



## Paradigm of AMS based SoC for Measurement of Physico-Chemical Parameters of the Water

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**Abstract-** *Indeed, mixed signal (Analog + Digital) based VLSI design is an innovative technology, realizing commendable reconfigurability, which helps to emphasize wide spectrum of applicability, particularly in the field of precision measurements. Moreover, designing of precision instrumentation for measurements and controlling of various parameters such as pH, temperature, electrical conductivity, etc. depicts the meritorious application domain. Further, the deployment of mixed signal based Programmable System on Chip (PSoC) overcomes constraints in the configurability, which are otherwise exhibited by traditional VLSI. Mixed signal based PSoC device vended by Cypress Semiconductor, USA has promising reconfigurability features. This paper presents the issues of the designing of an inexpensive and portable embedded system for precision measurement of electrical conductivity of solution under investigation. The PSoC, a CY8C55 family device, from Cypress has on-chip ARM7 cortex-M3 CPU core, which has operating at back end. Deploying standard conductivity electrode, the AC current, proportional to concentration of ions is extracted by programmable analog core of the PSoC5. Only conductivity electrode is off-chip. Rest of analog part of the hardware is designed on the chip. Analog as well as Digital signal processing is performed by configuring the system on-chip. The digitization of the signal is ensured by  $\Delta\Sigma$ ADC, which is configured for 10-bit resolution. Moreover, hardware & software are co-developed. The results are displayed on smart LCD. Instead of traditional method of calibration, wherein three point calibration process is adopted, the system is uniformly calibrated for the range of investigation. The system is calibrated to the electrical conductivity, micro Siemens ( $\mu$ S). The system is standardized against standard electrical conductivity meter model HANNA HI991300. The electrical conductivity measured by the system under investigation is more precise and accurate and results closely matched with that of shown by standard meter.*

**Keyword:** *Mixed Signal, PGA, Electrical Conductivity, PSoC5, VLSI Technology.*

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### I. INTRODUCTION

Now days, an innovative VLSI technology, the mixed signal (Analog + Digital) design, is becoming ubiquitous. This is playing a vital role in flourishing embedded technology. This mixed signal VLSI devices realizing commendable characteristics of reconfigurability and this reconfigurability helps to design a desired ubiquitous embedded system [1]. Therefore, mixed signal VLSI technology exhibits wide spectrum of applications in every domain, from simple toys to complex industrial applications. Further, designing of the instruments for precision measurement and control of various physical as well as chemical parameters such as dissolved oxygen, temperature, pH, electrical conductivity, etc. is the challenging job [2]. Presently, the investigators are employing the microcontroller of promising features for these parameters measurement. But in such embedded system the analog design is always off the chip, which realizes the concept of System-on-Board (SoB) design. Postolache et al have developed PIC 18F4520 based multi-sensor, temperature, electrical conductivity and turbidity, measurement system for water quality [3]. The 8031 microcontroller based embedded system for temperature dependent electrical conductivity has developed by Rajendran et al [4], wherein they measured conductivity by investigating ionic solution using a modified AC Wheatstone bridge network. SalehaBegum et al have employed a PIC microcontroller to develop an embedded system for measurement of electrical conductivity of the soil [5]. A new technique, Lorentz force sismometry, for the contactless measurement of the specific electrical conductivity of a solid body and electrically conducting fluid are reported by Uhlig et al [6]. Helena et al have developed microcontroller based system for monitoring of water quality, which is suitable for industrial applications [7]. All these embedded systems discussed so far have SoB approach. Moreover, analog part of the system as well as microcontroller has limited configurability. Further, due to BJT based operational amplifiers, low input impedance, the chemical sensors could not interfaced.

Therefore, to overcome the constraints in the designing of the embedded system, the VLSI devices are opted by the investigators [8]. Further, CPLD and FPGA devices have constraints to the designing, wherein the reconfiguration is available only for digital design and analog part of the system is off the chip. To avoid this problem and to ensure better integrability an innovative technology called mixed signal VLSI technology is suitable. The Programmable System on Chip (PSoC) is one of the fields of the mixed signal technology. Presently, various vendors are ventering their unique