**Synthetic Biology**

**Group:** #SD1501

**Advisor:** Dr. Ewert

**Group Members:** Andrew Bossert

            Christopher Jordan - Denny

            Nicolette Lippert

**Date:** 9/7/15

**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 and Execute an experiment that reveals the effects of Radio Frequencies on the Transmembrane Potentials of cells:
   1. Provide a way to turn the dielectric properties of the cell suspension into a measureable quantity.
   2. Provide a way to take that measurement and convert it into transmembrane potential.
   3. NDSU equipment can be used to take the measurements. There is no need for the students to create original circuitry and/or a PCB. The focus is on answering the question above and the students focus should be on answering that question in any way conceivable.
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.

**Summary**

In conclusion, the main focus of this project is to discover if we can alter the potential across the cell membrane using radio frequencies. The end goal of the project do an experiment on either real cells or synthetics ones and take transmembrane potential measurements while under the exposure of radio waves.

**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

Learn how to use Network Analyzers    Sep 14

Create Experiment Procedure     Sep 21

Test Experiment Procedure    Sep 28

Christopher

Design Cell Suspension Probe Housing    Sep 14

Create Cell Suspension Probe Housing    Sep 21

Test Experiment Procedure/ Cell Suspension Probe Housing    Sep 28

Nicolette

Find and purchase gold plated electrodes    Sep 14

Create Cell Suspension Probe Housing    Sep 21

Test Cell Suspension Probe Housing    Sep 28

Group

Have detailed Experiment Design ready to implement    Oct 2

* Experiment Design Ready for implementation
* Cell Suspension Probe Housing complete

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 our focus has moved away from building our own circuitry to using equipment provided by NDSU, such as a Network analyzer. A Cell interface device will still have to manufactured and from initial searching the estimates for those cost are listed in the Design 3 budget. Budget items in the Cell interface section were put there as instructed by our advisor.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **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 |
| 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** | | | | | | | |
| Part | | | Description | | | | Price |
| Cells | | | Cells to be suspended and tested | | | | $100.00 |
| Gold Plated Electrodes | | | Used as a parallel plate capacitor to capture cell solution impedance | | | | $50.00 |
| Mini-Circuits Balun | | | Converts singular impedance to differential impedance | | | | $150.00 |
| Glassware | | | used to hold cell solustions | | | | $20.00 |
| 3D printing | | | based on NDSU rate of $3/hr | | | | $30.00 |
| Total: | | | | | | | $350.00 |
| **Total Budget** | | | | | | | **$457.15** |