Digital Solutions in Novel Microsensor Measurement System

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Abstract: - The design of digital part in novel microsensor measurement system is presented. Digital solutions of the triangle voltage reference source and internal calibration memory are presented in this paper. The triangle voltage reference source with period range from 2 seconds to 60 minutes is necessary for microsensor measurement system. The novel microsensor measurement system is composed of two integrated systems and communication unit with PC or PDA.

Key-Words: - microsensor, digital design, programmable logic device

1 Introduction

This paper is focused on digital design of a novel microsensor measurement system. The principle function of this microsensor measurement system is to control potential and measure current. The microsensor measurement system is immersed in the test solution. The properties of solution are represented by magnitude of current responses. The system which is designed has two monolithic parts. The first part is sensor system and the second part is control system. Control system contains voltage control unit. Voltage control unit generates the triangle voltage reference source with period from 2 seconds to 60 minutes. High linearity of the voltage output signal is necessary [1].

2 Problem Formulation

The microsensor system is a monolithic integrated system, which contains sensor and basic integrated measurement system [2]. This one-slot component is thrown away when the measurement is finished. Second part is control system. This part is used for data evaluation and communication with external devices of PC or PDA types.

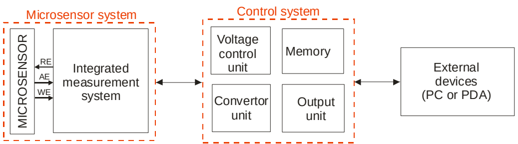

Fig. 1: Microsensor measurement system

The voltage control unit is used to generate triangle voltage reference output signal. The voltage control unit was designed in discrete version [1] at first. The triangle voltage reference signal output is based on the generation of a digital PWM stream (its mean value is equal to the requested output voltage) and it's following low-pass filtration. The second order ARC low-pass filter is realized by the well-known Huelsman structure. The 8-bit PWM stream was realized in discrete version. One of the requirements is increasing of bit resolution of PWM stream.

Therefore the discrete version of triangle voltage reference source is not good solution.

One of the better solutions to generate PWM stream is utilized programmable logic devices. Voltage control unit was designed by CPLD of family CoolRunner II. The advantage of PLD and FPGA circuits is possibility to change function of PWM stream by reprogramming.

The integrated measurement system is represented by chip, which was designed in technology AMIS CMOS 0,7 μm. The chip contains analog and digital parts.

3 Problem Solution

3.1 Control system

Control system was designed to processing, data storage and communication with external mobile devices such as pocket PC, notebook etc. Voltage control, digital memory, converter and output unit are components of control system.

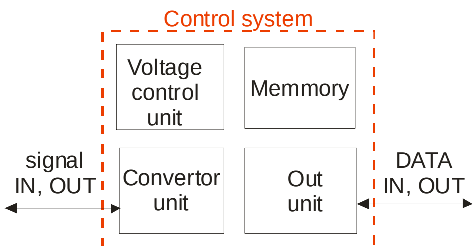

Fig. 3: Control system

Measured data are stored into the memory or transferred into the external devices.

3.2.1 Voltage control unit

Block schema of voltage control unit is shown on fig. 2.

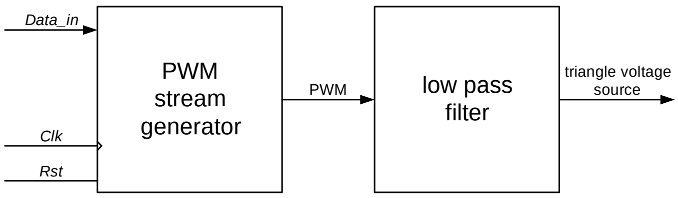

Fig. 2: The block schema of voltage control unit

The 12-bit PWM stream was implemented into CoolRunner II XC2C256-TQ144. Short times of triangle voltage output signal are crucial condition to determinate basic frequency. The basic frequency for 12-bit PWM stream has to be 4 096 kHz to generate triangle voltage output signal with period of 2 seconds. The 12-bit PWM stream was designed in Xilinx Webpack 6.3. VHDL language was used to program 12-bit PWM stream. Input *Data_in* (fig. 2) is utilized to set basic period of triangle voltage output signal. The block schema of PWM stream generator is shown on fig. 3.

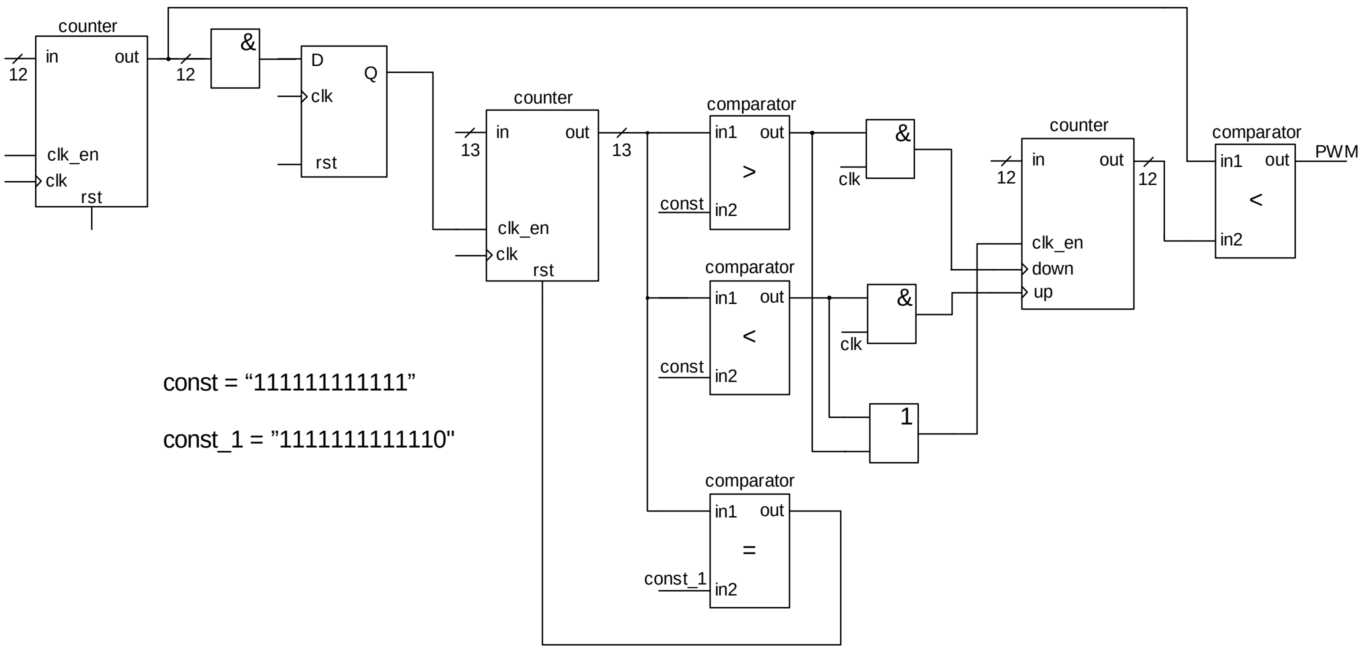

Fig. 3: The block schema of PWM stream generator

3.1 Microsensor system

The microsensor system is a monolithic integrated system, which contains microsensor and basic integrated measurement system. Integrated measurement system is fixed on microsensor, fig. 4. Microsensor is connected with integrated measurement system by three electrodes: working electrode WE, reference electrode RE, auxiliary electrode AE. The current and potential of the working electrode are represented by output sensor signals.

Signals *SC*, *SD*, *BCTRL*, *Wren*, *Dzap* and *VPP* are utilized for control internal calibration memory. Other pins of integrated microsensor system are used for communication with control system.

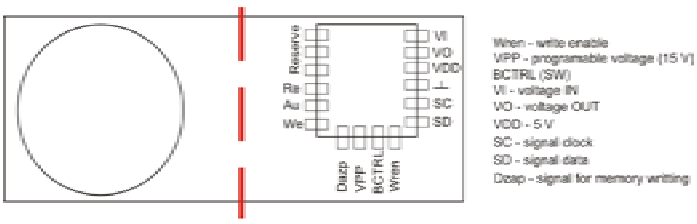

Fig. 4: Microsensor system

3.1.1 Microsensor

The ideal working electrode is formed by a very clean metal surface with a well-defined geometry that is in direct contact with an electrochemical test solution. Working electrodes intended for general purpose work are usually made from a metal that is electrochemically inert over a wide range of potentials. The most widely used metals are mercury, platinum, gold, and various forms of carbon. Solid metals are typically fashioned into disks surrounded by a chemically inert shroud made from Teflon, glass, or epoxy. Mercury, being a liquid, tends to be used as a spherical droplet in contact with the solution [2].

3.1.2 Integrated measurement system

Our basic integrated measurement system has four units. The first unit is measurement system that measures voltage and current from sensor. This part is very significant for accuracy of measurements, because this system measures very low currents in least range of -500 pA to 500 pA. The measured signal is converted into the frequency modulated signal and transferred out from the integrated measurement system. This signal has very good absolute resistance to electric and magnetic interference. Block diagram is shown on fig. 5.

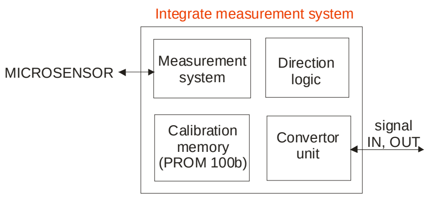

Fig. 5: Block schema of integrated measurement system

Specification and information about type and series of microsensor are stored in internal calibration memory. The internal calibration memory size is 100 bits.
Block schema of internal calibration memory is shown on fig.6.

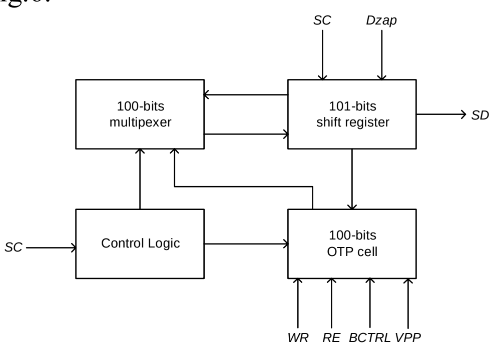

Fig. 6: Block schema of internal calibration memory

Calibration internal memory was designed in technology AMIS CMOS 0,7 µm. Simulation and design of internal calibration memory was executed by VERILOG language in CADENCE. Internal calibration memory contains 100-bit OTP cell, 100-bit multiplexer, 101-bit shift register and control logic. Signals *WR*, *RE*, *VPP* and *BCTRL* are used to control writing and reading from 100-bit OTP cell. Signal *SC* is input clock signal. Signal *Dzap* is input signal, which is used only for writing into 100-bit OTP cell. *Dzap* is first input of 101-bit shift register. Shift register shifts logic value 1 to input of one of the 100-bit OTP cell, which has to be zapped. Control logic is used to control writing or reading modes.

Conclusion

The novel solution of the microsensor measurement system is given. Digital solutions of the triangle voltage reference source and internal calibration memory are presented in this paper. The triangle voltage reference source signal with high linear rise and fall edge is necessary for high accuracy sensing of microsensor.

5 Acknowledgement

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