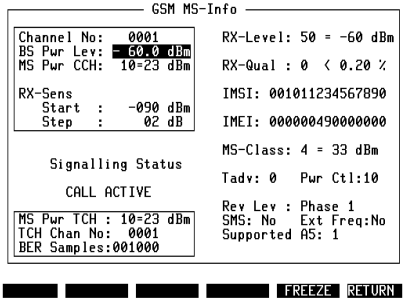


Fig. 10.16: GSM MS-Info mask:
Measurement report during an active call in the system GSM 900.

MS-CALL

In this test the MS initiates a call setup with STABILOCK.

Why?

Some signaling is necessary in a GSM network to set up a call. In the MS-CALL test the test item must prove that it correctly transmits and receives this signaling. After a call is established, transmitter and receiver tests can be performed.

How?

- Prepare measurement as described in section "Before testing".
- Start test with (MS-CALL) and dial a number on the MS. When the call is set up, the labelling of the softkeys changes (**Fig. 10.17).**The call being activated is shown by Signaling Status: `CALL ACTIVE`**.**
- (-ETC-) changes the labelling of the softkeys. Thus, other functions may be called up during a call in progress (see also sections "TX-TEST" and "BER").
- Audio quality measurements are invoked with (AUDIO) (see section "Audio measurements").
- Internal parameters of an MS can be called up with (MS-INFO) (see section "MS-INFO").
- The parameters `MS Pwr`, `MS Pwr TCH`, `Base Chan`, `TCH Chan No` (if FEX is installed) and `BS Pwr.Lev` can be altered during an ongoing test. By varying MS Pwr CCH you can check whether the MS correctly adapts to the specified levels. In idle mode, these parameters do not have any influence.
- The call can be terminated with (BS-CLEAR) or (MS-CLEAR) (see sections "BS-CLEAR" and "MS-CLEAR"), or you can halt it with (STOP).

Result

The righthand half of the GSM MS-Test mask shows the transmitter characteristics of the MS (**Fig. 10.17). Internal parameters and the measurement report of the MS appear in the mask GSM MS-Info (called up by** (MS-INFO)) (**Fig. 10.18).**

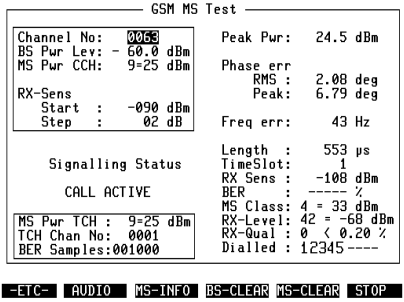


Fig. 10.17: CALL ACTIVE.
The call between STABILOCK and the test item is set up.
System: GSM 900.

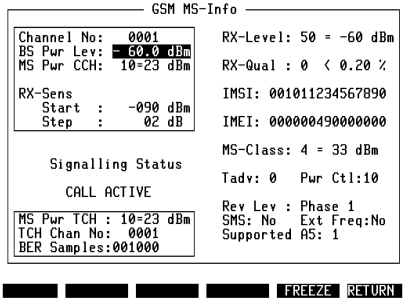


Fig. 10.18: GSM MS-Info mask:
Measurement report during an active call in the system GSM 900.

Cross-band channel assignment

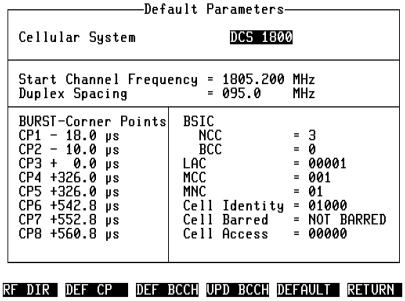
Why?

A mobile with cross-band capabilities is able to switch its TCH to another band during a call, independent whether the BCCH lies in the P/E GSM band or in the DCS 1800 band. After the channel being switched the STABILOCK can perform receiver and transmitter tests on both bands. Cross-band channel assignment is not yet defined in GSM specifications, but it is supported by the STABILOCK.

How?

- ❍ Prepare measurement as described in section "Before testing".
- ❍ Select the system DCS 1800 (or DCS 1900, if supported by the MS) in the `Default Parameters` mask (**Fig. 10.19).**

Fig. 10.19: System selection for cross-band: here DCS 1800.



- ❍ Set BCCH and TCH in the entry fields `Base Chan` and `TCH Chan No`. Before a call being set up (signaling status `IDLE`), all channel combinations are possible, that are available in the involved systems (see table on page 10-14).

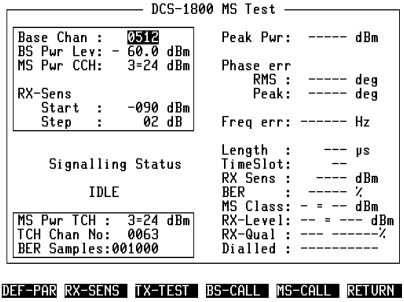


Fig. 10.20: BCCH lies in DCS 1800 band, TCH in GSM 900 band.

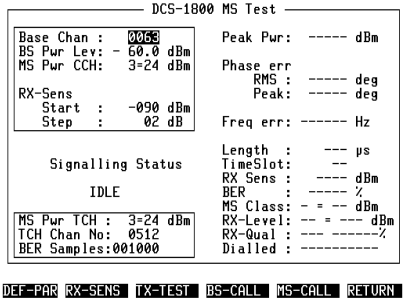


Fig. 10.21: TCH lies in DCS 1800 band, BCCH in GSM 900 band.

- Start test with (BS-CALL) or (MS-CALL) as described in the sections "BS-CALL" and "MS-CALL". As soon as the signaling status changes to CALL ACTIVE, the connection is established (**Fig. 10.22).**
- In the TCH Chan No entry field, the TCH can now be set to any desired inband or cross-band channel. The BCCH, however, keeps its value for the duration of the call.

Result

The righthand half of the GSM MS-Test mask shows the transmitter characteristics of the MS (**Fig. 10.22). Internal parameters and the measurement report of the MS appear in the mask** GSM MS-Info **(called up by** (MS-INFO)) **(Fig. 10.30).**

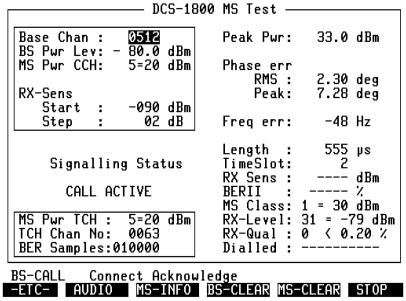


Fig. 10.22: TCH on channel 63 (GSM 900), BCCH on channel 512 (DCS 1800).

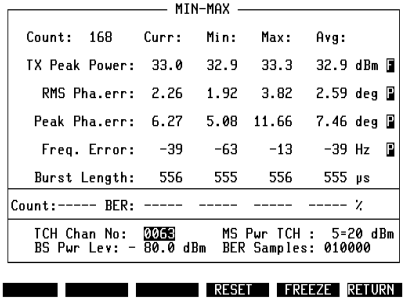


Fig. 10.23: Transmitting power level for power class 5 (GSM), here interpreted with power class 5 (DCS 1800).

Notes on testing cross-band mobiles

As mobiles with cross-band capabilities can be active in two different frequency bands, there are some peculiarities which have to be taken into account when testing.

The coding of the MS power level (MS Pwr CCH and MS Pwr TCH) is displayed in the system selected in the Default Parameters mask. In **Fig. 10.22 it is power level 5. In GSM 900 this corresponds to a value of 33 dBm.** MS Pwr TCH here reads 20 dBm, because the test was started in the DCS 1800 system. The Peak Pwr field displays the measured (and correct) power level of the MS as 33 dBm. This behaviour is shown by all TX test masks.

☞ In the MIN-MAX mask (**Fig. 10.23) the MS passed the test, although a Fail is displayed.**

Level	P-GSM/E-GSM		PCN (GSM1800)		PCS (GSM1900)	
5	33 dBm	±3 dB	20 dBm	±3 dB	20 dBm	±3 dB

☞ In consequence, the Pass/Fail result of the TX peak power measurement can not be used in remote applications (AUTORUN, GPIB). The Pass/Fail has to be drived from the measurement value and the permitted tolerances (see table on page 10-19).

☞ The MS class is evaluated by the STABILOCK from information in classmark 1 and 2 only. Classmark 3 contents are not displayed.

Audio measurements

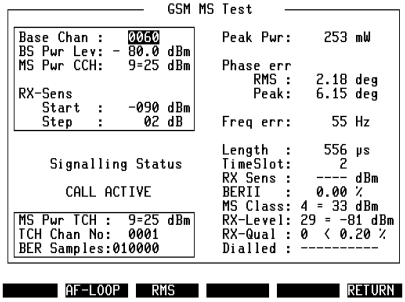
Why?

In a GSM network the speech signals are converted a few times between the microphone of the MS that you speak into and the ear of the person at the other end. There are high demands of the hardware and software of the MS. Whether the MS meets the requirements for sound quality, can be tested in two ways:
The RMS measurement uses the AF generator A of STABILOCK for RMS and SINAD tests.
AF-LOOP uses the ear as a very fine and reliable instrument to judge the quality of speech transmission, coding and components (as cables, speaker, microphones).

How?

- Set up the call with (MS-CALL) or (BS-CALL) (see preceding sections).
- Call up audio measurement with (AUDIO).The labelling of the softkeys changes (**Fig. 10.24).**

Fig. 10.24:
Audio measurement, invoked during an established call.



- (AF-LOOP) switches on the loopback function (see section "AF-LOOP"). When speaking into the microphone of the MS, your voice will be repeated in the receiver after a delay of approx. 1 s. (STOP) opens the loop again.
- (RMS) calls the RMS meter (see section "RMS"). (RETURN) ends the AF measurement.
- Terminate the call with (MS-CLEAR) or (BS-CLEAR).

Result

- The loopback function transmits your own speech via the MS receiver, thus enabling you to judge the speech quality. During an RMS measurement, the AF level and SINAD deliver quantitytive results regarding the speech quality of the MS.

10

AF-LOOP

This test loops the entire signal path between the microphone and loudspeaker of the MS (loopback function, **Fig. 10.25).**

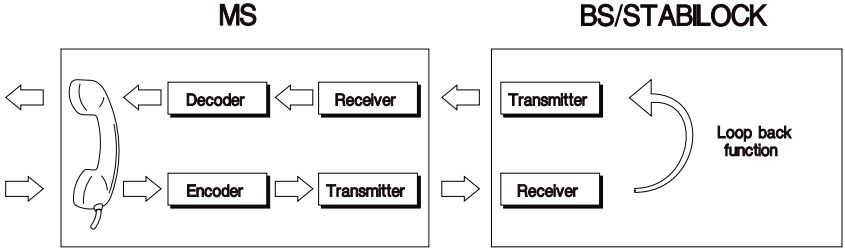


Fig. 10.25: Loopback function: The AF signal from the microphone of the MS is encoded and transmitted by RF to the BS. The demodulated signal feeds the modulator of the transmitter. Result: The signal follows the opposite path to the loudspeaker of the MS. You hear your own voice with a slight delay.

After (STOP) STABILOCK transmits the last second of speech data over the TCH, until the call is terminated via (MS-CLEAR) or (BS-CLEAR). The purpose of this is described in the following subsection.

☞ While the AF-LOOP is active the STABILOCK does not perform any measurements. The results are "frozen" until the loop is opened again.

What's damaged: the speaker or the microphone?

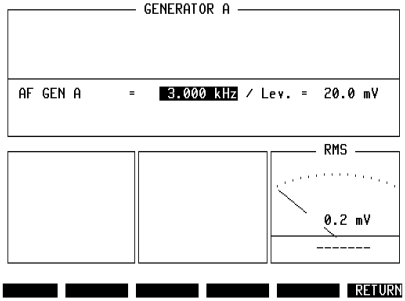
If no signal is audible in the AF-LOOP, you may check, whether the speaker or the microphone-path of the MS is damaged. This works as follows:

- Establish a call using a 'good' MS.
- Cut in the loopback function with (AF-LOOP).
- Speak into the microphone of the MS. Your voice will be repeated in the receiver after a delay of approx. 1 s.
- (STOP) opens the loop again. STABILOCK stores the last seconds worth of speech. The stored speech signals are continuously transmitted.
- Terminate the call with (MS-CLEAR) or (BS-CLEAR).
- Connect defective MS.
- Establish a call.
- The stored speech signals are transmitted again on the TCH. If you hear the signals in the mobile's speaker, then most probably the microphone-path is damaged, otherwise it is the speaker, provided the test results shown in the right half of the GSM MS-Test mask, indicate a stable TCH and RX Qual is less than 4 (in the GSM MS-Info mask).

RMS

The RMS measurement uses the RMS meter (see chapter 5, "Standard RX Tests").

Fig. 10.26:
Audio testing is also possible during GSM/DCST tests.



To judge the quality of the signal, the output of the AF generator (socket Bu ModGen) can be connected to an "artificial mouth". The VOLTM input can be connected to an "artificial ear".

☞ After calling up the mask, the generator GEN A is automatically activated and the socket VOLTM is connected. If the generator is not switched off before leaving the mask it will continue transmitting.

MS-CLEAR

This test checks whether the MS can terminate a call properly.

Why?

Some signaling is required to terminate a call. In the MS-CLEAR test the test item has to prove that it can master this signaling.

How?

- ❍ Set up the call with (MS-CALL) or (BS-CALL) (see section "MS-CALL" and "BS-CALL").
- ❍ Press (MS-CLEAR).
- ❍ Replace the receiver of the MS or press the 'clear' button on the MS.

Result

The call is properly terminated if the MS again indicates 'service' (MCC = 001, MNC = 01) and STABILOCK returns to the IDLE signaling state.

BS-CLEAR

This test checks the response of the MS when a call is terminated by the BS (STABILOCK).

Why?

Some signaling is required to clear down a call. In the BS-CLEAR test the test item has to prove that it can master this signaling.

How?

- Set up the call with (MS-CALL) or (BS-CALL) (see section "MS-CALL" and "BS-CALL").
- Press (BS-CLEAR).

Result

The call is properly terminated down if the MS again indicates 'service' (MCC = 001, MNC = 01) and STABILOCK returns to the IDLE signaling state.

BER

This tests the RF sensitivity of the MS by measuring the bit error rate of the bit classes RBER, RBERIb and RBERII.

Why?

In GSM, speech signals are digitally transmitted as bits. The higher the bit error rate (BER) gets, the worse the speech quality becomes.

How?

- ❍ Select appropriate bit class as described in section "Setting test parameters".
- ❍ Set up call with (MS-CALL) or (BS-CALL) (see sections "MS-CALL" and "BS-CALL").
- ❍ As soon as the signaling status CALL ACTIVE is shown in the GSM MS-Test mask, strike (-ETC-) + (BER).

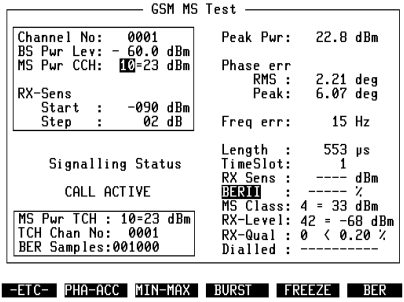


Fig. 10.27: GSM MS Test mask after (-ETC-). System: GSM 900.

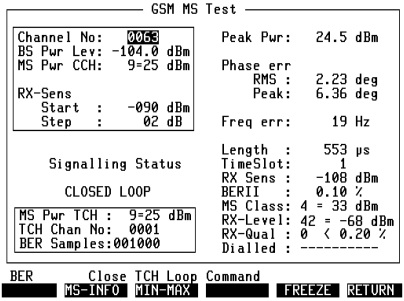


Fig. 10.28: BER test in progress.

- ❍ With (MS-INFO) internal parameters of the MS may be interrogated (see section "GSM MS-Info").
- ❍ The bit class to be tested may be selected during the test. STABILOCK then immediately continues testing the newly selected bit class.
- ❍ (MIN-MAX) takes you to the MIN-MAX mask (see **Fig 10.29**). This mask shows the test results over any test period. The MIN-MAX mask is described in "TX-TEST", "Result display".

- (FREEZE) freezes the display until the measurement is continued with (RUN).
- (RETURN) ends the BER test.

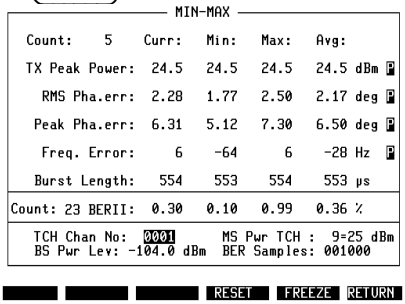


Fig. 10.29: MIN-MAX mask during a BER test in the system GSM 900.

Result

The GSM specifications prescribe, which maximum BER an MS may have. The values depend on the test conditions. The following table shows the prescribed bit error rates at different MS and BS power levels.

MS power	BS power	RBER II
any	> –100 dBm	= 0,00 %
> 2 Watt	–104 dBm	< 2,44 %
≤ 2 Watt	–102 dBm	< 2,44 %

MS-INFO

MS-INFO displays the measurement report and internal parameters of the MS.

Why?

During the call establishment the MS sends to the BS data about itself and about the qualtity of the received signals. As long as a call is set up, it sends a measurement report approx. every half second.

How?

- Set up the call with (MS-CALL) or (BS-CALL) (see section "MS-CALL" and "BS-CALL").
- (MS-INFO) takes you to the GSM MS-Info mask.
- (FREEZE) "freezes" the display of the test results. It is switched on again with (RUN).
- (RETURN) takes you back to the GSM MS-Test mask.
- (BS-CLEAR) or (MS-CLEAR) terminates the call.
- (STOP) in the GSM MS-Test mask halts the test.

Result

The GSM MS-Info mask shows major parameters of the MS as well as parts of the measurement report.

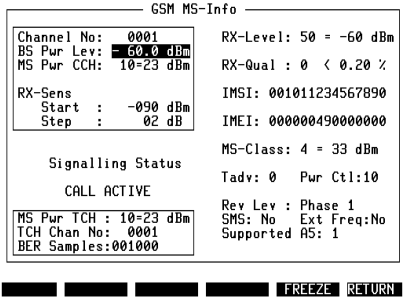


Fig. 10.30: GSM MS-Info mask in the system GSM 900.

`RX-Level`

The level at which the MS receives the signals of the BS (STABILOCK) on the TCH. See table for coding. RX-Level is transmitted with the measurement report.

RX-Lev	0	1	...	k	...	63
dBm	< –110	–109 to –110	...	–110+k to –109+k	...	> –48

`RX-Qual.` The quality with which the MS receives the signals of the BS on the TCH. This test is based on the bit error rate (BER) of the received signals. See table for coding. RX-Qual. is transmitted with the measurement report.

RX-Qual.	0	1	...	k	...	7
% BER	< 0.2	0.2 to 0.4	...	$0.1*2^{k}$ to $0.1*2^{(k+1)}$	...	> 12.8

`IMSI` International mobile subscriber identity, ie the individual identity number of the subscriber in the network. The MS reads the IMSI from the SIM card. The SIM cards delivered with the GSM option contain the IMSI 001011234567890.

`IMEI` International mobile equipment identity, ie the electronic "serial number" of the MS. Encoded in the IMEI are:
producer, country of origin, place of type approval and the producer's own serial number.

`MS-Class` Mobile power class. Shows the power class and the associated peak power of the MS.

`Tadv` Timing advance. If the MS is far from the BS, it must transmit a "tick" earlier to have the signal reach the BS "in time". The timing advance states this "tick" in quarters of bits. A quarter bit is about 0.9 µs of time (270 m signal propagation distance).
STABILOCK always commands Tadv=0.

`Pwr Ctl` Power control level. Transmitted by the MS. It states the MS setting of about the power level it transmits with. It is coded as shown in the table "Coding of MS transmitting power" in section "Setting test parameters". The value must be identical to the value entered in `MS Pwr TCH`.

`Rev Lev` This refers to GSM Specifications, ie whether the MS supports phase 1 or 2.

`SMS` This shows whether the MS supports short message services (YES/NO).

`Ext Freq` States whether the MS is able to use the 'extended frequency band'.

`Supported A5` This shows which A5 algorithm the MS can use for ciphering.
Example: 1 means, that the MS can use the algorithms A5/1.

External control via IEEE/AUTORUN

This section describes the most important commands for external control of the GSM/DCS option via AUTORUN or IEEE bus.

AUTORUN/IEEE commands

The available commands depend on the actually displayed mask. Every parameter that can be manually altered there, may also be set by using a command. The following table shows the commands available within the different masks.

☞ For further information on programming the STABILOCK see chapter 8, "AUTORUN and use of IEEE-bus controller".

Function	Command	Remark
`Default Parameters` mask		
Selecting system	`wrtva01,x` x: valid system	Example: wrtva1, GSM 900 selects GSM 900
Start channel frequency	`wrtva02,x` x: valid frequency	See "Selecting the system"
Duplex spacing	`wrtva03,x` x: valid frequency	See "Selecting the system"
Corner points CP1 to CP8	`wrtva04,x` to `wrtva011,x` x: time in µs	See "Before testing", "Setting corner points for power/time template"
NCC	`wrtva12,x` x: valid NCC	Siehe "Before testing", "Setting BCCH (only for GSM/DCS Microcell option)"
BCC	`wrtva13,x` x: valid BCC	as NCC
LAC	`wrtva14,x` x: valid LAC	as NCC
MCC	`wrtva15,x` x: valid MCC	as NCC
MNC	`wrtva16,x` x: valid MNC	as NCC
Cell Identity	`wrtva17,x` x: valid value	as NCC
Cell Barred	`wrtva18,x` x: valid value	as NCC
Cell Access	`wrtva19,x` x: valid value	as NCC
`GSM MS Test` mask (or `DCS-1800 MS Test`, `DCS-1900 MS Test`)		
Base channel ARFCN	`wrtva01,x` x: valid channel number	See "Setting test parameters"

Setting BS power level	`wrtva02,x` x: valid power level	See "Setting test parameters"
Setting MS power CCH	`wrtva03,x` x: valid power level	See "Setting test parameters"
Setting RX-Sens start value	`wrtva04,x` x: valid power level	See "Setting test parameters"
Setting RX-Sens step size	`wrtva05,x` x: valid dB value	See "Setting test parameters"
Setting MS power TCH	`wrtva06,x` x: valid power level	See "Setting test parameters"
Setting BER samples	`wrtva07,x` x: number of samples	See "Setting test parameters"
Setting TCH traffic channel ARFCN	`wrtva08,x` x: valid channel number	See "Setting test parameters"
BER	`wrtva10,x` x: BER, BERIb or BERII	See "Setting test parameters"
`MS-INFO`, `MIN-MAX`, `BURST` masks and `ZOOM` masks: All affectable parameters may be set by using the wrtva command. [HELP] shows the assigned variable numbers.		

☞ **Softkeys** are simulated by the `soft_[name]` command, where `[name]` is identical to the softkey labelling. The [STOP] softkey is simulated by the `Device clear` command.

Poll the ringing of the mobile

When the MS "rings" (and indicates this to the STABILOCK via signaling), then bit 3 of the SRQ mask is set. By means of the SMASK command, the SRQ mask can be checked. See STABILOCK manual, chapter 8, "Service Request" for further information.

☞ The SMASK command is not available in AUTORUN mode.

Poll the signaling state – when?

If you set parameters within the GSM/DCS option, which the mobile does not support, then the connection will break down. STABILOCK signals that by the signaling state "CALL DROPPED", which can be polled in RESULt8. Therfore, it is always recommended to always check the signaling state

- when a new power level is assigned (the MS might not support that level).
- when changing the traffic channel during an active call (the MS might signal "Assignment failed").

Polling results via IEEE/AUTORUN

☞ It depends on the operating state of STABILOCK, which result variables will be accessible at a certain moment.
Example: BER in RESULtA can only be checked, if the bit error ratio has been measured. Before that, a call must be set up.

Results of the MIN-MAX mask

Result	IEEE command	Position in string 01234567890123456789
TX peak power (current and MIN)	RESULt1	ccccc;llllll;******
TX peak power (MAX, average and unit)	RESULt2	hhhhhh;aaaaaa;uuu;**
RMS phase error (current, MIN, MAX)	RESULt3	ccccc;lllll;hhhhh;**
RMS phase error (average), Peak phase error (current and MIN)	RESULt4	aaaaa;ccccc;lllll;**
Peak phase error (MAX and average)	RESULt5	hhhhh;aaaaa;********
Frequency error (current and MIN), Bit mask of Pass (1) or Fail (0) result, Sequence: Peak power, RMS phase error, Peak phase error, Frequency error	RESULt6	cccccc;llllll;oooo;*
Frequency error (MAX and average)	RESULt7	hhhhhh;aaaaaa;******
Length of burst (all)	RESULt8	ccc;lll;hhh;aaa;****
Number of measurements, BER (current and MIN)	RESULt9	mmmmm;ccccc;lllll;tt
BER (MAX and average), number of BER measurements	RESULtA	hhhhh;aaaaa;nnnnn;**

Meaning of the entries

- `*` Reserved
- `c` Current
- `l` Lowest (MIN)
- `h` Highest (MAX)
- `a` Average
- `o` Bit mask for Pass/Fail results
- `t` Coding of signaling state (see RESULt8 in the following table)
- `u` Units in dBm, µW, mW, W
- `;` Used to separate the string entries from each other.

Resultats of the BURST mask

Result	IEEE-Command	Position in string 01234567890123456789
as in the following section "Results of other masks"	RESULt1 to RESULt9	
a = Level at corner point CP1 b = Level at corner point CP2 c = Level at corner point CP3 d = Level at corner point CP4	RESULtA	aaaaabbbbbccccddddd
e = Level at corner point CP5 f = Level at corner point CP6 g = Level at corner point CP7 h = Level at corner point CP8	RESULtB	eeeeeffffgggggghhhhh
v = Marker position in µs m = Level at marker * = reserved	RESULtC	vvvvv;mmmmm********

The following special values may be returned for the corner points CP1 to CP 8:

`-99.0` The measured value was below –40 dBm

`-----` No burst could be measured. Probably the call dropped.

Results of other masks

Result	IEEE-Command	Position in string 01234567890123456789
a = TX peak power b = TX power-/time template c = SMS/EXT (eg. 10=SMS only, 01=EXT only)	RESULt1	aaaaaaaaaa;bbbb;ccc;
d = RMS phase error e = Peak phase error	RESULt2	ddddddddd;eeeeeeeee;
f = Frequency error g = Burst length * = reserved	RESULt3	fffffffff;ggggggg;***
h = Receiver sensitivity t = Power control level u = Timing advance * = reserved	RESULt4	hhhhhhhh;tt;uu;*****
i = IMSI j = MS Class k = RX Qual	RESULt5	iiiiiiiiiiiiiii;j;k;
l = IMEI m = A5 algorithm (Ciphering), eg. 000=A5/1 only, 110=A5/2 only, 10 A5/3 only	RESULt6	lllllllllllllll;mmm;
n = Dialled number	RESULt7	nnnnnnnnnnnnnnnnnnnn
o = Signaling State tt in RESULt9 IDLE 00 IDLE/PAGING 01 MS CALLING 02 BS CALLING 03 MS CLEARING 04 BS CLEARING 05 CALL ACTIVE 06 CLOSED LOOP 07 ALERTING 08 CALL DROPPED 09 STOPPING 0A p = RX Level q = Rev Lev	RESULt8	oooooooooooooo;pp;q;
r = BER, BERIb or BERII s = Timeslot t = Signaling State (see RESULt8) x = FER * = reserved	RESULt9	rrrrr %;ss;xxxxx;*tt
w-250 = Power dBc at –250 kHz w-200 = Power dBc at –200 kHz w-100 = Power dBc at –y100 kHz	RESULtA	w-250;w-200;w-100;**
000dB = Power dBc at 0 kHz v+100 = Power dBc at 100 kHz v+200 = Power dBc at 200 kHz	RESULtB	000dB;v+100;v+200;**
v+250 = Power dBc at 250 kHz	RESULtC	v+250;**********

; separates the entries from each other.

Basics

This section is a brief introduction to the GSM system. The following points will be looked at:

- Anatomy of a GSM network
- Basic specifications of GSM radiocommunication
- Signaling
- Technical requirements and measured figures

This is as much as can be done at this point, because detailing GSM in full is the work of a lifetime. For interested people who may want to know more than this short overview can present, here is a hint:

☞ A comprehensive, detailed and yet easily understandable introduction to theory and practice of GSM technology is given in the book "Introduction to GSM" by Siegmund Redl, Matthias Weber and Malcolm W. Oliphant, Artech House, Boston, ISBN 0-89006-785-6, available April 1995.

Anatomy of a GSM network

GSM is a cellular network. The cells are theoretically organized in an hexagonal honeycomb structure (**Fig. 10.31). A mobile station (MS), located in any cell of a GSM network, can be called anytime and from anywhere.**

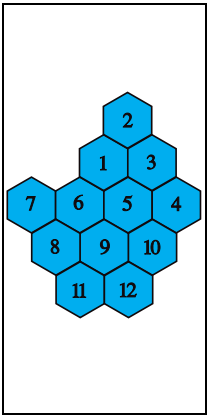


Fig. 10.31: Honeycomb structure of cellular network.

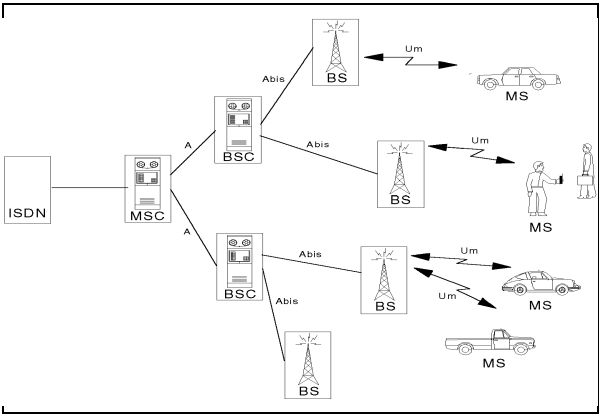


Fig. 10.32: Components in GSM network.

In each cell there is a base station (BS), the link between the wired network and any MS of its cell. The BS talks to the MS over the radio interface (Um interface). There is nothing else very special about it. It finds out what it has to talk about with each MS from its own controlling instance, the BSC, via the Abis interface (cabled).

The base station controller (BSC) coordinates the radio traffic of its BSs with the MSs, assigning traffic channels for instance. On 'the other side' it is connected to the MSC.

The mobile station switching center (MSC) administers all calls in its region, it can handle information about which MSs are located in its region and check their authentication (see below). The MSC is linked to the wired network.

With each call that an MS makes, all the instances (BSs, BSC, MSC) are involved. Going for a call, checking authorization, assigning traffic channels, changing cells – this all requires an intensive exchange of information between each of these instances and the next one up or down. This exchange of information is what is called signaling (see below).

Basic specifications of GSM radiocommunication

Parameter	GSM 900 [1)]	DCS 1800 (PCN)	DCS 1900 (PCS)
Frequency band			
MS → BS (Uplink)	880,2 MHz to 915,0 MHz	1725,2 MHz to 1799,8 MHz	1835,2 MHz to 1894,8 MHz
BS → MS (Downlink)	925,2 MHz to 960,0 MHz	1805,2 MHz to 1879,8 MHz	1930,2 MHz to 1989,8 MHz
Duplex spacing	45 MHz	80 MHz	95 MHz
Channel spacing	200 kHz	200 kHz	200 kHz
Channels	0 to 124 and 975 to 1023	512 to 885	512 to 810
Channel utilization	TDMA (time-division multiple access). A channel is split into eight timeslots. This allows eight calls simultaneously on one frequency.		
Length of timeslot	577 µs. Eight timeslots form a frame (4.615 ms).		
Modulation	GMSK (Gaussian minimum-shift keying). Phase shifts of ±π/2 on symbol transitions.		

[1)] Frequencies and channels of the extended GSM band. In the P-GSM band, only channels 1 to 124 are available (Calculation of frequencies: see page 10-14).

Timeslot and burst

An MS or BS may only transmit data during the timeslot assigned to it. Apart from this it must not emit any power. So it must increase transmitted power very fast (about 30 µs) from zero to nominal. And once it has transmitted data, it must abruptly decrease the power again. This radio pulse is what is called a burst.

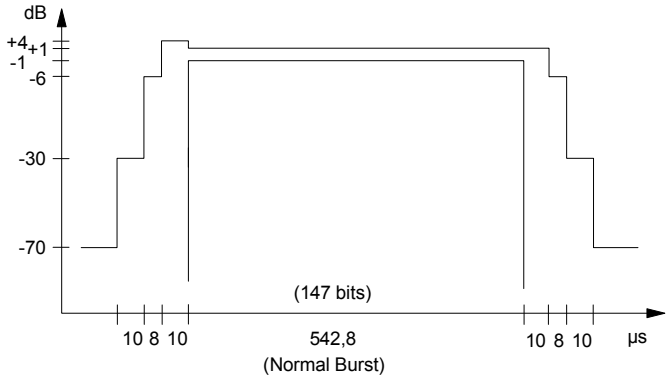


Fig. 10.33: The radiated power must be within the power/time template for the entire duration of a timeslot.

A timeslot transmits 148 bits. 114 of these are useful data. **Fig. 10.34 shows the structure of a frame and timeslot (burst content).**

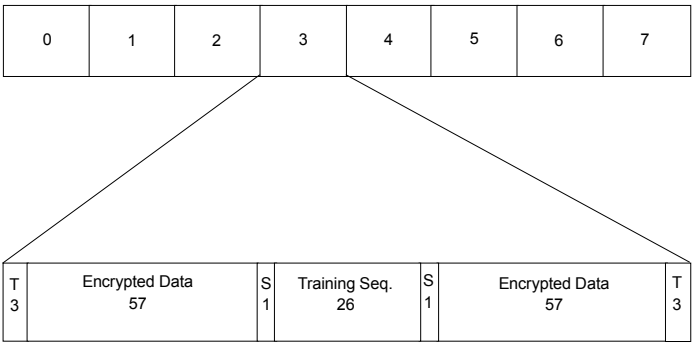


Fig. 10.34: A frame consists of eight timeslots. One burst is accompanied by tail bits (T) and includes stealing flags (S), the training sequence (26 bits) and 114 data bits.

`T` (tail bits)	Bear no information so that no data are lost if the burst does not exactly "catch" the timeslot.
`S` (stealing flag)	Only with bursts in the traffic channel. If the stealing flag is set, the burst will contain no user data but signaling.
`Training Seq.`	A bit sequence known to the transmitter and receiver. The receiver looks for this bit sequence in the burst for synchronization and channel equalization. If it finds it, it can work out exactly where the useful data are in the burst.
`Encrypted data` (data bits)	What is actually to be transmitted in the timeslot. The data are ❍ encrypted to guard against earesdropping (optional), ❍ channel coded so that incorrectly received bits can be corrected.

Signaling

Signaling could be thought of as the red tape in radiocommunication. So it is no wonder if the term strikes you as being somewhat mysterious and obscure. Here is an example to shed some light on the subject.

MS-CALL

A subscriber is called by an MS that is registered. The signaling necessary to set up the call is shown schematically below.

MS BS	Message	Meaning
→	Channel_Request	I want something from you.
←	Immediate_Assignment	Speak out! On channel 44, timeslot 3.
→	Service_Request	I want to make a call.
←	Authentication_Command	The MSC says you must prove your identity. What's the result of authentication procedure x?
→	Authentication_Completed	I'm OK. The answer is 42.
←	Ciphering_Command	Correct. Let's continue speaking encrypted. The parameter for encryption is 12345.
→	Ciphering_Completed	☼■❄▌✧❑❑❄❂❑❄▌✎ Encryption is on.
→	Setup	Dialled number xy.This is what I can do: I can fax, but sorry no half rate.
←	Call_Proceeding	Understood. MSC and the others are trying to get in touch with the person at the other end.
←	Assign_Command	Your TCH is channel 16, full rate.
→	Assign_Completed	Thanks a lot. I told my RF parts.
←	Alert	It's ringing. Wait till he picks up the receiver.
←	Connect	The call is through. Now he's there.
→	Connection_Acknowledged	Thanks. See you at the next measurement report.

☞ The righthand column of the table is a "personalization" of the MS and BS. The numbers that are used are just examples, ie there is no guarantee of correctness.

The signaling in the example is exchanged – in appropriate form – in the MS-CALL test between STABILOCK and the test item.

Technical requirements and measured figures

Radiocommunication in a GSM network is quite different from that in analog networks, so testing is also different. Some of the reasons for this are:

- Because of the GMSK modulation, new ways are needed to measure modulation (phase and frequency error).
- The transmitters do not work continuously but in a burst mode, so the peak power has to be measured.
- All information transmitted is digital. So the signal/noise ratio is no longer a criterion for judging a receiver.
- The software plays an increasingly important role in radiocommunication. Signaling is involved when a call is set up. A test of connection setup also tests the correctness of the software in the MS.

The GSM Specifications say what figures a GSM set must produce for successful type approval.

Phase error Quality feature of modulator.
The peak phase error is the maximum phase error in a burst.
The RMS phase error is the mean phase error for the duration of a burst.
According to GSM Specifications, the maximum phase error must not exceed 20 ° and the mean phase error 5 °.

Frequency error This tells you how well an MS can synchronize to a BS.
The frequency error is computed as the change of the phase error with time.
Example: the phase drifts for the duration of a burst by 2,3 °. So the frequency error is 70 Hz.
GSM Specifications specify a maximum permissible frequency error of 90 Hz.

Transmitted power In GSM the transmitted power is managed in power control levels. An MS in the vicinity of a BS must transmit at lower power than one at the boundary of a cell.
An MS transmits in burst mode, so the peak power is measured. It may not deviate from nominal power by more than 3 dB, and in some power classes by more than 2 dB.

Power/time response

Power/time response is the decisive criterion for interference-free transmission.
According to GSM Specifications the power of an MS must remain precisely within the socalled power/time template. This ensures that the MS does not disturb adjacent time-slots or the transmission power goes down during transmission (**Fig. 10.35).**

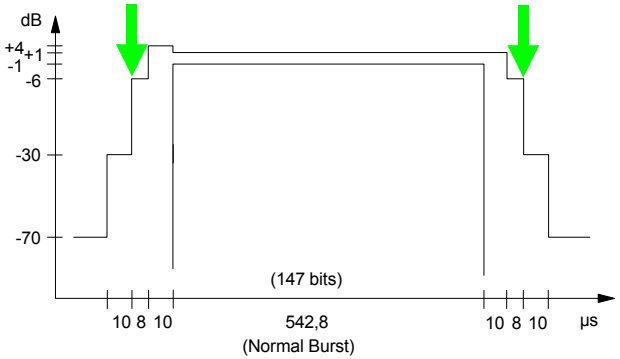


Fig. 10.35: Power/time template of a normal burst. The transmitted power of the MS must be within the template for the entire duration. Burst length is the time, while the signal is above –6 dB (arrows).

Receiver tests

Signals are transmitted in digital form, so SINAD measurement has to be replaced by something else. One way of testing the quality of a receiver is to measure bit error rate (BER). This computes the proportion of incorrectly transmitted bits among all bits transmitted in percent.
Permissible bit error rates are defined in the GSM Specifications.

BER in STABILOCK

The bit error rate is the amount of "falsely" interpreted bits in relation to all transmitted bits of the tested class. STABILOCK measures the bit error rate of all bits as well as the classes Ib and II. R stands for "residual". Here, only those bits count as transmitted, that are not contained in falsely interpreted (and thus invalid) frames.

Receiver sensitivity

The sensitivity of an MS receiver is also measured indirectly. You send the MS a message to which it must reply in a certain way. If the answer comes back, the MS has most likely received the message correctly. If the message is transmitted at different levels, the sensitivity is the lowest level at which the MS can still reply. STABILOCK uses paging messages and checks for channel requests (random access bursts).

Appendix

Ordering information and equipment supplied

248 274 GSM Package. This option consists of:	
253 001 GSM Unit	for slots 5+6
229 063 Duplex Meter DAMPS	GSM duplex module
860 185	GSM test plug in SIM card
860 184	GSM test SIM card
248 297 GSM/PCN/PCS option. This option consists of:	
248 297	FEX RF frequency expansion 2.3 GHz
248 274	GSM package
897 912 Memory card	Software GSM/DCS 1800/1900 MS-Test
248 322 Upgrade from 248 297 to Cross-band:	
No new parts are delivered. The upgrade is done in the factory.	
Additional software options	
897 078 GSM MS-Test AUTORUN	memory card for automatic tests (AUTORUN program)

Device data

Hardware interfaces on back panel	
The hardware interfaces are not supported by the software of the GSM/DCS option!	
IF input (Bu 103)	R_i approx. 2.8 kΩ, ±12 V (connection to IF stage)
AF input (Bu 104)	R_i approx. 1 kΩ, ±5 V
synchr. input (Bu 107)	TTL
synchr. output (Bu 108)	TTL
Socket Bu 106, sub D, 25 pins	
Ext TX anal I/Q inputs (pins 1+2)	R_i approx. 1 kΩ, ±5 V
TX demod I/Q outputs (pins 7+8)	load > 5 kΩ, ±5 V
RX mod I/Q outputs (pins 13+14)	load > 5 kΩ, 2.5 V_{dc}, 5 V_{pp}
Ext RX anal I/Q inputs (pins 15+16)	R_i approx. 1 kΩ, +2.5 V_{dc}, 5 V_{pp}
RX mod I/Q outputs (pins 18+19)	load > 5 kΩ, 2.5 V_{dc}, 5 V_{pp}
Power supply (pin 21)	+5 V, max. 50 mA
Power supply (pin 23)	+15 V, max. 50 mA
Power supply (pin 25)	–15 V, max. 50 mA
Ground (pins 3,4,5,6,9,10,11,12,17,20,22,24)	
Socket Bu 105, sub D, 9 pins	
RS232 interface	pin1 DCD, pin 2 RXD, pin 3 TXD, pin 4 DTR, pin 5 Gnd, pin 7 RTS, pin 8 CTS, pin 6,9 free

RS-232-C interface

The GSM module has a fully functional RS-232-C interface (socket Bu 105).

Requirements for operation

The RS-232-C interface of the GSM module will only work if your Communication Test Set satisfies the following requirements:

STABILOCK 4031	HOST-MCU ≥ 3.832
STABILOCK 4032	HOST-MCU ≥ 5.032
RS-232 driver software	DIG-MCU ≥ 1.20

If the STATUS mask (called up with [AUX]+[DEF.PAR]+[STATUS]) shows an older status, a software update will be necessary.

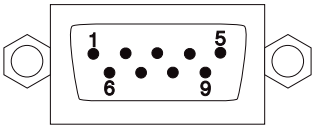
☞ **Do not start the GSM MS-Test system program:** the RS-232-C interface of the GSM module will *not* work properly if the GSM MS-Test system program is called up at the same time.

Control commands and transmission protocol

The RS-232-C interface of the GSM module offers exactly the same functions as the RS-232-C interface of the hardware option "RS-232/Centronics Interface". All control commands for the interface are explained in Chapter 8 under the IEEE section "Special commands". Setting the transmission protocol (baud rate, number of data bits, parity, handshake, etc) is explained in Chapter 4, section "General Parameters".

Special features Special operating parameters for the RS-232-C interface are normally assigned with the commands WRITE[3000...] or SLAVE3000... (see Chapter 8). Replace control sequence 3000 by control sequence **2010** if you want to assign the RS-232-C interface of the GSM module special operating parameters.
Example: not WRITE[300012...] but WRITE[201012...].

Pinning of RS-232-C interface



Bu 105					
Pin 1	=	DCD	Pin 5	=	GND
Pin 2	=	RXD	Pin 6	=	nc
Pin 3	=	TXD	Pin 7	=	RTS
Pin 4	=	DTR	Pin 8	=	CTS
			Pin 9	=	nc

Troubleshooting

In case you encounter a problem: this problem might be contained in the following table. If it is not, please tell us. We will then enclose this problem into the next manual version.

Problem	Possible reason	Remedy
1. MS receives a too weak signal.	RF input of MS is connected to RF socket, but signal path RF-DIR is activated.	Switch signal path to RF.
2. MS does not find a BCCH.		
MS does not respond in a TX test (of RACH bursts), in a RX test, or BS-CALL.	Instead of one of the delivered SIM cards, a different one is used.	Use a SIM card delivered with the GSM option for the test or register foreign SIM card by using MS-CALL. Select MCC=001 and MNC=01 on the mobile.
MS cannot find a network.	1. MS did not register or tries a location update.	Perform MS-CALL to register MS. Select MCC=001 and MNC=01 on the mobile.
	2. Wrong network selected.	Select the correct network in the `Default Parameters` mask.
SIM-Card is locked.	Wrong PIN was entered three times consecutively.	Enter PUK (Personal unblocking key), it is 76543210 for the SIM cards you got with the GSM option.
`Peak Pwr` output field displays ----- during peak power measurement.	Level is smaller than 20 dBm.	Perform a sample measurement: Set `MS Power` entry field to 25 dBm, wait for the measuring result, and reset `MS Power` to previous value.
RX-SENS test result is too low.	The MS registered or tries to register into another cell. It might be a real network or a STABILOCK standing nearby.	Switch off the other STABILOCK.
STABILOCK cannot receive the MS signal.	Start channel is not assigned the correct frequency.	Assign the channel in the `DEF. PAR` mask.

Test result display

In the output fields for the test results there are sometimes special entries, the meaning of which is described here.

`----`	The value has not been measured, or the measured value is below the measuring range (signal too small, underflow), or (in the Peak Power output field) no sample measurement has been made yet.
`>>>>`	The measured value is above the measuring range (overflow).
`<<<<`	The measured value is below the measuring range (underflow).
`!`	The measured value may be inaccurate, if the RX level at BS Pwr is greater than –60 dBm.
`?`	The measured value is exact, but the training sequence has not been detected, so the measured value is possibly not according to the GSM Specifications.

Timeline

The chronological timeline tells you what modifications have been made to the software (SW) and the operating instructions. After a software update the timeline helps you to find out quickly about all major changes (see code) in the updated operating instructions that are supplied.

Code: C = Correction, IN = Important Note, NF = New Feature

SW	Doc. Version	Δ pages	Code	Changes
1.00	9311-100-A	no	–	First documentation.
2.10	9406-210-A	all	NF	Extended test facilities.
3.00	9412-300-A	10-8	NF	Using of foreign SIM cards possible.
		10-12	NF	Measuring of unsynchronous bursts possible.
		10-13	NF	Measuring of frequency error possible.
		10-16	NF	Now with ZOOM function.
		10-17	NF	Phase/Modulation graphs.
		10-24	NF	Now with BER test.
		10-49	NF	Description of RS-232 interface.
	9502-300-B	10-8	C	Ch. 1: Check assignment to 935.2 MHz before testing.
		10-28	NF	Checking the mobiles ringing via SRQ mask.
3.01	9506-301-A	10-10, 10-11, 10-42	C	Neighbouring cells omitted.
4.00	9509-400-A	all	NF	Name changed to GSM / DCS MS-Test. Ordering code changed to 897 912. Software now supports GSM 900, DCS 1800 and DCS 1900 mobiles.
4.10	9603-410-A	some	NF	Corner points and GSM/DCS Microcell added.
4.11	9605-411-A	no	C	Default DC and IQ offset were changed.
4.20	9612-420-A	10-5	NF	Adapted to new features.
		10-20	NF	Marker in Burst mask.
		10-28	NF	Audio test now also includes RMS measurement.
		10-32	NF	BER measurement now tests all bit classes.
		10-40	NF	FER measurement available via GPIB.
4.30	9707-430-A	no	C	IMEI field now always cleared in idle state.
4.31	9803-431-A	no	C	Bug fixes.
5.00	9808-500-A	all	NF	Cross-band capability added.
	0002-500-A	10-1	C	Renaming of GSM/DCS to GSM