**Synthetic Biology**

**Group:** #SD1501

**Advisor:** Dr. Ewert

**Group Members:** Andrew Bossert

            Christopher Jordan - Denny

            Nicolette Lippert

**Date:** 9/1/15

**Introduction**

The purpose of this project is to answer the question: Is the transmembrane potential of a cell affected by exposure to radio waves? This project will be based on effort researching and developing an answer to the question stated above. The following are the requirements for the project created by the advisor (Dr. Ewert) and the students (Andrew Bossert, Christopher Jordan-Denny, and Nicolette Lippert), to which all parties agree to:

**Requirements**

1. Design a proof of concept experiment that would prove the possibilities of testing transmembrane potentials at Radio Frequencies Including:
   1. Provide a way to turn the dielectric properties of the cell suspension into a measureable quantity for microcontrollers.
   2. Provide a way to take that measurement and convert it into transmembrane potential.
   3. Frequencies may be measured at lower than the radio level in order to provide proof of concept of frequency shifting.
   4. Measurement devices need only be built to a level where they do there job. All enclosures and like additions are superfluous
2. Analyze all results from the experiment and report them in a professional manner whether conclusive or inconclusive.
3. Cells or a Cell suspension will be provided to the students.
4. Third party (NDSU) equipment will be used to generate required frequencies.
5. Jared Hanson is doing the theoretical research regarding the project.
6. The Intellectual Property produced by the students will belong to the students.

**This document describes all project requirements set forth by the advisor and/or client. Grading will be performed at the end of the semester according to the level at which these requirements are met.**

**TimeLine**

Andrew

Research the Dielectric Spectroscopy Method    Sep 7

* re-read previous research documents
* understand mathematical formula

Implement Membrane Potential Function into Matlab GUI    Sep 14

Christopher

Research and Design preprocessing filter setup    Sep 14

Design and create A2D circuitry    Sep 21

Nicolette

Research 3D printing techniques    Sep 7

Find gold plated electrodes    Sep 14

Create Cell Suspension 3D printed probe housing    Sep 21

Group

Complete Test Design Set up    Sep 21

* A2D converter board
* Preprocessing and filtering hardware
* Matlab real time plot GUI with Membrane Potential Function
* Cell Suspension 3D printed probe housing

Have detailed Experiment Design ready to implement    Oct 2

Data for final report will be collected    Oct 30

* Implement Experiment plan    Oct 9
* Revise Experiment plan    Oct 16
* Re-run Experiment    Oct 23

Final result report document ready for publication    Nov 23

**Budget**

**Introduction**

Last semester in Design 2 a circuit board was fabricated and parts were purchased for it. That purchase is reflected in the Design 2 Purchase. For Design 3 the plan is to create a new data capture board with some preprocess filtering. That is reflected in the DSP section. Budget items in the Cell interface section were put there as instructed by our advisor.

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| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| **Design 2 Purchase** | | | | | | | | | | |
| Qty | Value | Device | Package | Parts | Description | P/N | | | Price | |
| 1 |  | 40-XX | B3F-40XX | S1 | OMRON SWITCH | SW411-ND | | | $0.54 | |
| 1 |  | DB9FEMALE | DB9 | X1 | DB9 Connector | 609-2801-ND | | | $2.79 | |
| 2 |  | MOSFET-NREFLOW | SOT23 | Q2, Q3 | N-Channel Mosfet | SSM3J328RLFCT-ND | | | $0.47 | |
| 1 |  | PINHD-1X6 | 1X06 | JP1 | PIN HEADER | S7004-ND | | | $0.68 | |
| 1 |  | PINHD-1X9 | 1X09-BIG | JP3 | Pin header 1x10 0.1" spacing | 1212-1193-ND | | | $0.85 | |
| 3 | 100nF | CAP0603-CAP | 0603-CAP | C9, C10, C12 | Capacitor | 490-1524-1-ND | | | $0.10 | |
| 2 | 100uF | CAP0603-CAP | 0603-CAP | C7, C11 | Capacitor |  | | |  | |
| 1 | 10k | RESISTOR0603-RES | 0603-RES | R1 | Resistor | P10KBZCT-ND | | | $0.20 | |
| 1 | 10uH | INDUCTOR30OHM,1.8A | 603 | L1 | Inductors | 490-4025-1-ND | | | $0.14 | |
| 1 | 16Mhz | CRYSTALHC49S | HC49/S | Q1 | CRYSTAL | X439-ND | | | $0.81 | |
| 1 | 1N4004 | 1N4004 | DO41-10 | D1 | DIODE | 1N4004-TPMSCT-ND | | | $0.11 | |
| 5 | 1uF | CAP0603-CAP | 0603-CAP | C1, C2, C3, C4, C8 | Capacitor | 490-3897-1-ND | | | $0.10 | |
| 2 | 22 | RESISTOR0603-RES | 0603-RES | R2, R4 | Resistor | P22.00BZCT-ND | | | $0.20 | |
| 2 | 22pF | CAP0603-CAP | 0603-CAP | C5, C6 | Capacitor | 399-6864-1-ND | | | $0.25 | |
| 1 | 470k | RESISTOR0603-RES | 0603-RES | R3 | Resistor | P470KBZCT-ND | | | $0.20 | |
| 1 | 7805DT | 7805DT | TO252 | IC1 | Positive VOLTAGE REGULATOR | 497-7255-1-ND | | | $0.66 | |
| 1 | ATMEGA32U4TQFP | ATMEGA32U4TQFP | SPARKFUN-DIGITALIC\_TQFP44 | U$3 | Atmel 44-pin 8-bit Microcontroller with 32KBytes of ISP Flash and USB Controller ----- | ATMEGA32U4-AURCT-ND | | | $6.77 | |
| 1 | AVR\_SPI\_PRG\_6PTH | AVR\_SPI\_PRG\_6PTH | 2X3 | J2 | AVR ISP 6 Pin | 952-1921-ND | | | $0.29 | |
| 1 | LTC4412TSOT-23 | LTC4412TSOT-23 | SOT23-6-MCP4725 | U$2 | Wall Supply/usb Supply | LTC4412ES6#TRMPBFCT-ND | | | $3.18 | |
| 1 | MAX3322E | MAX3322E | TSSOP16 | U$1 | RS-232 Transceiver | MAX3323EEUE+-ND | | | $5.72 | |
| 1 | POWER\_JACKCOMBO | POWER\_JACKCOMBO | POWER\_JACK\_COMBO | J1 | Power Jack | CP-2519-ND | | | $0.87 | |
| 1 | USB-A | USB-A | MOLEX\_480371000 | X2 | USB type A 'plug' | 609-1484-ND | | | $2.32 | |
| 1 | Advanced Circuits PCB | |  |  |  |  | | | $52.65 | |
| For fabrication of one board and parts for two | | | | | | | | | $107.15 | |
| **Design 3 Budget** | | | | | | | | | | |
| Data Acquisition Device (DSP) | | | | | | | | | | |
| Qty | Value | Device | Package | | Description | | P/N | | | Price |
|  |  | DB9 FEMALE | DB9 | | Computer Interface | | 609-2801-ND | | | $2.79 |
|  |  | 7805DT | TO252 | | LDO Voltage Regulator | | 497-7255-1-ND | | | $0.66 |
|  |  | STM32L053R8 | QFP-64 | | Microcontroller (Capable of ADC 1.14Msps) | | 497-14654-ND | | | $5.18 |
|  |  | AVR\_SPI\_PRG\_6PTH | 2X3 | | AVR ISP 6 Pin | | 952-1921-ND | | | $0.29 |
|  |  | MAX3322E | TSSOP16 | | RS-232 Transceiver | | MAX3323EEUE+-ND | | | $5.72 |
|  |  | POWER\_JACKCOMBO | POWER\_JACK\_COMBO | | Power Jack | | CP-2519-ND | | | $0.87 |
|  |  | Passive Components |  | |  | |  | | | $10.00 |
|  |  | Connectors |  | |  | |  | | | $10.00 |
|  |  | Switches |  | |  | |  | | | $5.00 |
|  |  | Led's |  | |  | |  | | | $5.00 |
|  |  | Other IC's |  | |  | |  | | | $10.00 |
| 1 | Advanced Circuits PCB | |  | |  | |  | | | $52.65 |
| Total: | | | | | | | | | | $108.16 |
| Cell Interface/Fabrication | | | | | | | | | | |
| Part | | | Description | | | | | | | Price |
| Cells | | | Cells to be suspended and tested | | | | | | | $100.00 |
| Probes/Biological Equip. | | | Probes used to measure cells | | | | | | | $150.00 |
| Board Fabrication | | | Advanced Cirucits | | | | | | | $100.00 |
| Miscellaneous Parts | | | This includes parts for active filtering | | | | | | | $50.00 |
| Total: | | | | | | | | | | $400.00 |
| **Total Budget** | | | | | | | | **$615.31** | | |