Prospectus of Senior Project

Background:

The goal of this project is to make the data collecting and stimulus signal generating system as part of a biosensor device project.

The goal of the biosensor project is to develop a portable platform for rapid multiplexed analyte detection from blood samples of ill patients at a point-of-care. The device will enable physicians more accurate and faster diagnostics by delivering the results of lab test at the point of care.

The product of my senior project will help finalize the portable measurement setup, which will allow taking the measurement from a research lab to a point-of-care, ex. Yale Medical School.

Description of Task:

The board is also required to produce stimulant signals of given values and duration to any of the 16 output channels.

The 16-channel output current signal collected by the biosensor is first sent to an amplifier and amplified. After amplification, the signal needs to be sampled and graphed.

The amplifier board has already been assembled and is under testing. It consists of 10 amplifier circuits for signal amplification from 10 devices at the same time. The important aspect is the low noise figure of the system and amplification of currents ranging from 10nA-100nA. The measured current is outputted from an external device – nanowire field effect transistor, which operated at a bias point, Vds=100mV and Vgs ranging from -1V to -10V.

After amplification, the current signal from the 16 channels needs to be sampled and collected by an FPGA board. Then the signal shall be sent over USB to a computer program.

The computer program has a user interface that allows the user to specify which channels to collect the data from and what kind of graph shall be produced from the signals. It has another interface to let the user specify parameters of stimulant signal to generate and send to the rest of the biosensor device.
**Deliverables:**

The finished project shall be a fully functioning system that generates stimulant signals and sample and graphs the corresponding output. The system consists of the following major components:

- The fully functioning circuit board
- Programmed FPGA board (XEM6010)
- Computer program and user interface that allows the user to specify stimulant signal parameters
- Computer program that collects the data and produces a graph

**Specifications:**

Signal input range: 0~15V

Sampling frequency: >100Hz

Signal size: 16-bit

Number of channels: 10 required, maximum 16 allowed (adjustable)

**Implementation:**

*Power Supply*

Since the OP400 and multiplexer used require a power supply voltage, we need to provide a 18V power source along with the 5V power.

![Power supply diagram](image)

*Circuit Board*

Data is collected by the XEM6010 FPGA board and then sent to the
The maximum input and output voltage for the FPGA board is 3.3V and the input and the maximum input and output voltage for the entire circuit is 15V. Therefore, we need a circuit at both ends of the FPGA board to multiply and divide the voltage by 5. We do this using op-amps. To save space, we use a quad op-amp—OP400.

Since the signal received is analogue, we use an analogue-to-digital converter to convert the signal to digital before sending it to the FPGA.

The outline of the circuit is as follows:

*Computer program*

The computer program will be written in C++.

The program has a user interface that is responsible for both generating stimulant signals and collecting corresponding output data.

On the signal generating side, the program allows the user to specify value of output, duration of signal, channels that the signal will be sent through. Then the program sends the data to the FPGA board, which will generate the corresponding signals.

On the signal collecting side, the program receives data from the FPGA port and allows the user to select channels and type of graph to make from the data collected.

The program also detects irregular signals and shuts down malfunctioning channels.
Major Steps:

- Make PCB schematic and footprint
- Send design to factory
- Program the FPGA board
- Assemble the board
- Test the board
- Program the computer software and test with the board
- Test the system with the rest of the biosensor device