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Synthesis of Reconfigurable Embedded System to Measure Temperature Compensated Dissolved Oxygen Concentration

S. K. Tilekar, P. V. Mane-Deshmukh, B. P. Ladgaonkar and S. V. Chavan
VLSI Design & Research Centre, Post Graduate Department of Electronics, Shankarrao Mohite Mahavidyalaya, Akluj, Dist. Solapur (MS), India

Abstract- ***Emphasizing wide application potential of designing of ultra-low power instrumentation, a dynamic reconfigurable SoC is designed, wherein Analog and Mixed Signal (AMS) based VLSI design is employed. Measurement of concentration of Dissolved Oxygen (DO) and its temperature dependence is essential for typical chemical processes. Therefore, present prototype is designed using Programmable System on Chip (PSoC) for monitoring of the temperature compensated DO concentration. The Clark's Polarographic cell and semiconductor temperature sensor wired off-chip deploying the SoC is designed about Cypress PSoC5. Here, excluding sensors, the system is designed on single chip. By reconfiguration of highly featured on-chip resources such as voltage source, operational amplifiers, analog multiplexer, programmable gain amplifier, delta-sigma ADC, LCD block, etc., and on integration of the same by Cypress PSoC Creator, an Integrated Development Environment (IDE), the design of SoC is realized. The low power on-chip VDAC for excitation of the DO cell. Analog signals from both DO and temperature are multiplexed on-chip. The preciseness of SoC is achieved configuring ΣΔADC having 10-bit resolution. The developed system is calibrated to the standard temperature and DO units against the standard electronic meter. On implementation it is found the DO is not only sensitive to the temperature but also for atmospheric pressure. Results are interpreted in this paper.***

Key words: Mixed Signal, SoC, precision temperature measurement, Dissolved Oxygen.

I. INTRODUCTION

Recently, the mixed signal (analog + digital) design, an emerging VLSI technology, is realizes ubiquitous embedded system, which is playing a prominent role in dedicated VLSI based instrumentation [1]. The dynamic reconfigurability is an important feature of this mixed signal technology. Therefore, it has conspicuous application from simple domestic appliances to critical space shuttle application and investigators are showing their prominence to deploy Analog and Mixed Signal (AMS) cores for a ubiquitous embedded system [2]. In the field of precision measurement and controlling of various physical parameters, such as pH, concentration of Dissolved Oxygen (DO), Temperature, Electrical Conductivity (EC), etc. is the crucial task [3]. However, many investigators are opting microcontrollers from advanced families, such as ARM, PIC, etc., to design an embedded system for such parameter measurement [4-10]. All these embedded systems developed about microcontrollers realise the concept of System-on-Board (SoB) design as analog design is always off the chip. Thus the embedded design is realizes SoB approach. The SoB featured with hardware complexity, high power consumption, less flexibility in hardware as well as software design, less static as well as dynamic reconfigurability. Moreover, the operational amplifiers based on BJT have low input impedance due to which interfacing of physicochemical sensors is not accomplished [11]. Also analog part of the DAS as well as microcontroller has limited configurability. Therefore, the researchers are attracting towards an innovative field of VLSI called System-on-Chip (SoC) design.

Holistically, the literature reveals that analog signal processing is indispensable while designing an embedded system to interface the real world although most of the embedded system deploys digital functions for digital data processing. The VLSI devices have minimized these constraints of designing. But the VLSI devices like CPLD and FPGA again have constraints to the system designing, wherein only digital design reconfiguration is available on-chip while analog design is off-chip. The state of the VLSI technology emerges based on Computer-Aided Design (CAD) for analog and digital integrated circuits called Systems-on-Chip (SoC) designs [12], wherein both analog and digital design blocks are available. But, analog blocks of these SoC typically constitute small fraction of the components. Hence, an innovative technology, AMS VLSI technology, is highly suitable, which overcomes the on-chip analog designing constraints and ensures better integrability and configurability [13]. Still this AMS SoC has limited features for reconfigurability. One the field of AMS technology the Programmable System-on-Chip (PSoC) has an ability of on-chip dynamically reconfiguration of analog as well as digital resources. The vendors Micro-semi, Texas, Actel and Cypress Semiconductors are vendoring their unique featured PSoCs in various variants. Therefore, PSoC cores have better solution for embedded system. On literature survey, it is found that many investigators had reported the pH, Temperature, Humidity, Pulse-oximeter, DO, EC, etc. embedded system using the advanced microcontroller [14-17].

