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| **Arduino Controlled Micro-Pump**  **Mechanical Testing Protocol** | **ID: MTD-1** |

**Prototyping Protocol: – (Prototyping the Micro-Pump for the Bioreactor: PP-1)**

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**Protocol Description – (Bioreactor Pump/Mechanical Testing for the Bioreactor Micro-Pump)**

This protocol is used in testing the micropump and its activity once implemented with the innovative PCB board. An individual following this protocol should be able to attach the PCB board to the Arduino along with the assembled pump. Next, the Arduino code that has the UI can be used to input a desired volumetric flow rate. The pump should enable water to flow at the desired speed. The volumetric flow rate can be measured at various speeds as mentioned in the ‘Values to be Recorded’ section of this protocol. Ultimately, the flow rate of water should be faster at a higher speed and conversely at a lower speed. This ensures the proper functionality of the micropump.

**Tools and Equipment**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **#** | **Tool** | **Name / # if applicable** | **Location** | **Purpose** |
| TE1 | Computer | MacBook | N/A | A computer will be needed in order to create the parts, run an Arduino code, and enable the user to choose tubing geometry & flow rate. |
| TE2 | Arduino | Arduino UNO SMD Edition | BioScience 2 Design Lab | Enables one to run the circuit |
| TE3 | Circuit Software | Eagle | N/A | PCB design software |
| TE4 | Digital Multimeter | Digital Multimeter | BioScience 2 Design Lab | Allows for testing of each component in the PCB and see if the voltage is running through each of them. |
| TE5 | Soldering Kit | Elenco Electronics | BioScience 2 Design Lab | Connect pieces on the circuit board |
| TE6 | Arduino Program | Arduino | Computer | Run the code needed for circuit to work |

**Materials**

|  |  |  |
| --- | --- | --- |
| **ID** | **Material** | **Purpose** |
| MAT1 | Stepper Motor Driver | Circuit Assembly |
| MAT2 | LED | Circuit Assembly |
| MAT3 | Pushbutton | Circuit Assembly |
| MAT4 | Capacitors | Circuit Assembly |
| MAT5 | Resistors | Circuit Assembly |
| MAT6 | Wires | Circuit Assembly |
| MAT7 | 3D Printed Part | Circuit Assembly |
| MAT8 | NEMA 17 Stepper Motor | Pump Assembly |
| MAT9 | Housing For Pump | Pump Assembly |
| MAT10 | Pump Rotor | Pump Assembly |
| MAT11 | Tubing | Pump Assembly |
| MAT12 | Screws | Pump Assembly |
| MAT13 | Washers | Pump Assembly |
| MAT14 | Bearings | Pump Assembly |
| MAT15 | Nuts | Pump Assembly |
| MAT16 | Epoxy Resin | PCB Design |
| MAT17 | Copper foil | PCB Design |
| MAT18 | Fiberglass | PCB Design |

**Testing of PCB**

Assessment of PCB to ensure that all components on it are connected properly.

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| --- | --- | --- |
| **ID** | **PCB to Each Component Listed** | **Pass/Fail** |
| TES-1 | Arduino |  |
| TES-2 | Pushbutton |  |
| TES-3 | LED |  |
| TES-4 | Pump |  |

**Values to be Recorded**

To ensure proper flow rate, testing will be performed on the pump based on the UI that accepts volumetric flowrate and sets the appropriate control conditions in software. Basically, if the flow rate of water is in accordance with each speed listed below, then the pump works.

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| --- | --- | --- |
| **ID** | **Speed (milliseconds)** | **Pass/Fail** |
| VR-1 | 50 |  |
| VR-2 | 20 |  |
| VR-3 | 10 |  |
| VR-4 | 5 |  |