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| **Arduino Module**  **Design Controls Worksheet** | **ID: DCW-1** |

**Date Written –** 4/4/2020

**Date Revised –**4/6/2020

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**Improvement on Existing Design**

The previous design model implemented a breadboard for the circuit and included a button, LED, and stepper motor with rolling bearing pump assembly. The button initiated an LED light and motor stepper, which was located inside a bulky housing. This caused a loosening of wiring and components during function and agitation, and was unsuitable for small incubator spaces.

The current design features secure components soldered to a PCB for compaction (PP-1). Additionally, components were modified to enhance compactivity. The elimination of excessive hanging wire via soldered connections reduces risk and connectivity loss. By placing the processor and motor driver on one circuit framework, a ¾ size reduction is achieved.

**User Needs**

**Table 1.** User Needs Matrix

|  |  |
| --- | --- |
| ID | Description |
| UN-1 | UX / UI to allow for operator control (flow rate). |
| UN-2 | Begin/Terminate program under operator control |
| UN-3 | Run status indication |
| UN-4 | Pump fluids |
| UN-5 | Eliminate breadboard in circuit . |

**Design Inputs**

**Table 2.** Requirements Matrix

|  |  |
| --- | --- |
| Requirement ID | Requirement |
| DI-1 | The User Interface shall allow the user to set pump flow rate. |
| DI-2 | The design shall implement a printed circuit board |
| DI-3 | The button switch shall allow motor initiation/termination |
| DI-4 | The LED shall monitor run status (on/off) |
| DI-5 | The step motor assembly shall pump fluids |
| DI-6 | The PCB should be encased with a shell (w/ USB input) |
| DI-7 | The motor should be contained separately within the PCB shell |
| DI-8 | The LED and button should be attached outside the shell |

**Design Outputs**

**Table 3.** Design Outputs Matrix

|  |  |
| --- | --- |
| Requirement ID | Requirement |
| DO-1 | The serial monitor prompts for tubing geometry and flow rate, sets respective motor angular velocity (See code in PP-1) |
| DO-2 | The PCB holds all electrical components through soldered connections, except for stepper motor (See schematic in PP-1) |
| DO-3 | The button switch initiates motor activity |
| DO-4 | The button switch initiates LED light |
| DO-5 | The stepper motor rolling bearing assembly pumps fluids (See assembly in PP-1) |

**Table 4.** Verification Matrix

|  |  |  |
| --- | --- | --- |
| **Requirement ID(s)** | **Document ID** | **Description of Protocol** |
| DI/O-1 | MTD-1 | UI Flow Rate |
| DI/O-2 | PP-1 | PCB Functionality (Schematic) |
| DI/O-3 | MTD-1 | Button/Motor Functionality |
| DI/O-4 | MTD-1 | Button/LED Functionality |
| DI/O-5 | MTD-1 | Roller Bearing Pump Functionality |

**Design Validation**

**Table 5.** Validation Matrix

|  |  |  |  |
| --- | --- | --- | --- |
| User Need ID | Description | Expected Value | Actual (Pass/Fail) |
| D-VA1 | 2D area for PCB design is less than previous design. | ≤ ¾ A | NA |

\*For D-VA1, previous design area (A)