A microcontroller based system for noise characterization in switched devices.

Matías Miguez, Mauricio Mattos, Mijail Gerschuni - Alfredo Arnaud
Dep.Ingeniería Eléctrica, Universidad Católica del Uruguay
8 de Octubre 2738/DIE Montevideo Uruguay – CP.11600. *Contact email:* meiyas@ieee.org

ABSTRACT

In this work, a microcontroller-based system intended for low frequency noise measurements in MOS transistors is presented. The system has two A/D, and three D/As for a dynamic controlled transistor bias. The whole system communicates to a PC via an USB port, and has the proper software interface to be directly controlled with MATLAB – SIMULINK.

1. INTRODUCTION

The motivation behind this work is to provide an experimental setup allowing registering of the flicker noise of MOS transistors under switched bias condition. Noise measurement at very low frequency may take several hours, and a careful data analysis [1]. Thus an automatic tool is desirable. We opted to work with Matlab, and Simulink (*www.mathworks.com*), two software tools of frequent use in academic centers, that help to do simple but powerful real-time system control and data processing. To interface the PC with the device under test (DUT) a microprocessor based system was designed. A medium power microprocessor is necessary because allows a dynamic control of the bias of the DUT, like in example for switched MOS transistor measurements [2]. The low power preamplifier, previous to the A/D converters follows the architecture proposed in [3], but some other topology may be adopted in the future (like i.e. the one in [2]). A key aspect of this circuit is its flexibility; it may be adapted to different experiments just by changing the input and data processing / control in Simulink.

The work is organized as follows: section 2 describes system architecture; section 3 describes the input amplifier and some preliminary measurements using a carbon resistor as the DUT are presented.

2. SYSTEM DESCRIPTION

This system for automated noise measuring consists of five blocks as seen in figure 1. They are: a personal computer, a rabbit microprocessor (*www.rabbitsemiconductor.com*), an USB communication module, digital to analog converters and analog to digital converters. In addition to this we used a low noise amplifier and the device to be measured.

Our system contains two 20 bits ADC and three 16 bits DAC. This allows us not only to measure two signals simultaneously but also to control the experiment from the computer. This could be useful to study the noise of a switching device. We used the ADS1250 and the DAC7631 (*www.ti.com*) in our system.

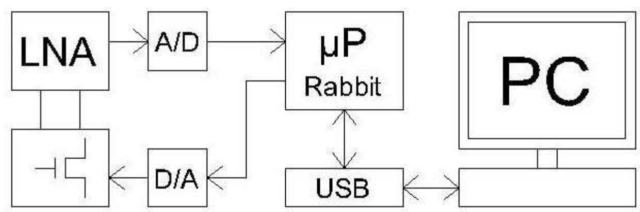

Figure 1: Hardware block diagram

To control these converters and communicate with the PC, we used a rabbit RCM3600 module, which stacks the data from the converters and delivers it to the computer when requested.

Because most new computers do not come with the traditional serial port, we designed our system to communicate via USB. For this we used a DLP-USB245M (*www.dlpdesign.com*).

We developed a library in C++ to communicate with the microprocessor via USB-port and to record and process the data.

In order to make the system easier to use we also developed an interface with Simulink, see figure 2. Simulink is an interface that allows simulation of complex system by just joining blocks. We designed one of these blocks, which uses the C++ dll, and can be used as a driver for the system. This allows us, using real time workshop, to create, control and process the results of experiment in real time in a simple and quick way.

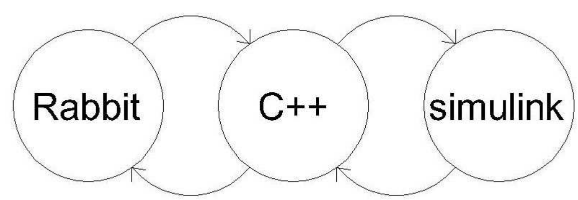

Figure 2: Software block diagram

The system is designed for low frequency measurements and it has a sampling frequency of just over 4 KHz. which gives us a maximum operating frequency of 2.2 KHz.

It is also a small measuring system of less than 10 x 10 cm. which allows for self contained battery operated measurements

3. MEASURMENTS

To evaluate our system performance we measured a constant voltage and concluded that at the moment we acquire data with 13 effective bits which we hope to improve once the system is better isolated from noise.

We have measured noise of a 100 KΩ carbon resistor, to test our system, using a two stages amplifier that serves as an anti-aliasing filter. To implementing this we used the TLC2654 (*www.ti.com*) low-noise chopper-stabilized operational amplifier. The total gain of the circuit is 100 and it has band pass poles at 1.5 Hz and 2.3 KHz.

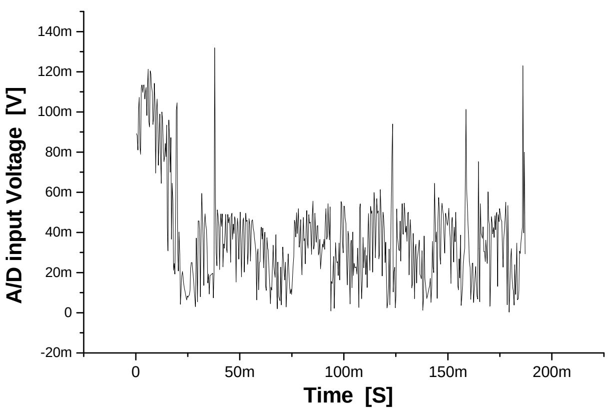

Figure3: Measured voltage vs. time

We can observe there is a DC voltage in our measurements, which we afterward removed before calculating the Fourier transformation of our measurements.

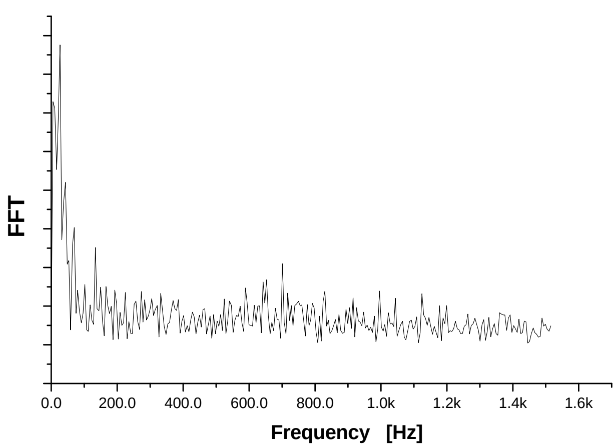

Figure 4: FFT of measured voltage calculated with matlab

We can observe the existence of flicker noise, which may be originated in the carbon resistor

4. CONCLUSIONS

We have developed and tested a system capable of measuring low frequency noise in switched devices, and may now proceed to measure different DUTs. The interface with Simulink makes the system very versatile, and simplifies the implementations of further experiments. Its small size and USB-port makes it also a portable and effective device.

5. REFERENCES

[1] A.Arnaud, C.Galup-Montoro, "A Compact Model for Flicker Noise in MOS Transistors for Analog Circuit Design", *IEEE TED*, Vol.50 nº8, pp.1815,1818, Aug.2003.

[2] A.P. van der Wel, E.A.M.Klumpernick, S.L.J. Gierkink, R.F.Wassenaar, H.Wallinga, "MOSFET 1/f Noise Measurements Under Switched Bias Conditions", *IEEE El.Dev.Letters*, Vol.21 nº1, Jan 2000.

[3] C.D.C.Caetano, C.Galup-Montoro, "Noise Characterization of Analog Devices", Procs. Student Forum Sforum 2003.