Department of Bioengineering
UNIVERSITY OF COLORADO
DENVER | ANSCHUTZ MEDICAL CAMPUS

Arduino Module ID: DCW-1

Design Controls Worksheet – 50 Pts

Date Written – 4/2/2020

Date Revised – 4/3/2020

Author: Sean Hansen, Shreemathi Harikrishnan, Kenny Ngo, Jihan Shah

Improvement on Existing Design

For the purposes of this design assignment, our team focused on the fabrication of a PCB to replace the existing breadboard circuit (UN-5, DI-5, DO-5). Our PCB is designed to be a shield that plugs into the Arduino Uno R3 (PP-1; PM11). Designing the PCB as a shield makes it so that the footprint of the circuit is about the same XY dimensions as the Arduino, but it increases the Z dimension slightly with the board itself and the solder-on components. This allows for the circuit to take up much less physical space, and the creation of a PCB cleans up the circuit so it is more visually appealing. Also, using copper traces and soldered-on components eliminates the possibility of loose connections or faulty wires. The fabrication of the PCB is outlined in detail in PP-1. It includes directions for how to create the PCB using the AutoDesk software application Eagle (PP-1: PT2) and also includes instructions on how to export the Gerber files and send them to Advanced Circuits in Aurora for fabrication. After that, PP-1 stipulates that the components (outlined in PP-1; Materials) would need to be soldered on to finish the fabrication of the PCB. Then, TP-1 outlines the testing process to ensure the PCB functions correctly. This primarily includes continuity testing on all of the traces to ensure the connections aren't faulty, as well as a systems level test to ensure the PCB operates the micropump correctly. After PP-1 and TP-1 have been completed, the PCB would need to be verified according to DV-5 to ensure it meets with our engineering specifications as listed in DO-5. Finally, a validation test (DVa-5) would be performed to ensure that the PCB meets the user need (UN-5).

User Needs

User Needs Matrix

ID	Description
UN-1	Improved UX / UI to allow for operator control.
UN-2	Improve Solidworks files to include assembly, hardware, configurations and drawings.
UN-3	Eliminate warping of the printhead resulting from motor temperature when located in the incubator.
UN-4	A method to stop or detach pump heads individually when part of a multi-pump design.
UN-5	Eliminate breadboard or prototype parts in the circuit.

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Design Inputs

Requirements Matrix

Requirement ID	Requirement
DI-1	The UX / UI should be optimized.
DI-2	The SolidWorks files should be updated to include more components.
DI-3	The pump shall have a method to dissipate heat.
DI-4	The device should accommodate for the use of multiple pump heads.
DI-5	The circuit shall not include a breadboard or prototype parts.

Design Outputs

Design Outputs Matrix

Requirement ID	Requirement
DO-1	A GUI was added to call the .ino file and accept inputs for flow rate and tubing diameter to adjust the speed of the motor.
DO-2	The SolidWorks files were updated to accommodate different configurations based on desired tubing geometries.
DO-3	A heatsink and fan assembly were attached to the motor to direct the heat generated while running out of the incubator.
DO-4	A single Arduino operates 5 different pump heads and has the ability to turn them on and off individually.
DO-5	A functional PCB was designed using Eagle and produced by Advanced Circuits.

Design Verification

Verification Matrix

Requirement ID	Description	Pass/Fail
DV-1	A GUI was designed to accept parameters and adjust pump speed. It is able to accept flow rate and tubing diameter and correctly convert them into a speed for the pumps stepper motors, which it then displays on the screen.	
DV-2	The Solidworks files accommodate for different tube geometries. Assembly, drawings, and hardware files were made for different configurations.	
DV-3	The pump was built with a heatsink and fan assembly to maintain a temperature of less than 40°C in the incubator for at least one hour.	
DV-4	The Arduino controls 5 different pumps heads simultaneously with the option to turn on/off and detach/attach tubes individually. Each pump can function on its own or in conjunction with 1-4 other pumps.	
DV-5	A fully functional PCB was developed for the circuit.	

Design Validation

Validation Matrix

User Need ID	Description	Pass/Fail
DVa-1	The UI was improved to allow more effortless operation.	
DVa-2	The Solidworks files were updated to be functional with different tubing configurations.	
DVa-3	The heat from the motor does not warp the printhead while the motor is running in the incubator.	
DVa-4	The Arduino can individually operate each pump while being part of a multiple pump design.	
DVa-5	The circuit doesn't include a breadboard or prototype parts.	