A SCIENTIFIC DEVELOPMENT SYSTEM FOR THE MEASUREMENT AND GENERATION OF LOW FREQUENCY SIGNALS

Ing. Vít MATOUŠEK, Doctoral Degree Programme (2)
Dept. of Microelectronics, FEEC, BUT
E-mail: matousv@feec.vutbr.cz

Ing. Lukáš DANĚK, Doctoral Degree Programme (2)
Dept. of Microelectronics, FEEC, BUT
E-mail: danekl@feec.vutbr.cz

Supervised by: Dr. R. A. Cottis

ABSTRACT

A universal development system has been designed for the measurement of a variety of items that generate low-frequencies. The main purpose for the design of the universal development system was for the measurement of electrochemical noise and electrochemical impedance.

1 INTRODUCTION

A measurement of low current and voltage is needed in electrochemical noise studies of corrosion. A harmonic signal of low current or potential is also needed. These two objectives have to be synchronised. A development board was designed where one part of the system allows the measurement of low current or voltage and the other part was used to generate the sinusoidal waveform.

2 DEVELOPMENT SYSTEM

The input of the development system is capable of measuring current down to tens of pA in the range of a frequency up to 1 kHz with a high resolution of about 1 pA. For the measurement of such low currents a 24-bit sigma delta analog to digital converter, AD7714 are used [1]. The converters are working in the frequency bandwidth of up to tens hertz with a high accuracy of about 20 bits. For the measurement of higher frequency, two internal converters of digital signal processor are used. These converters allow the system to work in a bandwidth up to hundreds of kHz. The overexertion between the sigma delta converters and the internal converters is driven from the PC.

The output part of the development system works as a generator of the sinusoidal waveform in the range of ±10 mA with a frequency of up to hundreds of hertz. The sinusoidal waveform is generated inside the DSP processor and sent through the SPI interface to the 18-bit digital to analog converter, AD1861 [1]. The core development of the system is the digital signal processor, DSP56F805 [2]. The DSP microprocessor drives all operations as communication between converters, manipulates the input and output signals and sends the results of the data to the personal computer. The communication between the development system and the PC is through a USB interface. All the construction of the development system is detailed in figure 1.

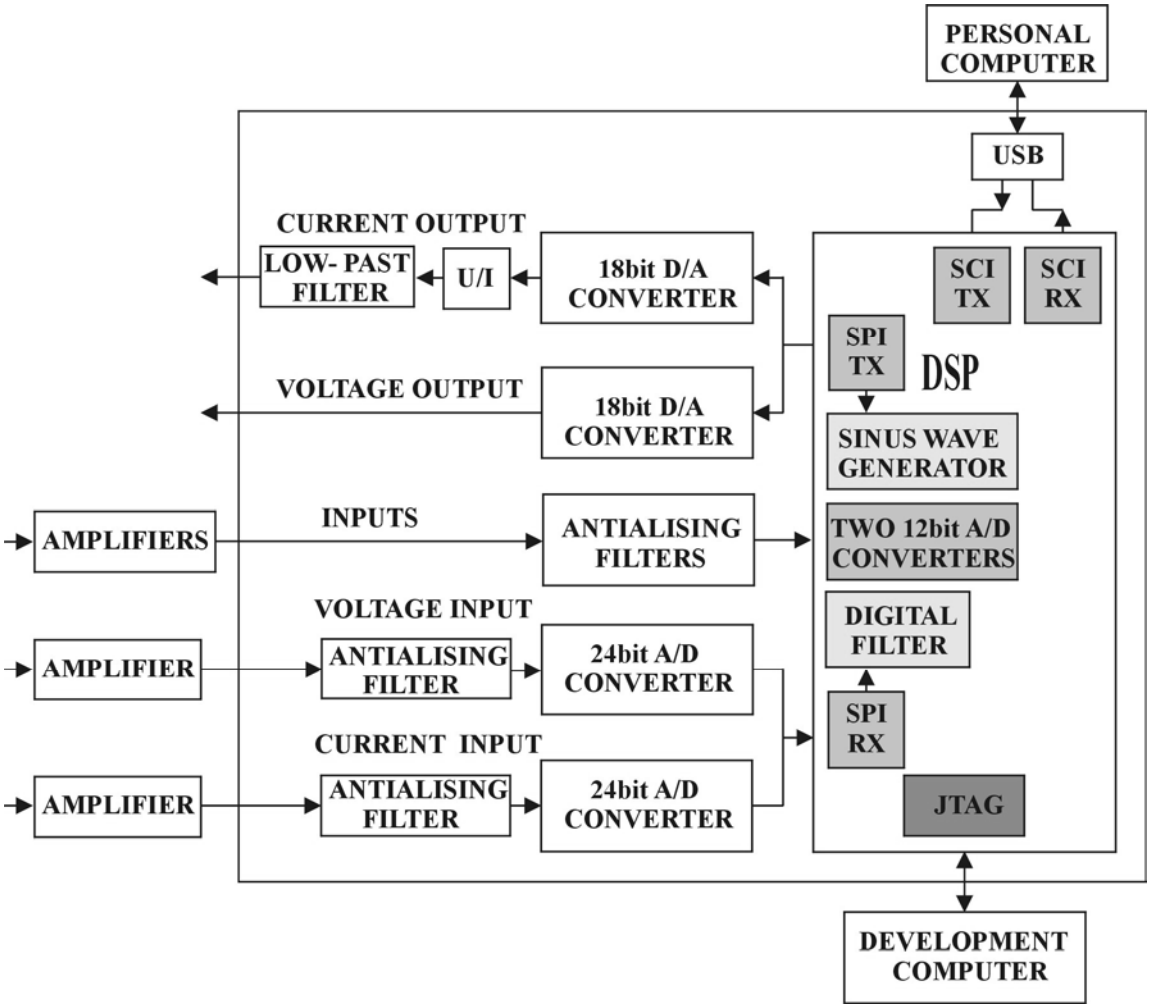

Fig. 1: *The whole configuration of the development board*

The DSP processor is programmed in C language. The user interface is programmed in C++ language. The software works under Microsoft Windows, which supports the USB interface. The user interface allows the user to control the DSP and display the measured data during measurement. The measured data are saved to files during measurement. The amount of data saved to each file has to be set by the user before the start of a measurement. The development board is shown in figure 2.

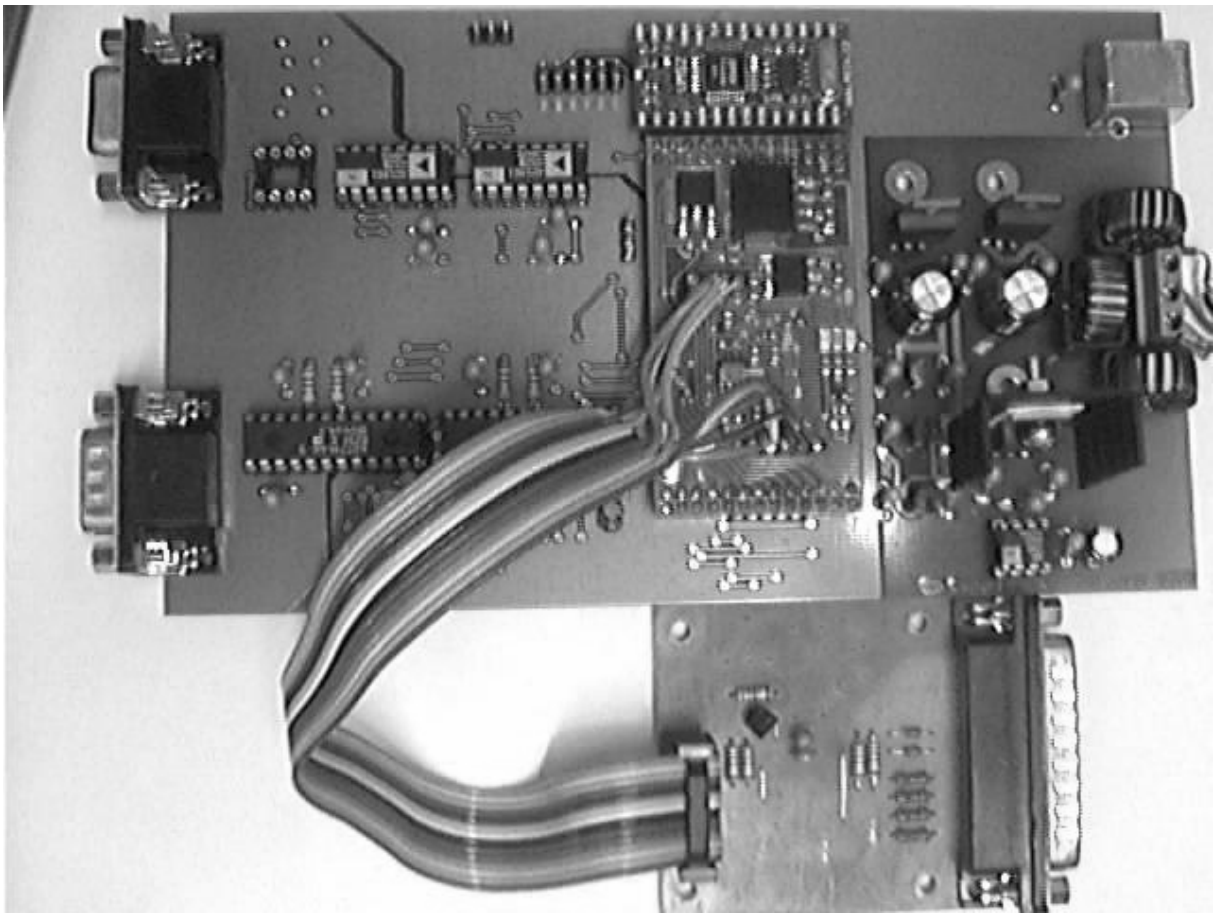

Fig. 2: *The construction of the development board¨*

3 INTRODUCTION OF AN ELECTRO CHEMICAL NOISE MEASUREMENT:

The development board for electrochemical measurement is used for corrosion studies of electrochemical noise.

The objective of electrochemical noise measurement is to use self-generated fluctuation in potential and current of corroding metal electrodes to derive information about the corrosion process.

To measure Electrochemical noise the system contains three electrodes, two working electrodes and a reference electrode. The electrochemical cell consisting of a solution with electrodes and measurement system is detailed in figure 3. The potential noise is measured between the working electrode two (WE2) and the reference electrode (RE). The current noise is measured between the working electrode one (WE1) and (WE2). The material of the samples used was stainless steel 303. The Electrolyte is 3.5% NaCl was used.

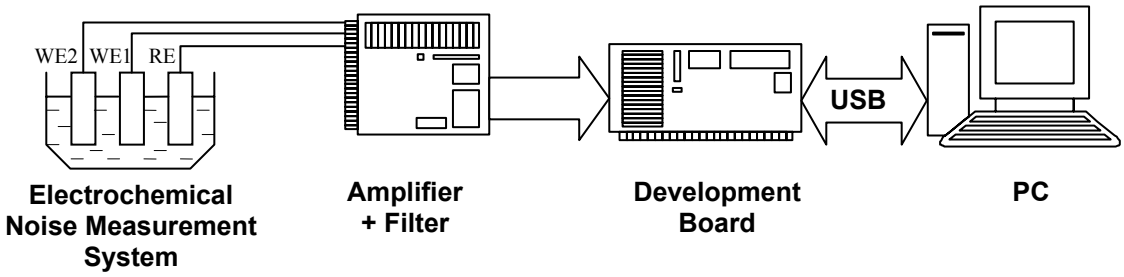

Fig. 3: *Used electrochemical noise measurement system*

Figure 4 shows prominent transients in both the potential and current time records. These transients are caused by the pitting corrosion processes. This agrees with the visual observation where there are a number of pits present with a maximum diameter of ~ 0.25 mm. The current transients occur in the positive and negative directions indicating pitting corrosion activities in both working electrodes, which also aggress with the visual observation of the samples.

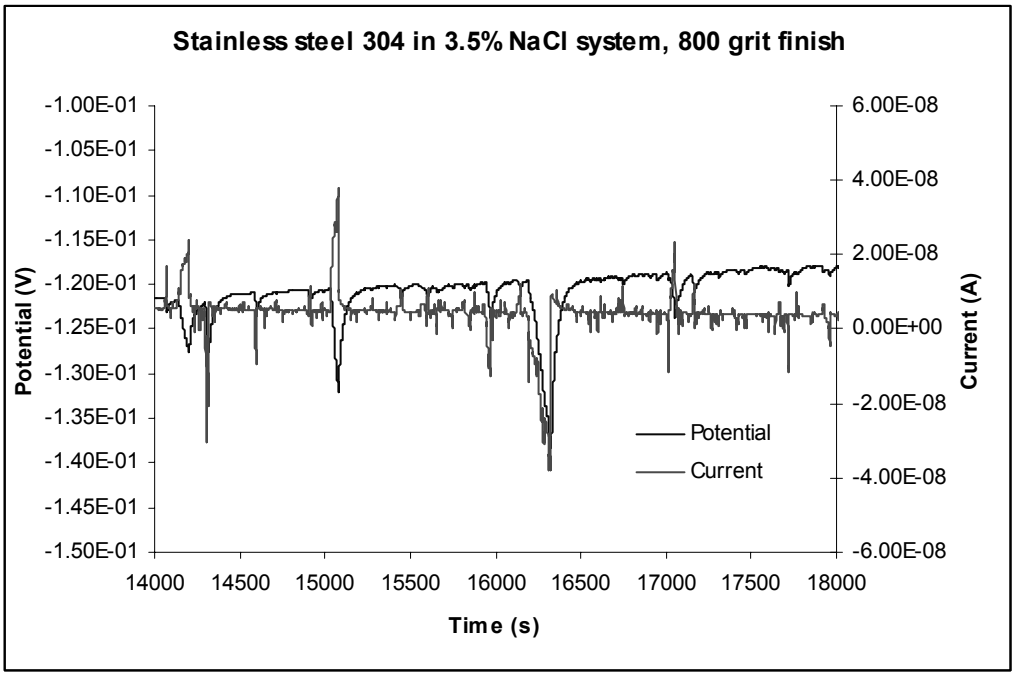

Fig. 4: *Potential and current noises of stainless steel 304 in 3.5 % NaCl 800 grift finish*

4 CONCLUSION

The universal development system has been designed for measurement of electrochemical values. The system was designed specially for the measurement of electrochemical noise and of the electrochemical impedance. The development of the system is for use at the Corrosion and Protection Centre Department, UMIST.

ACKNOWLEDGEMENTS

The development board was designed at UMIST Corrosion and Protection Centre with support from the Institute of Scientific Instruments, ASCR and the Microelectronics department at Brno University of Technology also by the Czech Ministry of Education in conjunction with the Research Plan MSM 262200022 MIKROSYT Microelectronic Systems and Technologies.

REFERENCES

[1] www.analog.com

[2] www.motorola.com