
Measurements on GSM Base Stations According to Rec. 11.20

Application Note 1EF23_0L

Subject to change

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Products:

FSE incl. Option FSE-B7



ROHDE & SCHWARZ

1 Introduction

The following application note describes the function and operation of user menus for FSE Spectrum Analyzers including option Vector Signal Analysis (FSE-B7). For measurements according to the GSM standard user menus are provided, which perform settings on FSE for Base Station testing required in the standard. The menu and the accompanying setups are stored on a floppy disk.

For operation of the menus firmware version 1.40 or higher is required.

Option Vector Signal Analysis FSE-B7 has to be installed for the use of the application menu.

The floppy disk for the user menus contains the following directories:

Drive	Directory	Contents
A:\		Settings for FSE incl. limit lines

2 Installation

Operation from floppy disk

Insert the floppy disk into drive A: of the FSE.

Load the softkey menu according the following steps:

- **RECALL:** EDIT PATH: A:\
- **SELECT ITEMS TO RECALL:** SELECT ALL ITEMS: ↑
- **DATA SET LIST:** {Select GSM_MAC in table}: **ENTER**
- {The filename GSM_MAC is entered into the input box}: Press **ENTER**
- **DATA SET LIST:** {Select GSM_MAC1 in table}: **ENTER**
- {The filename GSM_MAC1 is entered into the input box}: Press **ENTER**
- **DATA SET LIST:** {Select GSM_MAC2 in table}: **ENTER**
- {The filename GSM_MAC2 is entered into the input box}: Press **ENTER**

Operation from internal harddisk

(recommended, when Computer Function FSE-B15 has been installed)

- Switch over to computer function [ALT + SysReq] on external keyboard.
- Create GSM_BTS directory under C:\user\config directory: *md GSM_BTS*

- Copy files to c:\config\user\GSM_BTS directory:

```
copy a:\*. * c:\user\ config\GSM_BTS
```

Load the Softkey Menu according the following steps:

- **RECALL:** EDIT PATH: c:\ user \config\ GSM_BTS **ENTER**
- **SELECT ITEMS TO RECALL:** ENABLE ALL ITEMS: ↑
- **DATA SET LIST:** {Select GSM_MAC in table}: **ENTER**
- {The filename GSM_MAC is entered into the input box}: Press **ENTER**
- **DATA SET LIST:** {Select GSM_MAC1 in table}: **ENTER**
- {The filename GSM_MAC1 is entered into the input box}: Press **ENTER**
- **DATA SET LIST:** {Select GSM_MAC2 in table}: **ENTER**
- {The filename GSM_MAC2 is entered into the input box}: Press **ENTER**

Operation of the USER menu:

When pressing the USER key the following menu appears:

USER MENU	File for setting
GSM BTS PHAS_ERR	GSM_PHAS
PWR/TIME MEAN PWR	GSM_POW
PWR/TIME SA MODE	GSM_PWTS
TRANSIEN SPECTRUM	GSM_TSP
MODULAT SPECTRUM	GSM_MOD
SPURIOUS TRANSM_BD	GSM_SPUN
SPURIOUS WIDE	GSM_SPUW
DEFINE MACRO ↓	

Each menu recalls settings for the specific measurement. When the menu is operated from floppy disk the settings are downloaded from the floppy disk in drive A. Therefore the floppy must remain in drive A: when the GSM user menu is used.

After recalling a test setting, all parameters for the measurement can be changed manually. Normally the center frequency and the level settings required will be different from the settings stored.

If settings different from the supplied values are needed, they can be updated by storing the changed settings on disk according to the following procedure:

- Recall the setting to be changed using the specific softkey in the user menu.
- Change parameters eg CENTER, REF LEVEL, MARKER, ...

IMPORTANT:

- **SAVE: SELECT ITEMS TO SAVE: DISABLE ALL ITEMS: ENTER**
Afterwards switch on *HW SETTINGS* and *LINES*:
HW SETTINGS: ENTER
LINES: ENTER
- **SAVE: {the name for the specific file has been already entered in the input box}: ENTER**

- The new settings are stored on floppy in drive A or on internal harddisk depending on the path specified.

Warning: If changed settings are stored, the supplied default settings are lost and cannot be recovered. It is recommended to operate the FSE with a copy of the original disk.

Macros may be destroyed if SELECT ITEMS TO SAVE is not set correctly.

3 Measurement of Phase Error

GSM BTS
PHAS_ERR

With GSM BTS the phase error (PHAS_ERR) versus time is displayed on screen A and for level adjustment the burst is displayed on screen B. The peak and rms phase error are output on screen A using the modulation marker.

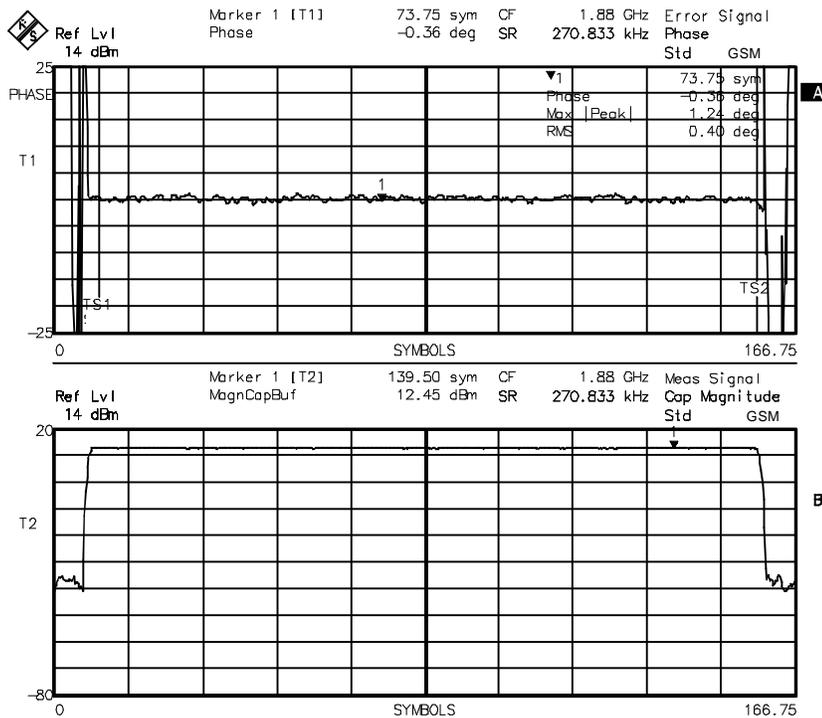


Fig 1 Display of GSM phase error measurement

Following steps have to be carried out to perform the measurement:

- Set the center frequency to the transmit channel
[CENTER: {xxx.x}: MHz]
- Adjust the level settings of the FSE so that the signal level is about 3 dB below reference level on screen B. **[REF LEVEL: {Input Ref Level = signal level + 3 dB}: dBm]**
If the signal level is too high, OVLD is output

on the screen, if the signal level is too low, UNLD is displayed.

- For triggering, the midamble of the burst is used. The default setting for the midamble is GSM_BTS0. If the signal contains a different midamble, select the appropriate by [TRIGGER: SYNC SEQUENCE: {select the appropriate midamble (GSM_BTS0 to GSM_BTS7) in table}: ENTER] If the burst contains no midamble, switch off synchronization to midamble [TRIGGER: SYNC SEARCH OFF].
- When the reference level is set properly, screen B can be switched over to Symbol Table/Error Summary in order to get the numbered values of all modulation errors: [TRACE 2: MODE: MEAS RESULT: ERR SUM/SYMB TABLE]. The limits for error calculation in screen B have to be set by switching on the limit search function in the marker menu: [MARKER SEARCH: SEARCH LIM ON].

4 Measurement of the Power / Time Template and the Mean Power

The measurement of power versus time can be performed in analyzer mode (PWR/TIME) or in vector analyzer mode (PWR/TIME MEAN PWR).

In the analyzer mode the highest dynamic range is attained. In vector analyzer mode the FSE offers best time accuracy due to the synchronization to the midamble. With both modes, limit lines for base stations according to the standard are output on the screen.

4.1 Measurement in Vector Analyzer Mode

PWR/TIME
MEAN PWR

The softkey PWR/TIME MEAN PWR recalls the settings for measurement of the burst timing and power measurement. The FSE is switched to split-screen display. In screen A the burst timing is shown with the limit lines according to the standard. In screen B the Symbol Table / Error Summary is output. That way burst timing and modulation errors can be readout with a single measurement.

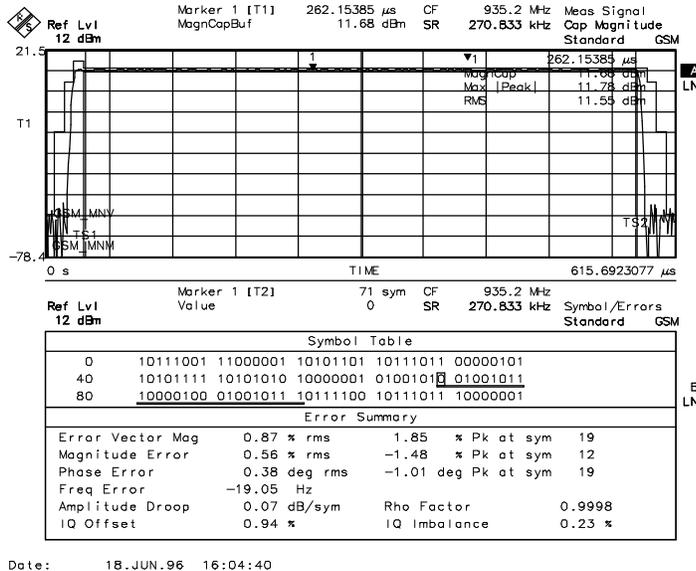


Fig 2 Display for power vs. time measurement in vector analyzer mode

Following steps have to be carried out to complete the settings for a specific signal:

- Set the center frequency to the transmit channel [CENTER: {xxx.x}: MHz]

- Adjust the level settings of the FSE so that the signal level is about 3 dB below reference level.

[REF LEVEL: {Input Ref Level = signal level + 3 dB}: dBm]

If the signal level is too high, OVLD is output on screen, if the signal level is too low, UNLD is displayed.

- Adjust vertical scaling of the display
[RANGE: REF VALUE Y AXIS: {Ref Level -3 dB}: ENTER]
- For triggering the midamble of the burst is used. The default setting for the midamble is GSM_BTS0. If the signal contains a different midamble, select the appropriate by [TRIGGER: SYNC PATTERN: SELECT PATTERN: {select the appropriate midamble (GSM_BTS0 to GSM_BTS7) in table}: ENTER]

If the burst contains no midamble, switch off synchronization to midamble:

[TRIGGER: SYNC SEARCH OFF].

Note: If the message 'Sync not found' is output on the screen, the FSE centers the burst on the middle of the screen. The exact timing referred to the limit lines is lost in this case.

- Normally the ± 1 -dB tolerance on top of the limit lines does not fit to the burst level measured. The limit line can be shifted on level axis for this purpose.

- [LIMITS: Y OFFSET: {Change the offset via the keypad in order to shift the limit lines; positive offset shifts the limit lines upwards, negative offset downwards}: ENTER]

- Resolution of level axis can be increased by changing the Y per div value:
[RANGE: Y PER DIV: {xx}: dB]

- To check the rising slope of the burst simply change with [MODE: MEAS RESULT: RESULT LENGTH: 20 SYMBOLS: ENTER]

- To check the falling slope of the burst additionally set:
[TRIGGER: SYNC OFFSET: -76 SYMBOLS: ENTER]

[LIMITS: X-OFFSET: -238 μ s]

4.2 Measurement in Spectrum Analyzer Mode

In the analyzer mode the FSE attains the highest dynamic range for burst measurement (>85 dB). Therefore measurement can be carried out with 1-MHz resolution bandwidth. But it is not able to synchronize on data patterns within the signal. Triggering is performed via the video trigger according to the best fitting method.

PWR/TIME

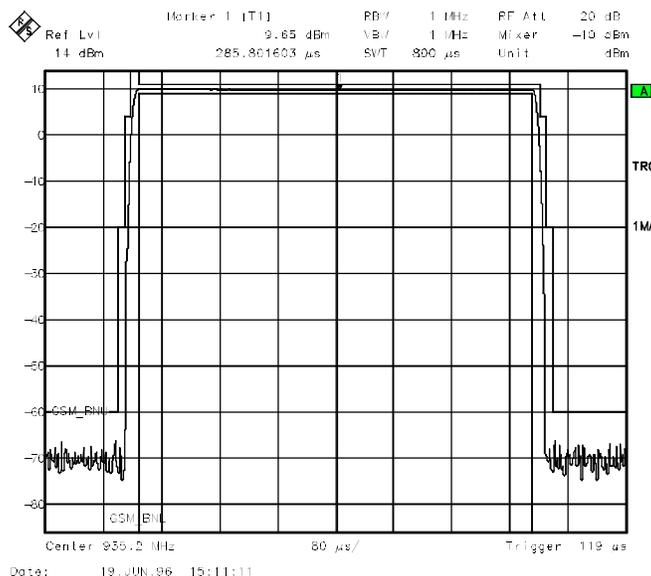


Fig 3 Measurement of power time template in spectrum analyzer mode

Following steps have to be carried out to complete the settings for a specific signal:

- Set the center frequency to the transmit channel
[TRACE1: CENTER: {xxx.x}: MHz]

- Set reference level to expected signal power + 6 dB
[TRACE1: REF: {signal power + 6 dB}: dB]
- The settings recalled by the softkey PWR/TIME SA_MODE provide a raw trigger-

ing using the video trigger in connection with the pretrigger.

To fit the trace measured to the limit mask first the level has to be set properly. Best procedure is to change the reference level, ie to shift the trace in the Y direction until it is in the middle of the ± 1 -dB limit on top of the mask.

REF: {Change Ref Lvl according to the mask via keypad}: **dBm**

- To fit the limit line to the trace in the time axis the limit line has to be shifted:

LIMITS:X OFFSET: {Shift the limit line in the x axis using the tuning knob}

Hint: If the trigger level causes time jitter of the burst, ie. the rising ramp of the burst is not stable at the trigger level, it may be appropriate to change the trigger level.

5 Measurement of the Transient Spectrum

TRANSIEN SPECTRUM

With the softkey TRANSIEN SPECTRUM, settings for the transient spectrum test are activated. The transient spectrum is measured in analyzer mode using the bandwidth settings according to the standard. The limit in the standard is given in relative values (dB) referred to the maximum BTS peak power, but the power level of -36 dBm shall not be exceeded. The supplied limit line are valid for all power levels.

Performing the measurement:

- Adjust center frequency: [**CENTER:** {input center frequency}]: **MHz**.
- Set reference level: [**REF:** {input reference level = signal level + 3 dB}].
The shown spectrum should be slightly below the center of the limit line. Make a fine adjustment of the reference level with the knob.
- To achieve maximum noise performance it may be necessary (dependent on signal level) to overdrive the FSE by 10 dB:
[REF: {input reference level = old reference level - 10 dB}]

Shift Limit Line by 10 dB:

[LIMITS:Y_OFFSET {old Y-OFFSET + 10 dB} dB}]

6 Measurement of Spectrum due to Modulation

MODULAT SPECTRUM

Spectrum due to modulation is measured using the gated sweep function. The FSE sweeps only from 50 % to 90 % of the burst. The midamble is excluded. Gating can be performed using an external gate derived from the device under test or by using the internal RF power trigger.

Note: With instruments delivered until June 96 trigger level for RF power trigger is about -4 dBm mixer level, ie. always above the reference level. Instruments delivered from June 1996 provide a trigger level of about -20 dBm mixer level, ie. 10 dB below reference level, when -10 dBm mixer level is set. Older instrument can be modified.

With -20 dBm RF power trigger level, the use of the internal trigger is recommended as no additional means are needed to provide a trigger.

The default settings use the internal power gate. The gated sweep parameters are set correctly in this case.

When an external gate is used it has to be connected to the input TRIGGER/GATE at the rear panel of the FSE.

The settings for the gated sweep have to be adjusted according to the external gate available.

To set gate length and gate delay, zero span setting is recommended. The gate delay and the gate lengths are shown on display as vertical lines.

- Switch the span to zero: [**SPAN:** ZEROSPAN]
- Attention: With the preset RMS-Detector Sweep Time in Zero Span is limited to min. 5 ms. Set Max PK Detector when adjusting the Gate Settings:
[TRACE 1: DETECTOR:MAX PK]
- Set the parameters for gated sweep:
[SWEEP: EXT GATE SETTINGS: GATE EXTERN: GATE LEVEL: {input the gate level available}: **GATE MODE EDGE: GATE POL POS or NEG** (depends on gate source available): **GATE LENGTH:** {214 μ s}: **GATE DELAY:** {tune the sweep time (= time between the two vertical lines on screen) to the 2nd half of a burst}: **↑** (menu up): **SPAN: LAST SPAN: SWEEP: EXT GATE ON]**
- Switch on RMS Detector again:
[TRACE 1: DETECTOR:RMS]

The limit line in the settings supplied is valid for 39 dBm output power. If the spectrum at a different power level has to be tested, the limit line can be exchanged.

- Select the appropriate limit line:
[LIMITS: {select the appropriate limit line from limit line table using the cursor}:
ENTER]. The limit line switched on is marked with \surd .
Switch off the default limit line GS1_MB39:
[{select the limit line GS1_MB39}: ENTER]

Following limit lines are supplied for the modulation spectrum:

Name	Output power level
GS1_MB43	≥ 43 dBm
GS1_MB41	41 dBm
GS1_MB39	39 dBm
GS1_MB37	37 dBm
GS1_MB35	35 dBm
GS1_MB33	≤ 33 dBm

Note: The Limits are relative to the power measured with RBW 30 kHz.

Performing the measurement:

- Adjust center frequency: [CENTER: {input center frequency}: MHz].
- Set reference level: [REF: {input reference level} » signal level + 3 dB].
- To fit the limit line to the trace measured, limit line can be shifted in the Y direction by giving it an offset:
LIMIT: Y OFFSET: {shift limit line eg via tuning knob so that top of limit line is slightly above maximum level of trace displayed}.

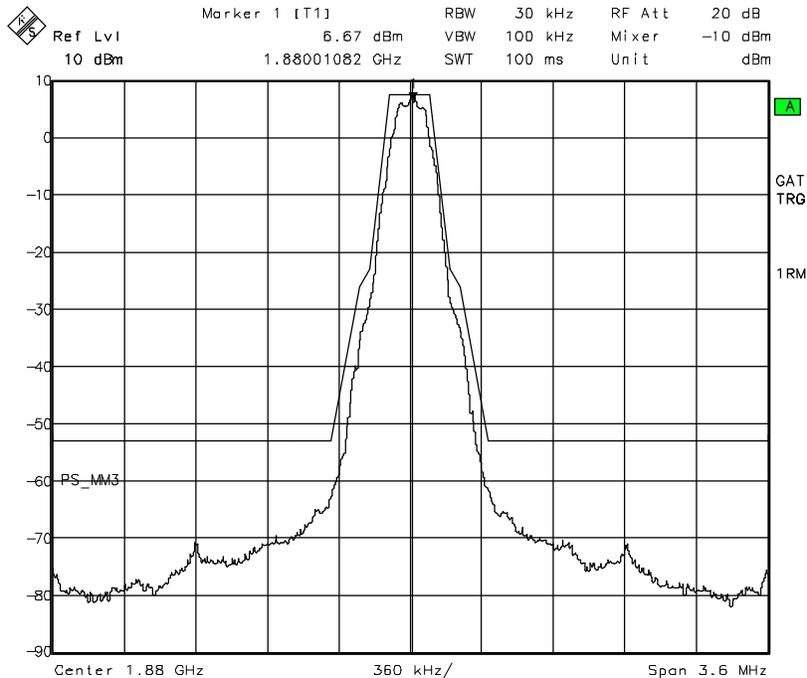


Fig 4 Spectrum due to modulation measured with the rms detector

For measurement in the default setting, the rms detector is used. For spectrum analyzers which do not provide an rms detector, use the sample detector and average the trace to attain a stable test result. With the rms detector averaging is not necessary as each frequency point on the screen is the rms value of all samples represented by the point. When sweep time is increased, also the number of samples for rms calculation is increa-

sed. Generally, measurement is much faster than with the sample detector. The reason is that due to the limited number of pixels in the frequency axis with the sample detector most measurement values are discarded and only a few are displayed. Only the displayed ones are averaged. The limited resolution of the rms detector at low levels (< -70 dB) can be overcome by averaging over different sweeps. But the number of aver-

ages needed is much lower as with the sample detector. Sliding average over 10 traces is sufficient (average sweep count = 0). The difference can be seen clearly when switching over to sample detector [TRACE1: DETECTOR: SAMPLE].

7 Measurement of Spurious in Transmit Band

SPURIOUS
TRANS_BD

Spurious in the transmit band 935 - 960 MHz have to be tested. Different bandwidth settings have to be used depending on the offset from the carrier.

The following settings of the resolution bandwidth (RBW) and video bandwidth (VBW) dependent on carrier offset are required:

carrier offset:	RBW	VBW
>600 kHz to 1.8 MHz:	10 kHz	30 kHz,
>1.8 MHz to 6 MHz:	30 kHz	100kHz,
>6 MHz up to the band limits:	100 kHz	300kHz

The supplied settings use the bandwidths required for carrier offsets > 6 MHz (RBW = 100 kHz, VBW = 300 kHz).

Test procedure:

- Set reference level: [REF: {input reference level} » signal level + 3 dB].
- To fit the limit line to the transmit channel it has to be shifted in the frequency axis. In the supplied default setting it is centered at channel No. 1 at 935.2 MHz with the appropriate offset of -12.3 MHz.(= 935.2 - center frequency: 947.5MHz)
According to the channel to be tested a different X offset has to be defined:
LIMITS: X OFFSET: {input appropriate X offset}
Example: Transmit channel 124
(935 + 0.2 * 124= 959.8 MHz):
Offset = 959.8 MHz - center frequency: 947.5 MHz = 12.3 MHz.
- The required bandwidths settings for carrier offset < 6 MHz are:
carrier offset: >1.8 MHz - 6 MHz:
Set the required bandwidth:
[COUPLING: RBW MANUAL: {30} kHz: VBW MANUAL: {100} kHz]
carrier offset >600 kHz - 1.8 MHz:
Set the required bandwidths:
[COUPLING: RBW MANUAL: {10} kHz: VBW MANUAL: {30} kHz]

8 Measurement of Spurious in Complete Band (without RX Band)

SPURIOUS
WIDE

Spurious have to be tested according to GSM 11.20 from 30 MHz to 12.75 GHz. Different bandwidths have to be used in the individual frequency ranges as follows:

Frequency range	RBW	VBW
30 to 890 MHz	3 MHz	3 MHz
890 to 915 MHz*)	1 MHz	1 MHz
915 to 925 MHz	300 kHz	1 MHz
925 to 930 MHz	100 kHz	300 kHz
930 to 933 MHz	30 kHz	100 kHz
TX Band	—	—
962 to 965 MHz	30 kHz	100 kHz
965 to 970 MHz	100 kHz	300 kHz
970 to 980 MHz	300 kHz	1 MHz
980 to 990 MHz	1 MHz	3 MHz
990 MHz to 12.75 GHz	3 MHz	3 MHz

*)For RX band separate setting necessary

In default settings provided by the function SPURIOUS WIDE the FSE shows the complete frequency range (dependent on model of FSE). For the measurement 1-MHz resolution bandwidth is used. To adopt the FSE to the different frequency bands following steps are required:

- Set start frequency and stop frequency according to the table above:
[START: {xxx} MHz: STOP: {yyy} MHz].
- Set reference level: [REF: REF LEVEL: {signal level + 3 dB}].
- Set RBW and VBW according to the table above: [COUPLING: RBW MANUAL: {nm} MHz : VBW MANUAL: {mm} MHz]

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