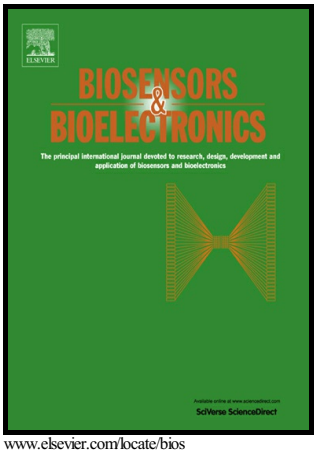

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A low-cost and miniaturized potentiostat for the monitoring of immunobiosensors by electrochemical impedance spectroscopy

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Abstract

Miniaturizing potentiostats, keeping their cost low and yet preserving full measurement characteristics (e.g. bandwidth, determination of capacitive/inductive contribution to sensor's impedance and parallel screening) is still an unresolved challenge in bioelectronics. In this work, the combination of simple analogue circuitry together with powerful microcontrollers and a digital filter implementation is presented as an alternative to complex and incomplete architectures reported in the literature. A low-cost acquisition electronic system fully integrated with a biosensors platform containing eight gold working microelectrodes and integrated reference and counter electrodes was developed and validated. The manufacturing cost of the prototype was kept below 300 USD. The performance of the proposed device was benchmarked against a commercial impedance analyzer through the electrochemical analysis of a highly sensitive biosensor for the detection of tumor necrosis factor α (TNF-α) within the randomly chosen range of 266 pg/mL to 666 ng/mL in physiological medium (PBS). A strong correlation between the outputs of both devices was found in a critical range of frequencies (1-10 Hz), and several TNF-α cytokine concentrations were properly discriminated. These results are very promising for the development of low-cost, portable and miniaturized electrochemical systems for point-of-care and environmental diagnosis.

Keywords: miniaturized potentiostat; cytokines; point-of-care; biosensors platform; electrochemical impedance spectroscopy; immunobiosensor.

1. Introduction

Heart failure (HF) is one of the fastest growing cardiovascular disorders (CVDs), since approximately 1 million new patients are diagnosed with this illness every year (Jessup and