Compact, Adaptive, Multichannel Electrochemical Instrument for Point-of-Care Sensing

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***Abstract*— This paper presents a versatile, multichannel electrochemical interface circuit capable of performing multiple electrochemical techniques for point-of-care testing. Device functionality is briefly demonstrated through amperometric measurements of *Plasmodium falciparum* Histidine-Rich Protein 2 (*Pf*HRP2), which could be rapidly detected at several concentrations in spiked blood samples.**

I. Introduction

Electrochemical sensing is emerging as a prominent platform for compact environmental and biomedical sensing [1]. This technology is being used to facilitate point-of-care testing in various applications such as serologic diagnosis of infectious diseases [2].

To assess a patient's condition, it is often desirable to perform multiple tests to detect various analytes and/or biomarkers. However, these tests may utilize different measurement techniques and exhibit a wide range of response currents. Efforts are being made to address this issue using portable electrochemical lab instruments [3]. However most of these instruments are tailored to specific sensors, are not suited to interface with multiple sensor types, or do not adequately address the challenges for point-of-care or remote location testing. Toward this end, we build on prior work [3] and introduce a fully autonomous, compact electrochemical instrument called aMEASURE, which is the first highly portable, multichannel, electrochemical instrument capable of interfacing with various types of electrochemical sensors and adapting to response current levels.

II. Design and Testng

The aMEASURE electrochemical system consists of a custom analog readout board and a microcontroller to provide an autonomous interface between a sensor and a USB host, as shown on Fig. 1. Using the microcontroller as an embedded stimulus signal generator, aMEASURE can readout four input channels with most voltammetry techniques, including constant potential amperometry and cyclic voltammetry. It dynamically manages its internal gain to support sensor currents ranging from 0.9 nA to 2.4 mA. It is capable of switching gain mid-test to allow itself to operate at peak sensitivity at all times by adapting to the input current. aMEASURE is powered through USB or USB-OTG, making it compatible with portable electronics (e.g. mobile phone, tablet), and consumes 90 mA of power on average.

To test system performance, amperometric measurements were performed to detect *Pf*HRP2 in spiked blood samples. Measurements were carried out using gold tri-electrode electrochemical sensors on PMMA [2]. A sandwich assay format was employed where *Pf*HRP2 capture antibodies were immobilized on the working electrode via linking with self-assembly carboxyl groups. Spiked samples and *Pf*HRP2 detection antibodies labelled with horseradish peroxidase were sequentially dispensed on the sensor followed by rinsing in PBS and drying using argon gas. Measurements were carried out by dispensing a TMB/H_2O_2 substrate on the sensor followed by the application of a 0.2V bias potential. As shown in Fig. 2, amperometric signals were clearly distinguishable at the three tested concentrations with relatively smooth response profiles and minimal noise.

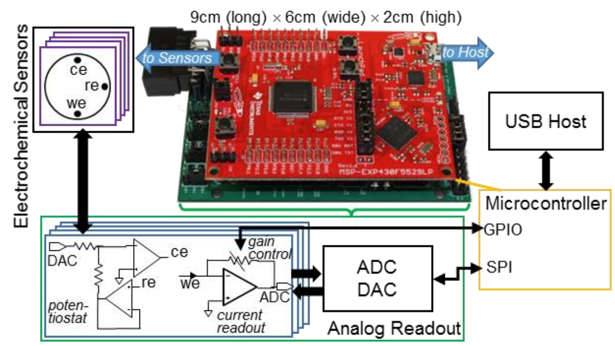

Fig. 1. Versatile electrochemical instrument for interfacing with a variety of electrochemical sensors and streaming measurements to a USB host.

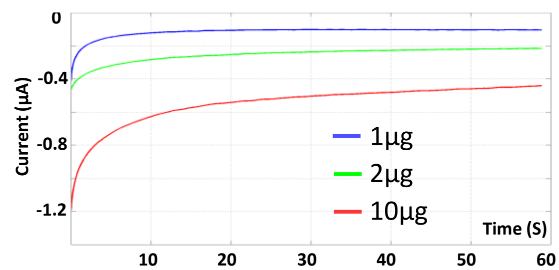

Fig. 2. Amperometric signals of PfHRP2 spiked in blood obtained using aMEASURE.

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References

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