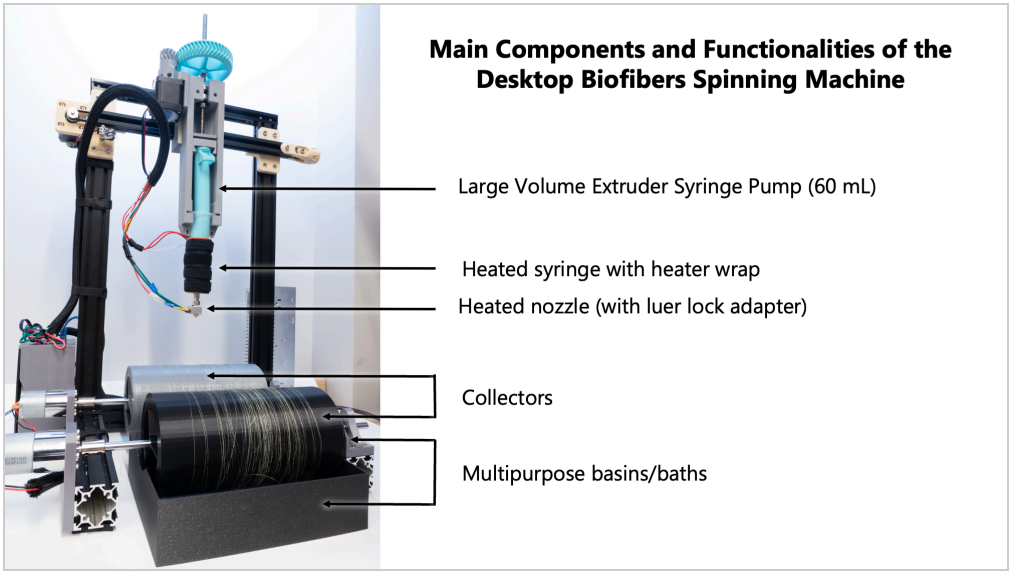
v1.0.2 Instructions

[WIP] V1.0.2 - Biofibers Assembly Guide

Last Updated: 2025-07-17



Welcome! We're glad you're building a Biofibers Machine! This guide serves as a reference for helping you assemble the machine. Please note that **this guide is a work-in-progress**! If you find areas that could use improvement, please leave a comment.

For reference, the machine's bill of materials, printed parts, and fully assembled 3D model can be found on our GitHub Page: https://github.com/utilityresearchlab/desktop-biofibers-spinning

Our software tool can be found here:
https://github.com/utilityresearchlab/biofibers-machine-control/

Please also join our Biofibers Community Discord server for help:
https://discord.gg/vDmk3t2FMX

Contents

⚙️ [COMING SOON] Mechanical Set-Up

To get started on the mechanical set-up, download and open the Fusion360 CAD assembly file. Use this assembly as a guide as all of the parts are labeled/or can be easily identified.

At a high level, it is best to assemble the frame first, then the X-axis with carriage, then the collectors, then the Syringe Pump/LVE (this can be assembled separately and has its own instructions linked below).

Once you have the LVE assembled, you can attach it to the X-axis carriage to complete the assembly.

🏗️ [WIP] Frame

🚃 [WIP] X-Axis

🛗 [WIP] Z-Axis

⛽ [WIP] Syringe Pump

Follow **[0:00 to 9:50]** in the ▶ Large Volume Extruder (LVE) Assembly Instructions Video. See their their paper for additional details.

🚡 [WIP] Mounting the Syringe Pump to the X-Axis Carriage

TBD

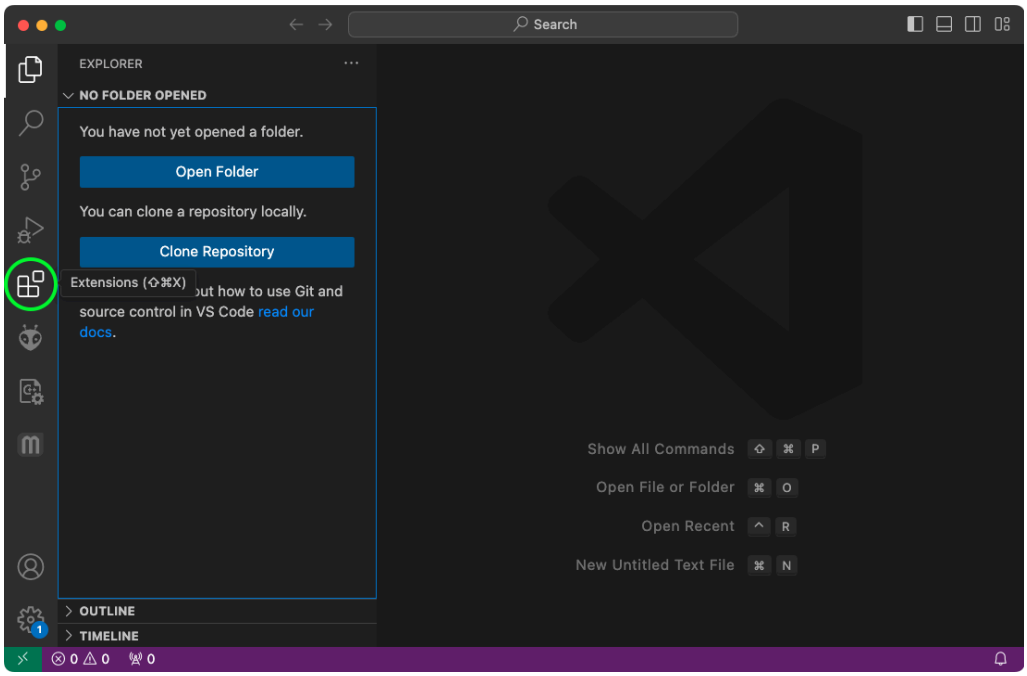
 [WIP] Collector Assembly

💾 Firmware

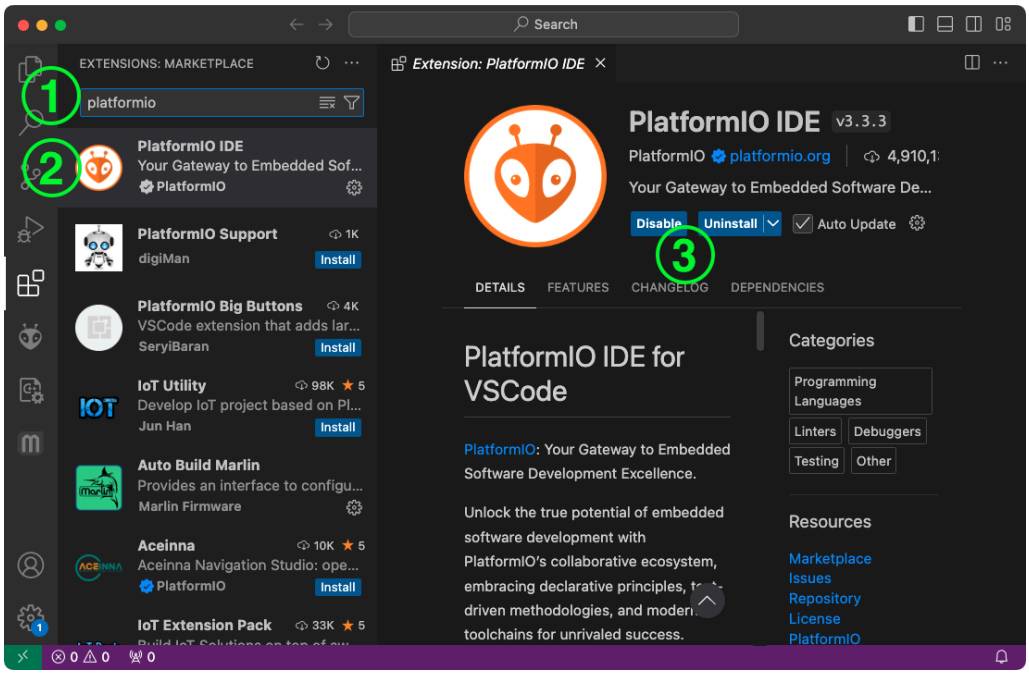
Our machine uses a modified version of the Marlin Firmware available on our GitHub repository. The default configuration in the repository is **intended for a Arduino Mega 2560 + RAMPS 1.4 control board**.

Installing VSCode, PlatformIO, and AutoBuild Marlin

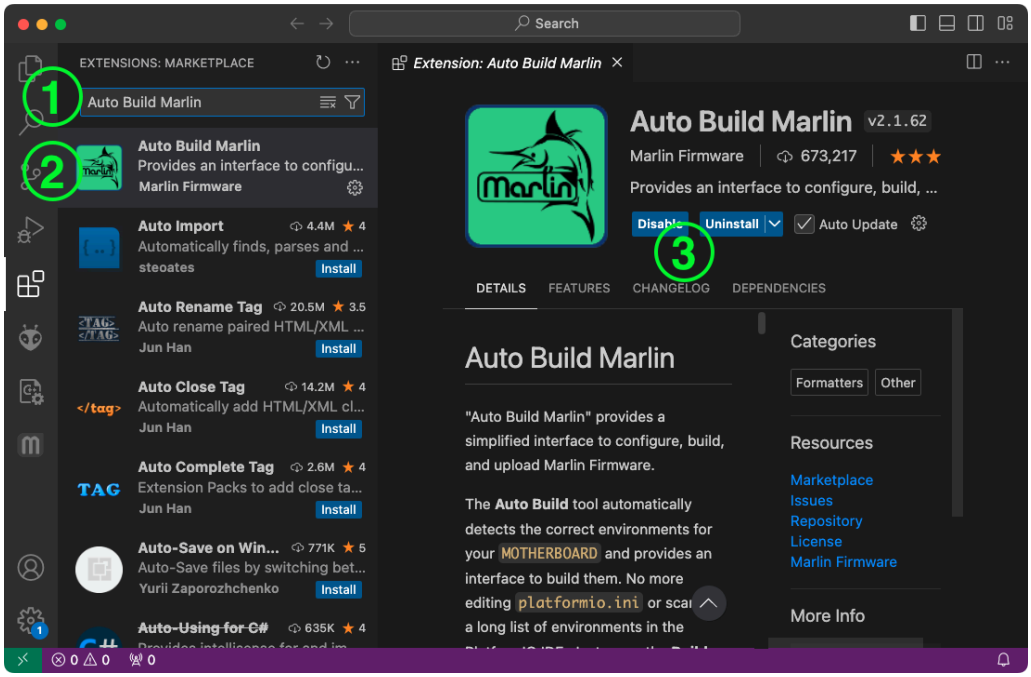
1. Download and Install **VSCode**: https://code.visualstudio.com/Download
2. Open VSCode
3. From within VSCode, click the “Extensions” icon (green circle below)



4. **For PlatformIO**: In the search of the “Extensions: Marketplace” window:
   (1) search “**platformio**” → (2) Select “PlatformIO IDE” in the results → (3) Click **Install**.



5. From **Auto Build Marlin**: In the search of the “Extensions: Marketplace” window → (1) search for “**Auto Build Marlin**” → (2) Select “Auto Build Marlin” in the results → (3) Click “**Install**”



6. After installing the plugins, **restart VSCode**.

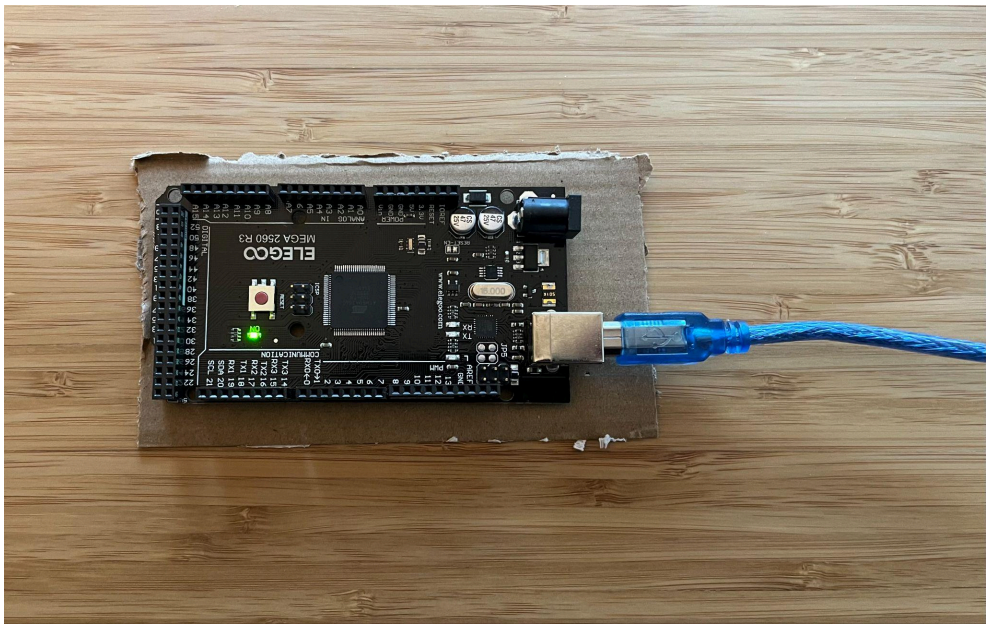
Compilation and Upload

Once you've properly set-up VSCode, you can now compile and upload the firmware using the following steps.

1. Ensure Power Supply and control electronics are **COMPLETELY OFF.**
2. Disconnect power cables AND any USB cables from the Arduino Mega.
3. **Separate the Arduino Mega board from the RAMPS 1.4 board (if they are attached).**
4. Place the Arduino on a non-conductive surface like a wood table or piece of cardboard.

   ⚠️ NEVER PLACE EXPOSED ELECTRONICS ON A METAL SURFACE—you will damage the electronics.

5. Connect a USB cable to the Arduino Mega board and to your computer.



   The Arduino should power on (**you should see an LED steadily on**). In addition, you may see another LED blinking (this is typically the default firmware).

6. On your computer, open VSCode.
7. In VSCode, go to **File** → **Open**,
   a. Go to the location where you downloaded the desktop-biofibers-spinning GitHub repository , then go to the folder:
   `desktop-biofibers-spinning` → `firmware` → `Marlin-2.1.1-biofibers` → **Click Open.**

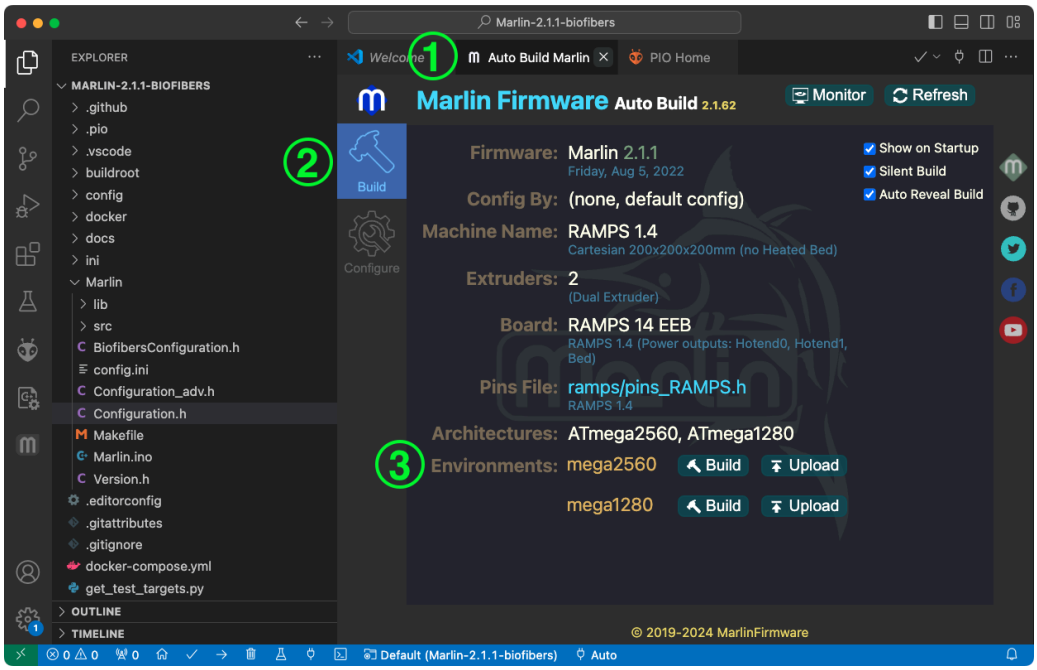
8. The folder should open in VSCode and **after a few seconds**, you should see tabs appear for “Auto Build Marlin” and “PIO Home”:

   (1) Click the tab for “Auto Build Marlin”

   (2) In the “Build” sub-tab, verify the following information:

   - Extruders: 2
   - Board: RAMPS 1.4
   - Pins File: ramps/pins_RAMPS.h
   - Architectures: ATmega2560, ATmega1280

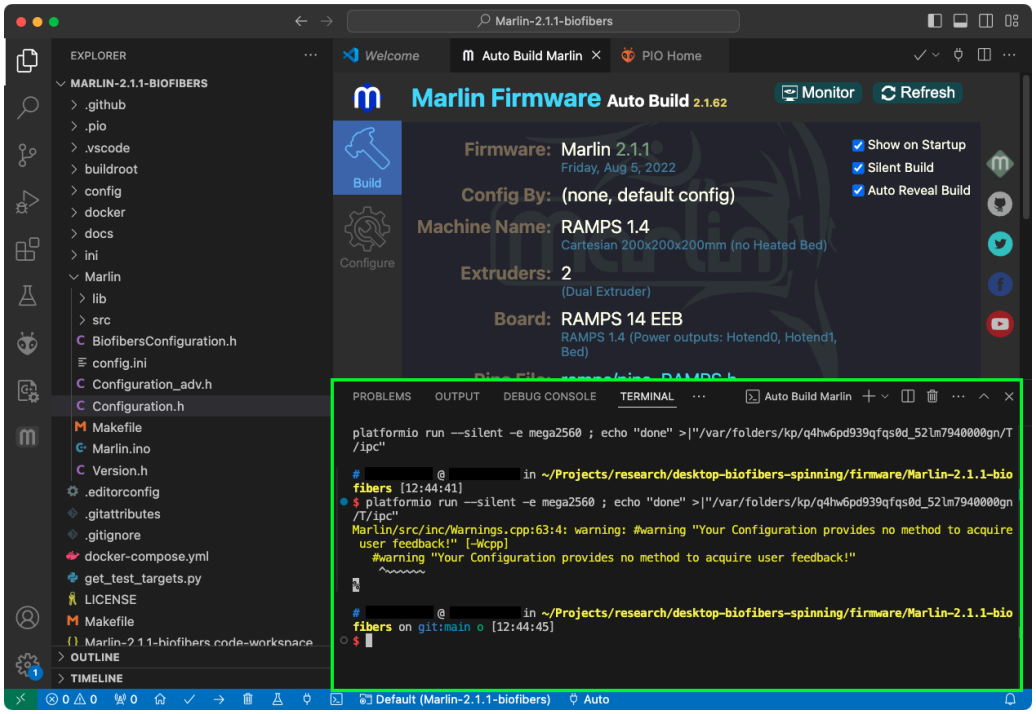
   (3) Under “Environments” → “**mega2560**” → **Click “Build”.**



9. A terminal tab should appear that runs a command to compile the firmware (see the green box in image below). **You should only see a warning** (‘`#warning “Your Configuration provides no…”`’).

   <u>If this warning is the only message that appears</u>, your compilation was successful 🎉. Proceed to the next step.

   ⚠️ **If you have any other errors, reach out in the `#firmware` channel on Discord—**we’ll have to help you debug!



10. Now that you've successfully compiled the firmware, the next step is to upload the firmware to the board.

    In VSCode, in the "Auto Build Marlin" tab, under "Environments" → "**mega2560**" → **Click "Upload".**

    Another command will run in the terminal window, showing the progress of the upload.

    If all goes well, there should be no errors and you should see the message:
    "`avrdude done. Thank you.`"

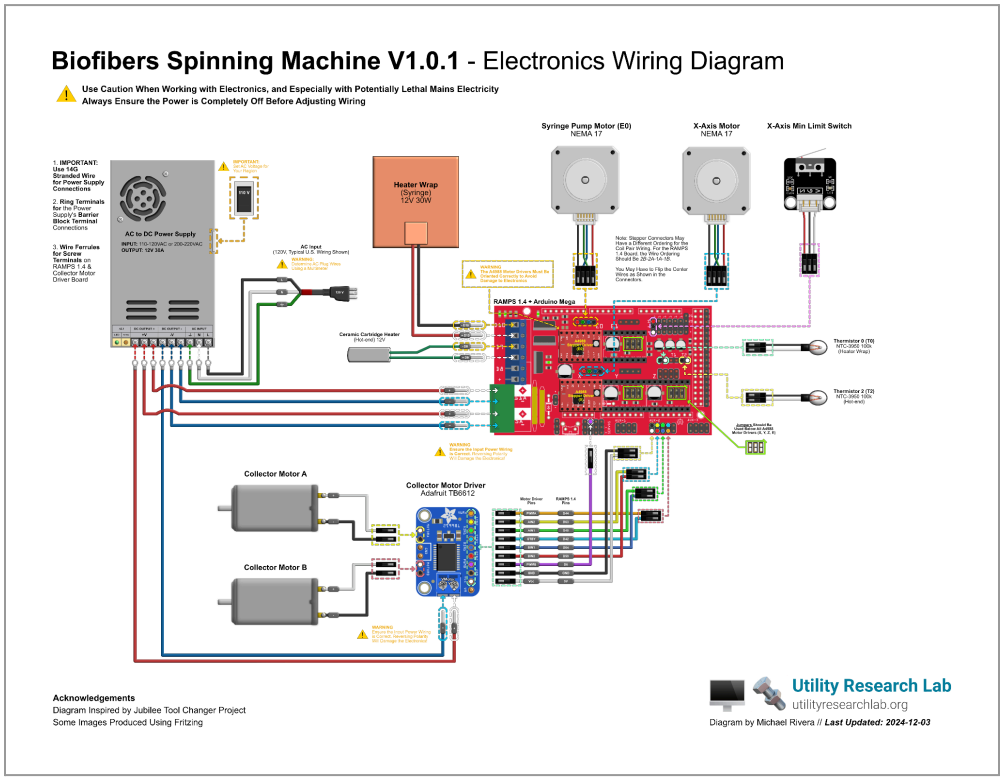
11. Unplug the Arduino from the USB cable, and reconnect the Arduino to the RAMPS 1.4 board (**be mindful that the pins are oriented and inserted correctly**!)

12. You are now ready to wire the electronics 🎉.

⚡ Electronics and Wiring

1. Download the wiring diagram from the electronics-assembly folder in GitHub Repository linked below:
   https://github.com/utilityresearchlab/desktop-biofibers-spinning/tree/main/hardware/electronics-assembly

   ⚠️ **Be sure to use the version that matches the machine you are building.** Version V1.0.1 is shown as an example below.



2. Use the wiring diagram to connect the electronics, and **pay careful attention to any listed ⚠️ warnings and practice good electrical safety.**

   Note that the color of the wires shown here are a guide—the important aspect is that the wires join the intended pins. For example, on the X-Min Endstop, the signal pin "S" should be wired to the RAMPS board's X-min "S" pin (shown with a red wire above).

   While we strive to make this process as easy and safe as possible, **<u>you are assembling this machine at your own risk!</u>**

   a. **Always use caution when working with electronics, especially lethal mains voltage.**
   b. **MAKE SURE ALL POWER IS OFF** BEFORE INSERTING OR REMOVING WIRES**.**

    c. **Do not reverse the polarity of wires! You will damage your electronics!**
3. **If you have questions, reach out on Discord in the #electronics-and-wiring channel.**

🔌 Electronics Testing

After you have completed the wiring and successfully uploaded the firmware, there are two stages to testing the electronics of your machine:

- **"Smoke Testing"** — this ensures that you have wired everything correctly and will not cause a fire.
- **Software Control & Wiring Testing** — this is to verify that your various electronics (motors, temperature sensors, heaters) work as expected.

⚠️ For all of the electronics testing, ensure that there are no exposed wires or metals touching your control boards (Arduino/RAMPS 1.4), and that all wires are secure.

🚭 Smoke Testing

Before beginning:

- Make sure your Arduino/RAMPS 1.4 board is assembled correctly; disconnected from the power supply and your computer; and **completely powered off.**

- **Triple-check your wiring** with the wiring diagram for your machine (See ⚡Electronics and Wiring).

In this test, you will make sure there are no short-circuits or improper connections in your electronics.

⚠️ If you see/smell smoke, or any signs of burning, you should immediately unplug and power off the electronics. Otherwise, you risk damaging your electronics and causing a fire.

1. Unplug your power supply from its AC wall input.
2. Connect a USB cable to the Arduino+RAMPS 1.4 board.
3. Wait a few seconds and verify that the Arduino+RAMPS 1.4 board powers on. **There should be no signs of smoke or burning**.
4. Unplug the USB cable from the Arduino+RAMPS 1.4 board, and ensure the power is completely powered off.
5. Connect the power supply to the Arduino+RAMPS 1.4 board using the green connector.
6. Plug your power supply into your AC wall input.

7. Wait a few seconds and verify that the Arduino+RAMPS 1.4 board powers on. **There should be no signs of smoke or burning**.
8. If everything appears to be working well so far, you can proceed to test the rest of the electronics and wiring using software control 🎉.

🎛️ Software Control Testing [WIP]

In this section we will connect to and communicate with the Biofibers Machine to ensure proper wiring and functionality. You will first install and set-up control software on your computer, then you will connect to the machine, visualize sensor readings, and send test commands.

Software Installation and Configuration

1. Download and Install Repetier Host on your computer. This is a **free** and commonly used 3D printer control software that allows you to send g-code commands and visualize machine sensor readings like temperature.

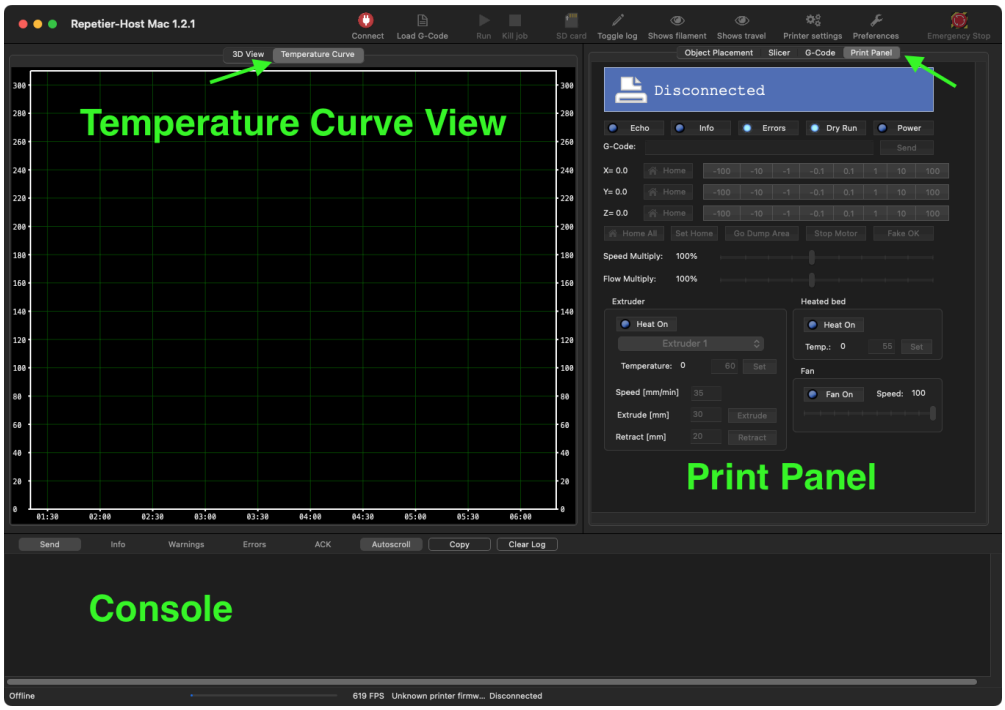
2. Open Repetier Host on your computer. You should see a window with 3 sections (left, right, bottom).

   - **On the left,** there are tabs that display either a “3D View” or a “Temperature Curve”. **Select the** “**Temperature Curve**” tab.

   - **On the right,** there are tabs for “Object Placement”, “Slicer”, “G-Code”, and “Print Panel”. The first two are only relevant for 3D printing, so we will not use them. The G-Code view is useful later if you’d like to write and run a G-code script with many commands. **Select the “Print Panel”** tab. We will use this panel to directly control the machine and send individual commands.

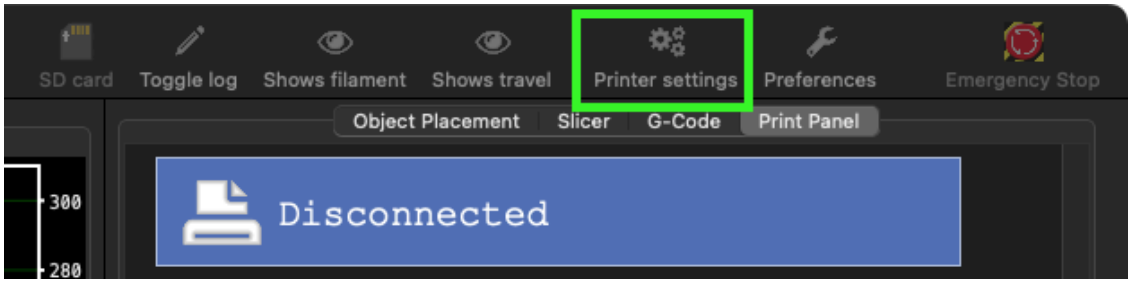
   - **On the bottom**, there is a “console” section that will display information sent to/from the printer as well as any errors/warnings.

   Your window should now look the like following image:



3. **Connect a USB cable to your Arduino+RAMPS 1.4 board and your computer.** The Arduino should power on.

4. To communicate with the machine, we need to configure Repetier Host. Click the "**Printer Settings**" button in the top button bar.



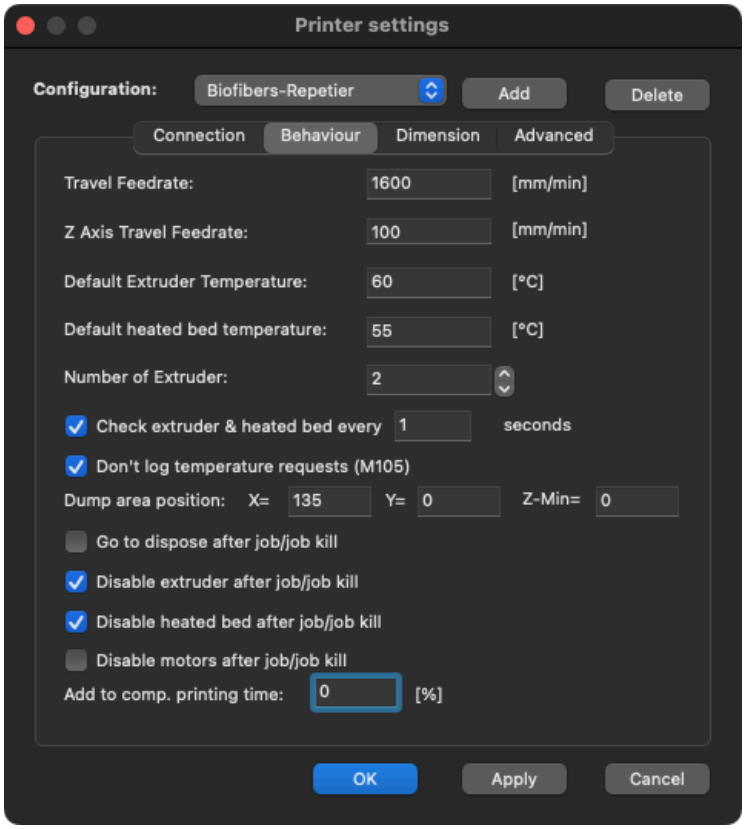
5. A “Printer Settings” window should appear like below:

6. Click the “Add” button and create a new configuration with the name “Biofibers-Repetier”.

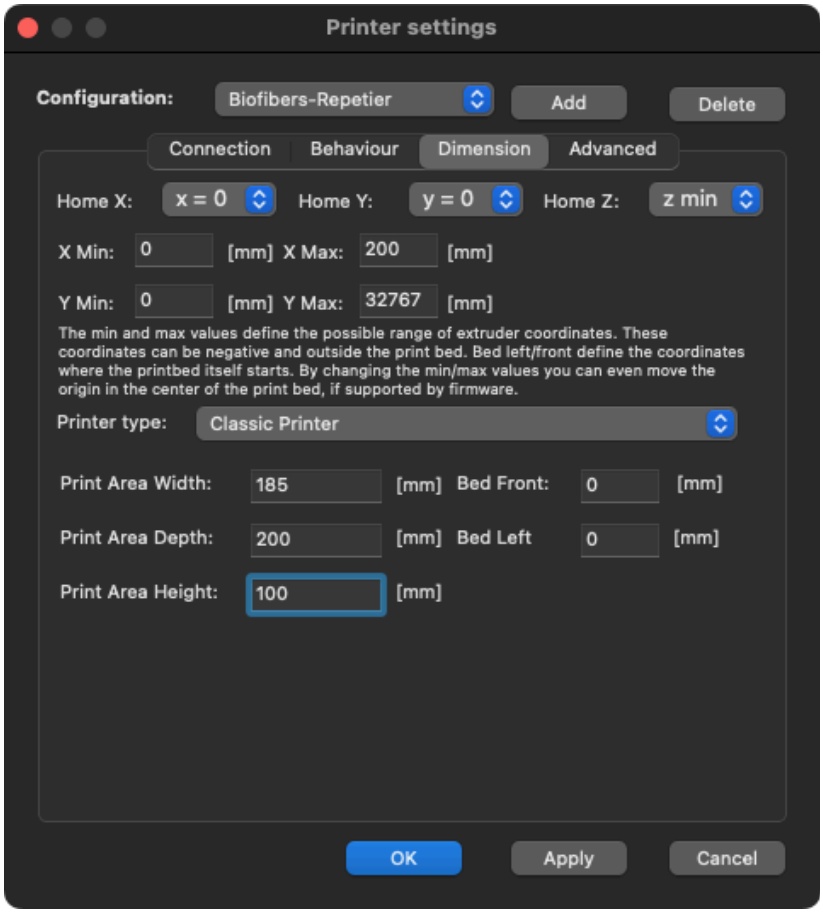
7. In the “**Connection**” **tab**, configure the following values (with the exception of the Port, these are all shown in the image above).

    - **Port**: Click the drop down menu, and **select the a USB port with a name similar to “usbmodem###”**. **There may be multiple ports listed, and you will have to determine which port is correct later. In addition, this port will change if you switch USB ports on your laptop, etc. You can always update the port here.**
    - **Baud Rate**: 250000
    - **Receive cache size:** 127
    - **Timeout**: 40
    - **Use Ping-Pong Communication:** ☐ **UNCHECKED**
    - **Firmware sends OK after error:** ☐ **UNCHECKED**

8. Select the “**Behavior**” tab, and configure the following values:

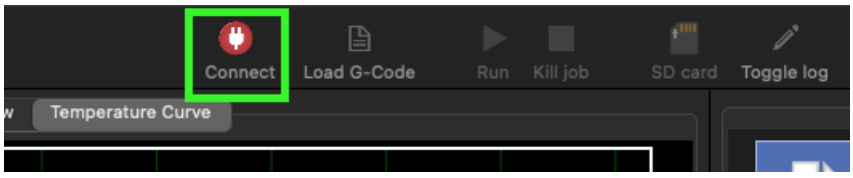


9. Click the “**Dimension**” tab, and configure the following values:

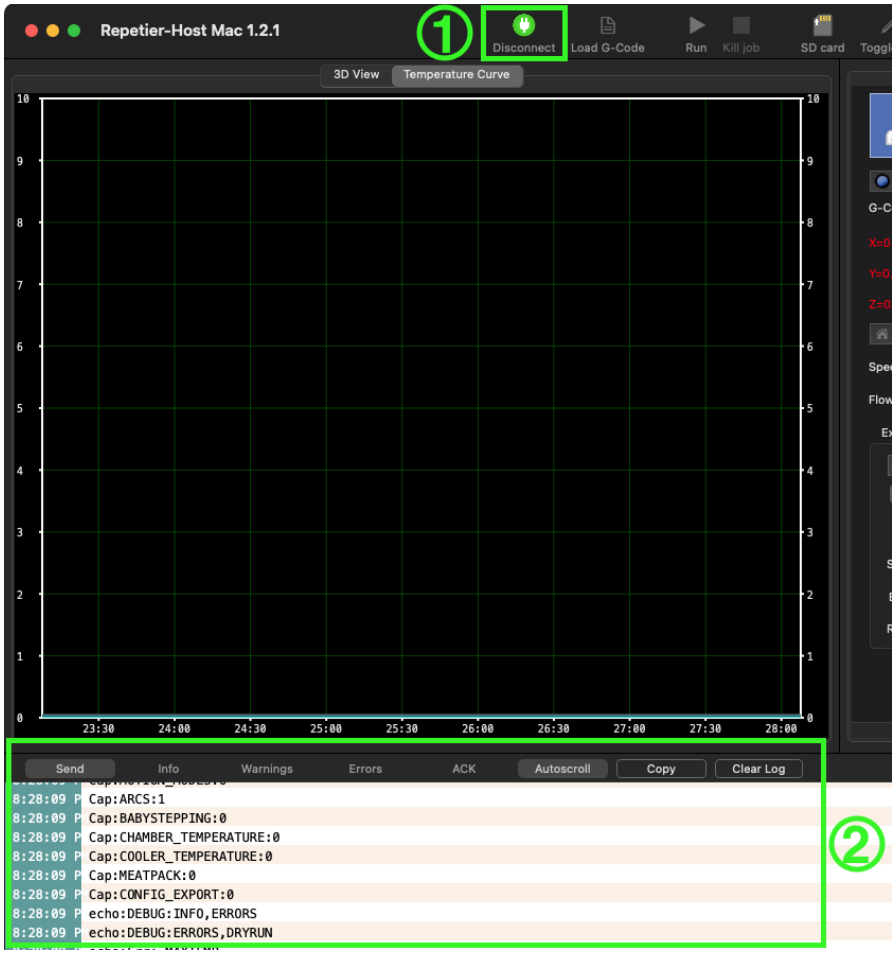


10. **Click** the “**Apply**” button and **then** click “**OK**”.

11. From the main Repetier Host window, click the “**Connect**” button in the top button bar.



If the connection is successful, then (1) the “Connect” button will become a green button with a “Disconnect” label; and (2) the console window will show messages from the machine as seen in the image below:



If the connection fails OR nothing appears to happen, you likely have selected the wrong USB port. Go to "**Printer Settings**" → "Connection" tab → "Port", and then select a different usbmodem### port and try again.

If you've tried all the listed ports to no avail, try plugging your Arduino+Ramps 1.4 board into a different USB port on your computer. If that fails, reach out on Discord.

12. You are now connected to the machine and can begin testing the wiring and electrical components of the machine 🎉.

Testing Components and Wiring

⚠️ For all of the tests below: **if at any point you need to adjust or unplug/plug-in wires, you should completely power off the electronics** and unplug the Arduino+Ramps 1.4 board from your computer AND unplug the power supply from the AC wall input.

Temperature Sensors

At the bottom bar of the Repetier Host window, you should see the temperature readings for T0 (extruder) and T1 (heater wrap). The default temperature reading should be around room temperature (between 23 to 28 C).

If your temperature sensor readings are very negative or if you have no temperature sensor reading (the value is 0.0 or “unknown”), you should ensure the wires are properly connected and in the right locations. Also check to make sure the wire is not damaged at the sensor end. The glass-bead temperature sensor wires can break easily during installation to the heater block if you are not careful.

Heaters

Start with the Extruder Heater—try setting the temperature to 40 C. The extruder temperature (T0) should rise and stabilize.

If nothing happens, confirm that the heater wires are correctly wired and secure. If the syringe wrap temperature (T1) rises, you have either swapped the wire positions for the heater or swapped the wire positions for the temperature sensors. You will need to trace the wires back to the board and confirm they are wired according to the electronics wiring diagram.

If the wires are not correct, power down the board by unplugging the USB cable and AC wall input. Then correct the wiring and repeat the test.

After confirming the extruder heater and temperature sensor, repeat this process for the syringe heater wrap (T1) and temperature sensor.

X-Min End-Stop

First send the G-code command: M119
In the console of Repetier Host, verify that the output of the “endstop status” for “x-min” is **OPEN**.

Now use your hand to press and hold the X-min endstop closed. While pressing the X-min endstop, send M119 again. Verify that the endstop status for “x-min” is now **TRIGGERED**.

Motors

⚠️ **For all of the motor testing: if any motor is spinning in the opposite direction to what is expected, you should completely power off the electronics by unplugging the USB cable and AC wall input. Then if it is a stepper motor (X-Axis and Syringe Pump), flip the**

cable of the motor on the RAMPS board. If it is a collector motor, swap the wire connections for the motor.

X-Axis (X)

X-axis Carriage / Syringe Pump should move to the right with positive movement; to the left with negative movement.

Syringe Pump (E)

Positive movement should cause the pump to extrude (large gear teeth spin counter-clockwise >>); negative movement should cause the pump to retract (large gear teeth spin clockwise <<).

As a note, **the syringe pump is not designed to move at fast speeds**, especially when material is loaded. It is recommended that you test the motor at low speeds (<= 25 mm/min). When a highly viscous material is loaded, speeds <= 15 mm/min are usually ideal. If you experience skipping or stalling of the syringe pump motor, you should try decreasing the speed.

To test the syringe pump, send the command: G1 F16 E1.0
This should move the syringe pump's shuttle down 1 mm to extrude 1 mm worth of material (positive movement) at 16 mm/min.

Collectors

Collector motors should spin in the same direction at the same time and at the same speed. The collectors are controlled by three gcode commands: M3 S[0-255], M4 S[0-255], and M5.

The M3 command spins the collectors clockwise. The M4 command spins the collectors counter-clockwise. For both M3 and M4, the S parameter specifies the speed as a proportion of the motor's max RPM from 0-255. So S255 would run the collector motors at their max RPM. To run the motors at 50% of their max RPM, you would use S128.

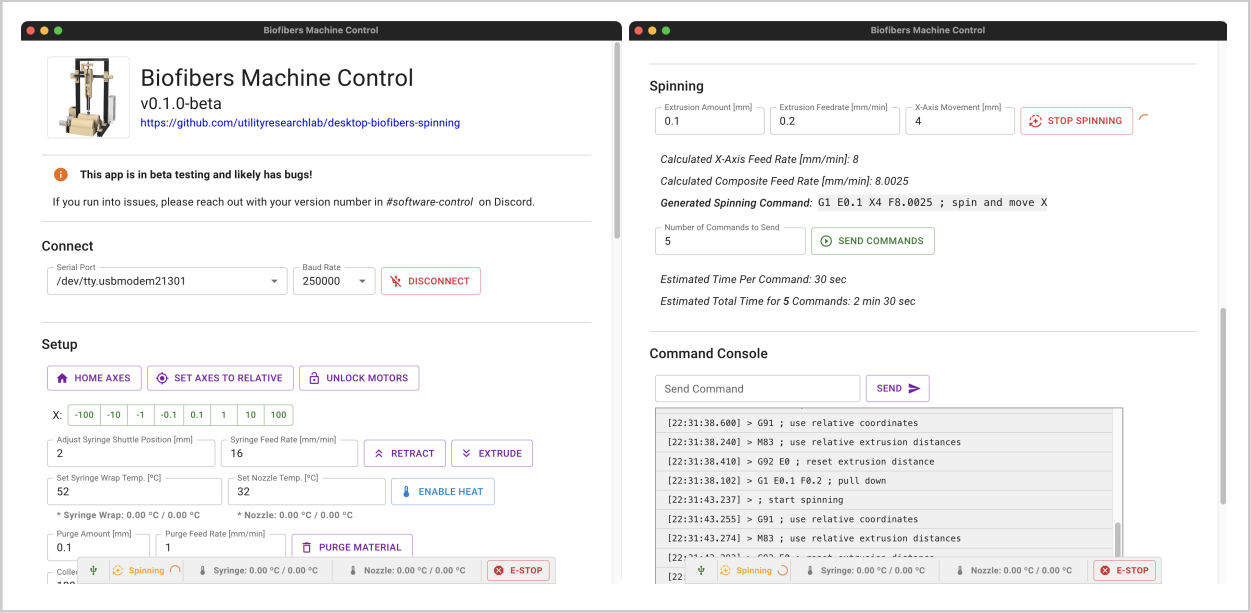
As a note, S-values <= 30 will often not produce enough current to drive the motors at a steady speed so you may notice some stalling or skipping at these values.

As a test, send the command M3 S255. Both collectors should spin clockwise at full speed. *If one or both are spinning in the wrong direction, you will need to power down your electronics and flip the connections for the specific motor's wires at the Adafruit motor driver.*

To stop the collectors, send an M5 command.

🧑‍💻 Controlling the Machine

To control the machine, **we highly suggest using our open-source tool for MacOS and Windows available on our [Biofibers Machine Control repository](#)**. The latest release can be downloaded here: https://github.com/utilityresearchlab/biofibers-machine-control/releases/



We recommend our app as it is designed to handle sending repeated sequences of commands at regular intervals (useful for spinning), and it streamlines controlling components like the collectors with the click of a button—you don't need to write any g-code!

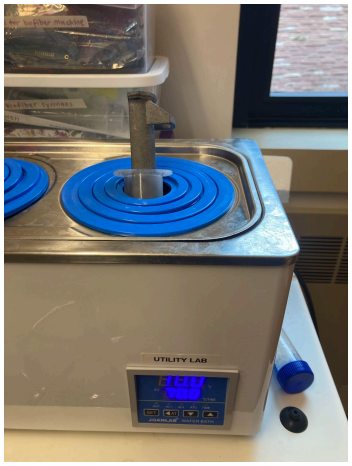
Alternatively, you may use any 3D printer host controller software like Repetier Host or Universal G-Code Sender to communicate with the machine. In your host controller software, set the baud rate to 250000, and connect as you would a typical 3D printer. You can then use g-code commands to set the temperature of the syringe heater and nozzle, as well as set the collector speed/direction. More details are in the paper linked above.

The machine follows **Marlin G-Code Commands** for setting temperatures, moving motors, etc. **There are also some additional commands that we have enabled/customized to support control over the collectors on the machine**.

For information about commands and the spinning procedure, please see **Section 3.2 (Biofibers Spinning Walkthrough)** of the research paper and the section below.

🧵 [WIP] Spinning Gelatin Fibers

Step 1: Pre-heating the spinning solution



For gelatin, we recommend pre-heating the spinning solution at 60℃ - 70℃ for about 15 min until the solution turns from solid to a viscous liquid.

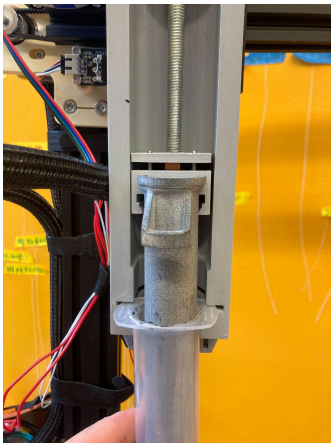
This can also be done on the machine, but may take a bit longer for the heat to propagate through the material in the syringe.

Step 2: Prepare multipurpose bath

If you are not planning to coat the fibers using the collector basins, you can skip this step. You can also coat the fiber by spraying or brushing on the coating as an alternative to using the bath.

If you are using a bath in the collector basins, you should prepare the liquid, and pour the liquid in the basin(s). You can either lift the machine so that collectors are positioned in collector basins or temporarily remove the collector assembly while preparing the baths.

Step 3: Loading the syringe with material into the machine

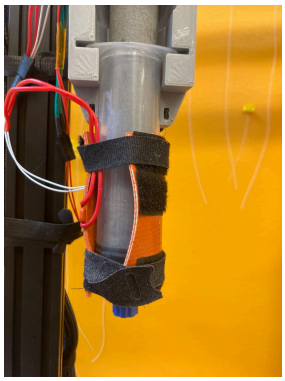


First, enter the following commands to home the X-axis carriage and set all axes to relative:
`G28; home all`
`G91; use relative coordinates`
`M83; use relative extrusion distances`
`G92 E0; reset extrusion distance`

Then, adjust the pump height to slot in the syringe by using the following command(s) to lower or retract the pump (change the E value to adjust how much you want to move the pump). For example:

- To lower the pump by 2mm: `G1 **E2** F10`
- To retract the pump by 2mm: `G1 **E-2** F10`

In the photo above, the pump is too low for the syringe to be slotted in so it needs to be retracted. You can also adjust the speed at which the pump moves by changing the F value (larger F value means faster speed).



Once you finish inserting the syringe, add the heat wrap and set the temperature with this command where the F value is the temperature in Celsius:
M104 S[40] T0; set temperature

TODO Step 4: Setting up the nozzle and collectors

TODO Step 5: Pull-down to start the spinning process

TODO Step 6: Spinning biofibers

TODO Step 7: Collecting the biofibers

🆘 Troubleshooting FAQ

Here is a list of common issues and frequently asked questions. If you're struggling or your issue is not listed, the best way to get help is to **join our Biofibers Community Discord server**. After joining, you can post a question in the **#troubleshooting** channel. This will allow the Biofibers community to directly assist you in resolving your specific challenge.