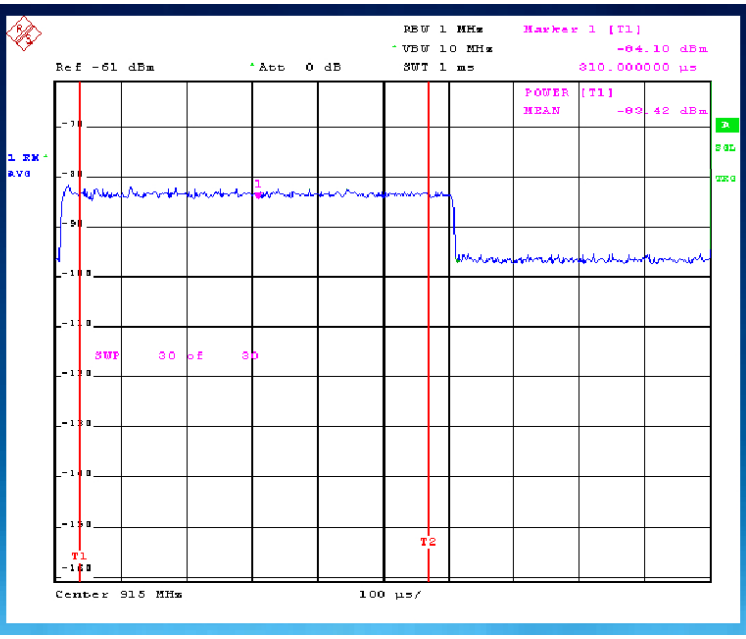

Products: FSP, FSE, FSIQ, ESI, FS-K3

Noise Figure Measurements on Amplifiers in Pulsed Mode

Application Note

Power amplifiers in digital TDMA mobile phones are fed with current only during the active slot to save power. Using conventional measuring equipment, the noise figure, an important parameter in power amplifiers, can only be determined with the amplifier in continuous operation. However, continuous operation can lead to amplifier overload and produce distorted results. Now there is a convenient way of determining the noise figure of amplifiers with pulsed power supply: using a Spectrum Analyzer (FSP or FSE or FSIQ or ESI), Noise Measurement Software FS-K3 and a function or pulse generator.

ROHDE&SCHWARZ

Subject to change – Minihold 12/2000 – 1MA32_0E

Contents

1 Overview

Power amplifiers in digital TDMA mobile phones are fed with current only during the active slot to save power. The bias voltage of the amplifier is applied in pulsed form, for GSM with a pulse width of about 1/8 of the total period of 4.615 ms. Using conventional measuring equipment, the noise figure, an important parameter in power amplifiers, can only be determined with the amplifier in continuous operation. However, continuous operation can lead to amplifier overload and produce distorted results. Now there is a convenient way of determining the noise figure of amplifiers with pulsed power supply: using a Spectrum Analyzer (FSP or FSE or FSIQ or ESI), Noise Measurement Software FS-K3 and a function or pulse generator.

2 Principle of Operation

Noise Measurement Software FS-K3 determines the noise figure at each frequency point in zero span mode. The noise source is switched on and off at every point and the average power measured by the analyzer. From the average values obtained, the software calculates the noise figure and the gain.

To determine the noise figure of an amplifier for a given part of a periodic pulse, the analyzer needs a corresponding periodic trigger signal. The active phase of the amplifier can be displayed, starting from the lefthand edge of the analyzer screen, by setting an appropriate sweep time (1 ms for GSM applications) and a suitable trigger offset. Now the search limits have to be activated and set so that only the trace section representing the active phase of the amplifier is used for calculating the average power and thus the noise figure. This is illustrated by Fig. 1.

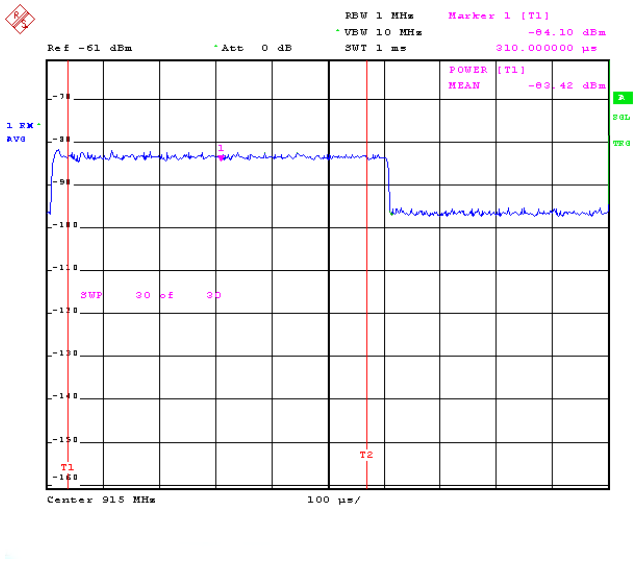

Fig. 1: Correct trigger setting and setting the required trace sectionusing search limit lines (T1, T2)

3 Test Setup

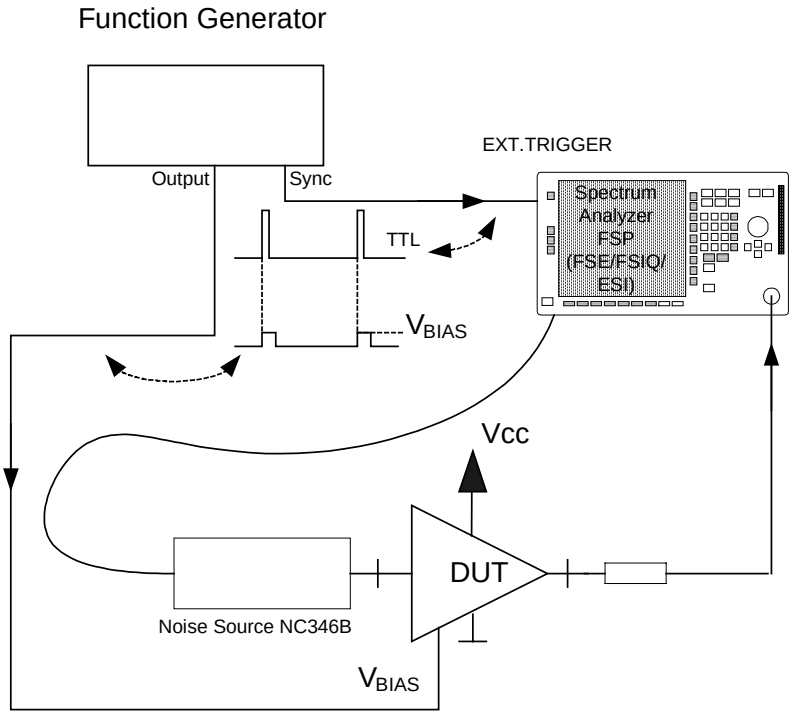

Fig. 2: Test setup for determining the noise figure of an amplifierin pulsed mode

The bias input of the amplifier under test is driven by a function or pulse generator. The pulse width and repetition period are set for the standard being tested, e.g. 577 µs or 4.615 ms for GSM. The pulse amplitude is set depending on the bias voltage so that the required current flows in the amplifier under test.

The external trigger input of the analyzer is driven by a TTL pulse from the function generator, from the sync or trigger output, which is synchronous to the pulse applied to the amplifier. This synchronizes the pickup of measured values with the switch-on phase of the amplifier under test.

The noise source is connected to the noise source output of the analyzer. The output signal of the noise source drives the input of the amplifier under test. It is advisable to terminate the amplifier output with a power attenuator (6 dB attenuation) that matches the output power capacity of the amplifier to protect the RF input of the analyzer.

4 Setting of Parameters

FS-K3 is set up as for conventional noise measurement, with only a few very small changes to the defaults in the *DEVICE* menu to set the analyzer up for noise figure measurement. See Fig. 2.

Presettings of FS-K3 Noise Measurement Software

- *INIT BEFORE MEASUREMENT* must be switched off.
- Set the *Sweep Time* to a suitable value (about twice the length of the active time slot). In the example given in Fig. 2, a sweep time of 1 ms has been selected to match the slot length of 577 µs (1 ms is the shortest sweep time selectable with FS-K3). If shorter sweep times are needed, they can be set by hand directly on FSP (FSE/FSIQ/ESI).
- To achieve reproducible results, taking into account the relatively short sweep time for pulsed signals, a sufficient number of sweeps have to be averaged. About 30 is usually sufficient for FSP, which uses an RMS detector. For an FSE/FSIQ/ESI, which all use a sample detector, the average number has to be increased (e.g. 100 for 1 ms sweep time).
- Only for FSE (FSIQ/ESI): Set the video bandwidth to 1 MHz (deviating from the default setting of 100 Hz) to avoid any problems during settling of the pulsed signals.
- Click the *INIT* button once, then make the following manual settings on FSP or FSE/FSIQ/ESI:

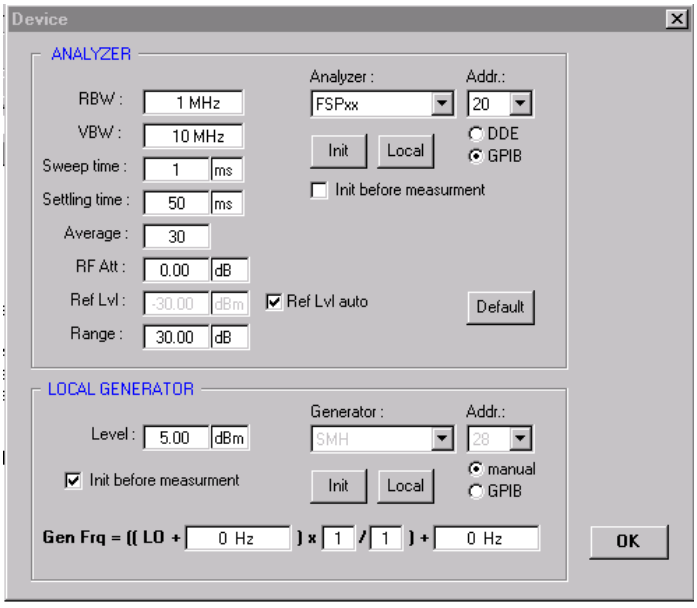

Fig. 2: Setup of FSP with FS-K3 Noise Measurement Software

Presettings on FSP

- Key ***TRIG***:*EXTERN*: Set the trigger offset so that the switching pulse (bias ON) just appears on the screen.
- Key ***MEAS***: *TIME DOMAIN:SEARCH LIMITS ON*

Set *START LIMIT* to the start of the pulse and *STOP LIMIT* to the end of the pulse (see Fig. 1).

This ensures that only the trace section representing the active phase of the amplifier will be evaluated.

Presettings on FSE/FSIQ/ESI

- Key ***TRIG***:*EXTERN*: Set the trigger offset so that the switching pulse (bias ON) just appears on the screen.
- Key ***MARKER SEARCH***:*SEARCH LIMITS ON:*
- Key ***LINES***: Set *TIME LINE 1* to the start of the pulse and *TIME LINE 2* to the end of the pulse.

5 Measurement

Further operation as well as graphical or tabular output of results with Noise Measurement Software FS-K3 are the same as with conventional measurements.

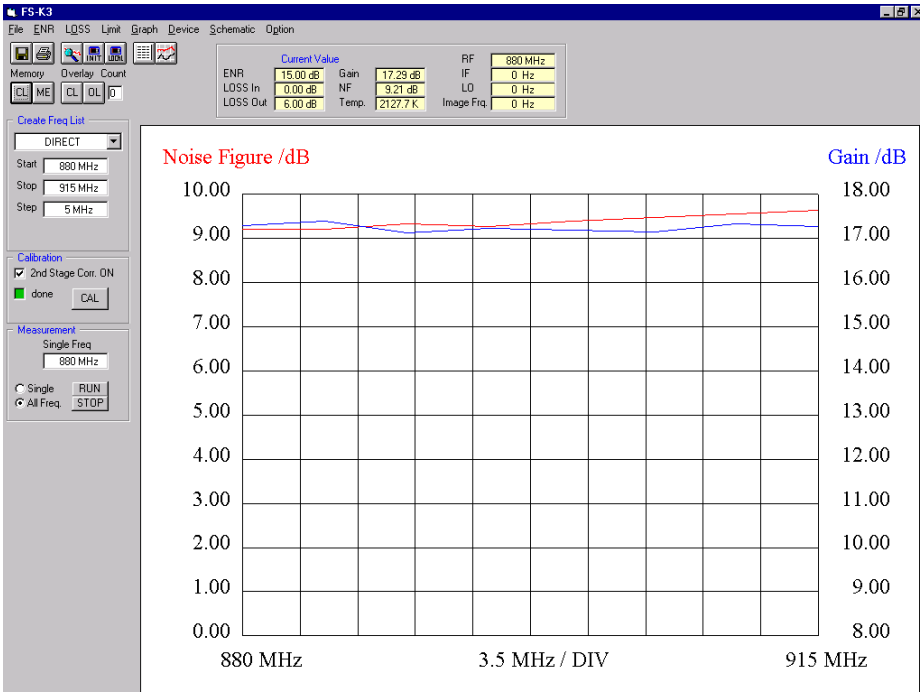

Fig. 4: User interface and graphical display of results with Noise Measurement Software FS-K3

6 References

Data sheet PD757.2380.12 for Noise Measurement Software FS-K3

Noise Measurement Software FS-K3, News from Rohde & Schwarz No. 168

7 Ordering Information

Spectrum Analyzer		
FSP3/7/13/30	9 kHz to 3/7/13/30 GHz	1093.4495.xx
FSEx20/30	9 kHz to 3.5/7/26.5/40 GHz	--
FSIQ3/7/26.5/40	9 kHz to 3.5/7/26.5/40 GHz	1119.5005.xx
ESI7/26.5/40	9 kHz to 3.5/7/26.5/40 GHz	1088.7490.xx
Software		
Noise Measurement Software FS-K3		1057.3028.02

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