Arduino Module ID: PP-1

Prototyping Protocol – 10 Pts

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Protocol Description – (PCB Manufacturing Protocol)

1. Open Eagle and gather necessary parts for wiring as a reference.
    a. Most parts are provided in the Eagle library already, but if there are missing parts, they can be imported from other online sources.
        i. Add to Eagle by putting into the Eagle libraries folder and selecting "use library" in Eagle.
    b. Needed parts (outlined in Materials table):
        i. Arduino Uno
        ii. Microstepping Driver
        iii. 5 mm LED
        iv. Push Button
        v. Capacitor (100 μF)
        vi. Resistors (1k, 50k)
        vii. Unidirectional Plug
        viii. Generic 4 pin connector
        ix. Voltage sources (12V and 5V)
        x. Ground
2. After gathering the parts, wire them accordingly to Figure 1 (instructions are also provided in this section):
    a. Ground connections:
        i. Arduino GND pin.
        ii. Driver ENABLE & GND pins (1, 9, & 15).
    b. Power Connections:
        i. 5 V power supply to Arduino 5V and Driver VDD pins.
        ii. 12 V power supply to driver VMOT pin (16) with 100 μF capacitor in parallel with GND pin 9.
    c. LED:
        i. Controlled by Arduino digital pin 6.
        ii. In series with 1kΩ resistor.
        iii. Ground.
    d. Push Button:
        i. Controlled by Arduino digital pin 5.
        ii. In parallel with 50kΩ resistor.
        iii. Ground.

e. Stepper and Directional Pins:
   i. Stepper on driver controlled by Arduino digital pin 3.
   ii. Direction for the driver is controlled by Arduino digital pin 2.
f. Additional driver connections:
   i. Jump the RESET and SLEEP pins (5 & 6).
   ii. Pins 11 through 14 are wired to the motor using a generic 4 pin connector.

3. Generate a new board file to format wired pieces (Figure 2):
   a. Utilize both the top and bottom layers of the board to ensure there are no connections crossing on the same layer.
   b. Use the via command to jump wires between layers.
   c. For power traces, use a thicker trace to accommodate the higher current.
4. Export files to send to Advanced Circuits for production:
   a. Use the CAM Processor command to export the board and schematic as Gerber files (be sure to rename the files appropriately).
   b. These files can be sent to Advanced Circuits in Aurora, CO to be produced.
5. Once the PCB has been received by advanced circuits, all of the circuit components can be soldered onto the board and it can then proceed to testing, outlined in TP-1.

Figures and Diagrams

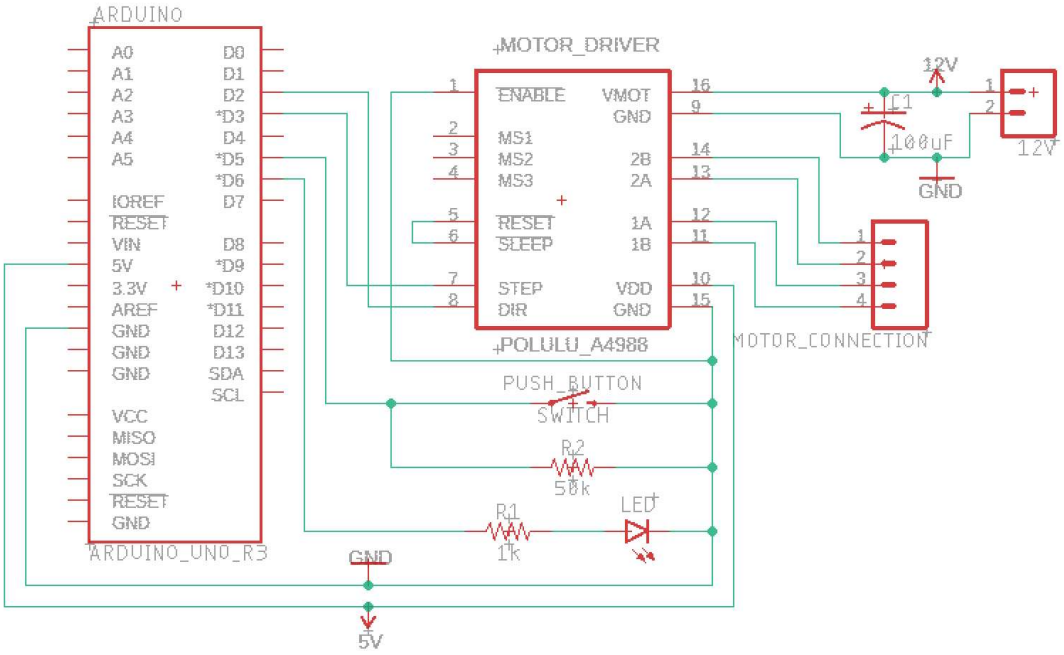

Figure 1. Wiring schematic for PCB (CF1).

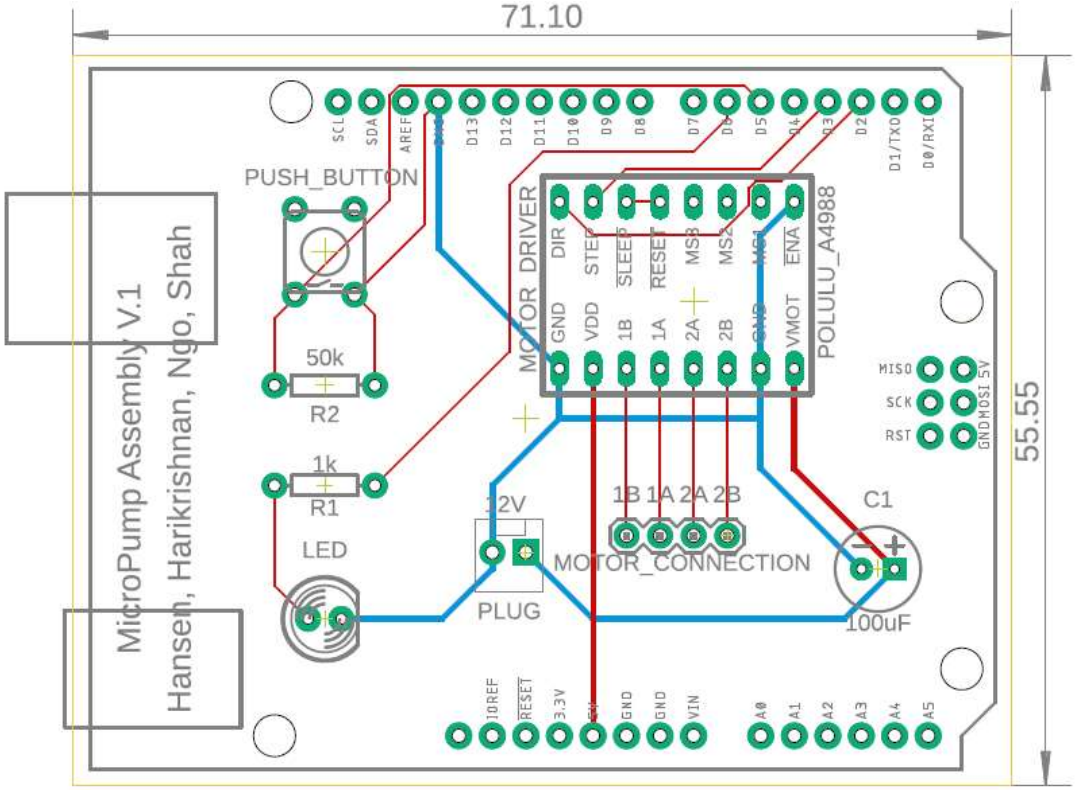

Figure 2. Board schematic for the PCB (CF2). Note that the power and ground traces are thicker to accommodate higher current.

Tools and Equipment

ID	Tool	Name / # if applicable	Location	Purpose
PT1	Arduino Computer Application	Arduino IDE	Personal Computer	To generate the code for the Arduino.
PT2	Eagle Computer Application	N/A	Personal Computer	To design and generate the PCB.
PT3	Screwdriver	N/A	Design Lab	Used to assemble the pump and its housing.
PT4	USB Cable	N/A	Design Lab	Used to connect the Arduino board to the computer.
PT5	Soldering Iron	N/A	Design Lab	Used to solder components onto the Arduino board.

Materials

ID	Material	Purpose
PM1	Flanged ball bearing (x4)	It provides the rotating component with an area for the tube to be placed.
PM2	Screws, washers, and bolts (5 short, 2 longer screws; 4 small, one large washer; 6 small bolts)	Used to attach the 3D printed parts to the stepper motor, and to assemble the rotating component of the pump.
PM3	3D printed parts	Used to house the motor component and to make the rotating centerpiece of the pump.
PM4	NEMA 17 stepper motor	The basis for the pump that rotates and pushes the liquid through.
PM5	A4988 motor driver	The chip used to allow higher currents and voltages to be supplied to the motor.
PM6	Wires	To connect the different components of the circuit.
PM7	4-pin generic header connector	To connect the stepper motor to the circuit.
PM8	2-pin Molex connector	Unidirectional connector for 12 V power supply (prevents backward connection).
PM9	Small peristaltic tubing	The liquid will be pumped through the tube.
PM10	Solder	Solder components onto the Arduino board.
PM11	Arduino Uno R3	Electronic platform for the circuit.
PM12	Resistors (1 kΩ, 50 kΩ)	To limit the current flow.
PM13	Capacitor (100 μF)	To store current flow and reduce noise.
PM14	LED	When the push button is pressed, the LED lights up and initiates the pumping process.
PM15	12 V Power Supply	It provides the stepper motor with a sufficient power supply to function.

Datasheets (*for all parts not listed, any generic part works*)

Part	Link
NEMA 17 stepper motor	https://www.pololu.com/file/0J685/SY42STH47-1206A.pdf
A4988 motor driver	https://www.pololu.com/file/0J450/a4988_DMOS_microstepping_driver_with_translator.pdf
Molex 2-pin connector	https://www.sparkfun.com/products/9918
Arduino UNO R3 (ATMega48A microchip)	http://ww1.microchip.com/downloads/en/DeviceDoc/ATmega48A-PA-88A-PA-168A-PA-328-P-DS-DS40002061A.pdf

Computer Files

ID	FileName / Link	Purpose	Location
CF1	MicroPumpPCB.sch	Shows how to wire the components together	/Arduino_HansenHarikrishnanNgoShah/MicroPumpPCB.sch
CF2	MicroPumpPCB.brd	Shows how the wiring fits on a PCB board.	/Arduino_HansenHarikrishnanNgoShah/MicroPumpPCB.brd
CF3	MicroPumpPCBGerbers.zip	Sent to Advanced Circuits in Aurora to be built. Contains all of the Gerber files.	/Arduino_HansenHarikrishnanNgoShah/MicroPumpPCBGerbers.zip
CF4	MicroPumpCode.ino	Uploads to Arduino to control how the board functions.	/Arduino_HansenHarikrishnanNgoShah/MicroPumpCode/MicroPumpCode.ino
CF5	Pump_SW_Files.zip	Contains all of the Solidwork files necessary to create the 3D printed parts for the micropump assembly.	/Arduino_HansenHarikrishnanNgoShah/Pump_SW_Files.zip