

r3bEL mini

User Guide

Version 1.1

Contents

- 1 r3bEL mini Overview..... 6
- 2 Safety Precautions..... 7
 - 2.1 General Safety..... 7
 - 2.2 Protection..... 7
- 3 Accessory Checklist 8
 - 3.1 Additional Items..... 8
- 4 Software Installation..... 9
 - 4.1 USB Control 9
 - 4.1.1 Step 1: Download Pronterface 9
 - 4.1.2 Step 2: Download and Install Arduino IDE 10
 - 4.1.3 Step 3: Download, Install and Configure Slic3r 12
 - 4.2 Setting up Pronterface 19
 - 4.3 Custom Buttons..... 22
 - 4.4 Understanding the Custom Button Functions 24
 - 4.5 Editing Graph dimensions 25
- 5 Your First Print..... 27
 - 5.1 Required Items: 27
 - 5.2 Loading and Unloading Syringes..... 27
 - 5.2.1 Loading a syringe 27
 - 5.2.2 Unloading a syringe 28
 - 5.3 Procedure 28
- 6 Printing from SD card 30
- 7 Shutdown Procedure 31
- 8 Connect via Wi-Fi 32
 - 8.1 Printer Driver Installation (Windows)..... 32
 - 8.2 Configuring the Wi-Fi 35
 - 8.2.1 YAT Terminal (Windows)..... 35
 - 8.2.2 Coolterm (macOS) 40
 - 8.3 Web Control Interface..... 46



- 9 **Connecting to Rebel Mini in access point mode** 47
 - 9.1 Windows Users..... 47
 - 9.2 macOS computer 52
 - 9.3 Connecting to Web Control:..... 58
- 10 **First Print using Web Interface** 62
 - 10.1 Required Items: 62
 - 10.2 Loading and Unloading Syringes 62
 - 10.2.1 Loading a syringe 62
 - 10.2.2 Unloading a syringe 63
 - 10.3 Procedure 63
- 11 **Maintenance**..... 65
 - 11.1 Calibration Guide..... 65
 - 11.2 Resetting Bed Leveling Plane..... 67
 - 11.3 Cleaning the printer 68
- 12 **Advanced Settings**..... 69
 - 12.1 G-code Adjustments 69
 - 12.2 G-code Customization 70
- 13 **Troubleshooting guide** 71
- 14 **Technical support**..... 74
- 15 **Specifications** 74

SE3D One-Year Limited Warranty

This Limited Warranty applies to new and refurbished r3bEL bioprinters (the “Product”) sold by SE3D, Inc. (SE3D) or a current authorized reseller of Products and Smart Extruders (collectively “Authorized Party” or “Authorized Parties”).

(A) **LIMITED WARRANTY.** SE3D represents and warrants to the first end-user (“End-User”) of Product that the Product shall materially conform to SE3D’s published specifications in the user manual, subject to the terms and conditions below.

(B) **FOR A WARRANTY CLAIM TO BE VALID.** (i) notification must be made before the end of the Warranty Period, as defined below; (ii) must accompany customer logs and/or any other documentation if requested by SE3D; and (iii) must be substantiated with original proof of purchase from an Authorized Party, including the serial number of the Product(s).

(C) **CLAIM HANDLING.** (i) the remedy shall be repair or replacement of the non-conforming hardware SE3D or non-conforming part(s) of a hardware Product in a commercially reasonable time by SE3D or its authorized representative as solely determined by SE3D or its authorized representative; (ii) SE3D shall bear the cost of repair and/or replacement and the shipping costs incurred therein provided, however, that the return is authorized via an RMA number and return instructions are followed; (iii) replacement parts or Products will either be new or refurbished and will be furnished on an exchange basis. If defective Parts or Products are not returned, SE3D shall bill for the unreturned hardware. All replaced parts or Products become the property of SE3D. Consumable parts not covered are: Biokits, SD card, syringe holder tabs, acrylic plate and glass plate. (“Consumables”, defined as disposable items, parts or components of the Product which are inherently subject to deterioration and wear out during the normal operation of the Product.)

(D) **WARRANTY PERIOD.** 1 year from the date a new or refurbished Product is first delivered to the End-User after being purchased.

(E) **EXCLUSIONS.** The limited warranty obligations do not cover physical damage sustained from improper handling during shipping as well as normal wear and tear in use of Product. The limited warranty shall be voided if alleged Product failure was caused in whole or part by (i) improperly or incorrectly performed modifications, alterations or repair; (ii) parts or consumables were installed and used that were not certified or approved by SE3D or its designated representative; (iii) unusual physical or electrical stress; (iv) abuse, misuse, accident, neglect; (v) exposure to excessive water, flooding, fire, electrical problems associated with incoming power or other acts not the fault of SE3D; (vi) not adhering to SE3D’s recommended maintenance procedures or failure to comply with Product instructions and/or documentation; (vii) to the extent allowed by applicable law, the Product has been removed from the country or region where it was originally sold by SE3D or its designated representative. No coverage under the Limited Warranty will exist if SE3D was not notified of the alleged defect or malfunction prior to the expiration of the Warranty Period. SE3D shall make the final determination as to the existence and cause of any alleged defect.

(F) **LIMITATIONS/DISCLAIMERS.** This limited warranty is the end-user’s sole and exclusive remedy against SE3D where permitted by law. Except for this limited warranty, SE3D makes no other warranties whether expressed or implied by law, course of dealing, course of performance, usage of trade or otherwise, with regard to the performance of any product. Without limitation of the foregoing, all implied warranties, including warranty of merchantability or fitness for a particular purpose, are hereby excluded. SE3D waives all liability for any indirect, incidental, collateral, exemplary, punitive, special or consequential damages, including loss of use or loss of profits, even if SE3D has been advised of the possibility of such claims or damages. SE3D reserves the right to modify or update without obligation to replace any Product delivered prior to any such change.

(G) **HOW TO GET WARRANTY SERVICE.** To make a claim under this Limited Warranty, please contact the Authorized Party where the Product was purchased, or, contact SE3D Support via email support@SE3D.com. Support is available 9am to 5pm PST Monday through Friday.

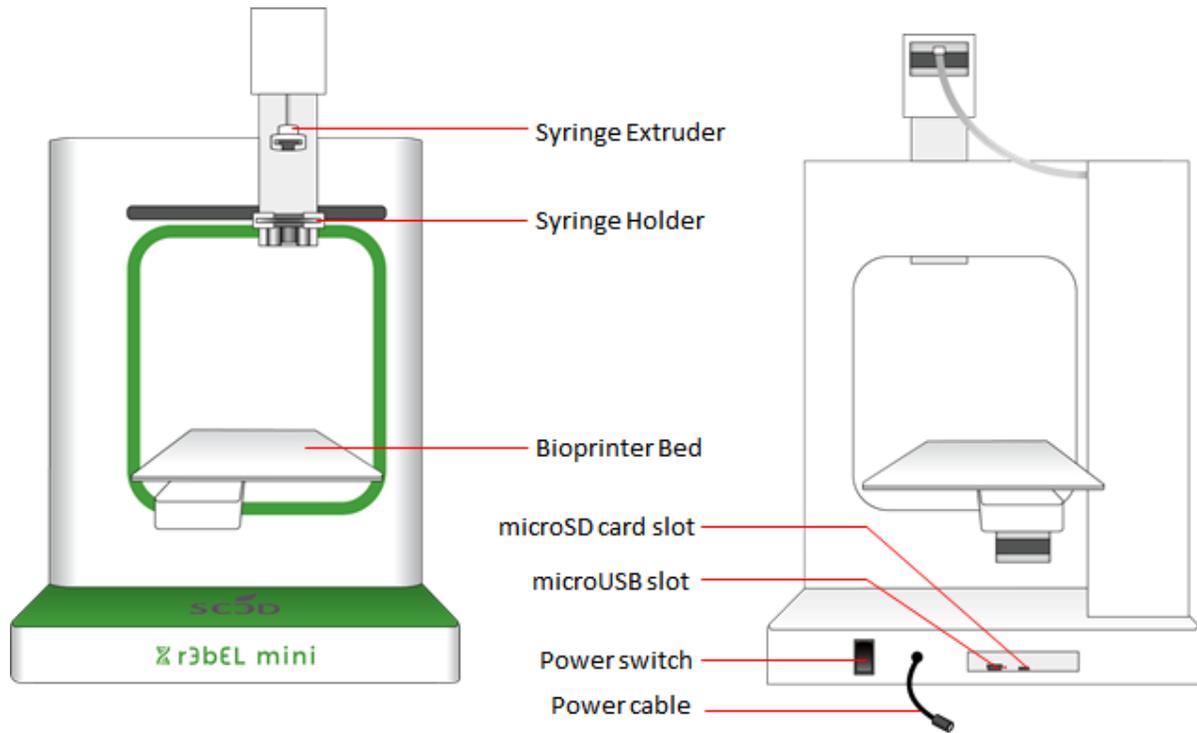
(H) **EXTENDED WARRANTY.** Customers can choose to purchase a 2-year extended warranty within 90 days of purchasing the Product. To purchase extended warranty, please mail us at sales@se3d.com.

FCC Compliance

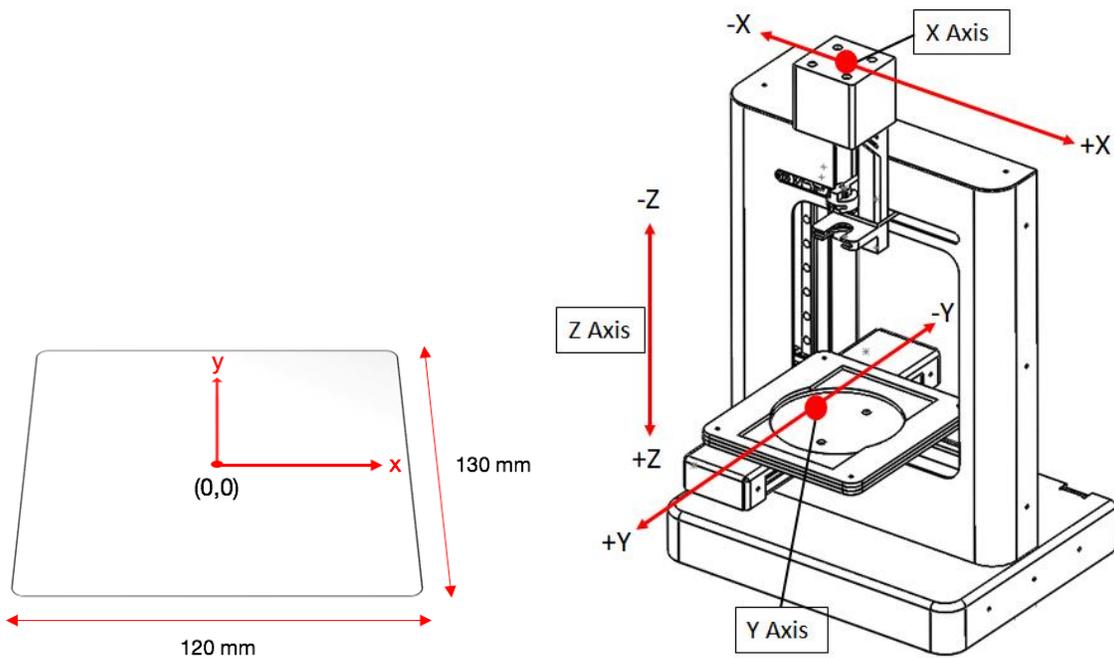
Note: This equipment has been tested and found to comply with the limits for a Class B digital device, pursuant to part 15 of the FCC Rules. These limits are designed to provide reasonable protection against harmful interference in a residential installation. This equipment generates, uses and can radiate radio frequency energy and, if not installed and used in accordance with the instructions, may cause harmful interference to radio communications. However, there is no guarantee that interference will not occur in a particular installation. If this equipment does cause harmful interference to radio or television reception, which can be determined by turning the equipment off and on, the user is encouraged to try to correct the interference by one or more of the following measures:

- Reorient or relocate the receiving antenna.
- Increase the separation between the equipment and receiver.
- Connect the equipment into an outlet on a circuit different from that to which the receiver is connected.
- Consult the dealer or an experienced radio/TV technician for help.

1 r3bEL mini Overview



Printer Overview



Printer Axis

2 Safety Precautions

Please read this section carefully before using the printer.

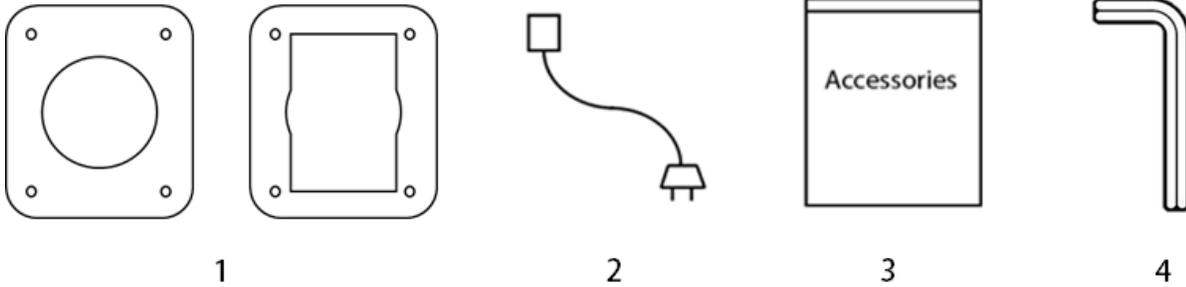
2.1 General Safety

- The r3bEL bioprinter should only be used with the supplied power adapter outputting 12V to avoid the risk of fire or damage to the bioprinter. The voltage rating can be found on most power supplies.
- Wires carrying current will be running at 120V AC or 12V DC and can cause electric shock if tampered with.
- Loose clothing or hair should be secured prior to using the bioprinter to prevent being caught in moving parts of the machine.
- Moving parts can crush and cut, care should be taken to avoid insertion of finger into the equipment while the unit is running.
- The printer is designed to work properly at an ambient temperature between 15°C and 37°C. Operating outside these limits may result in decreased print quality.
- When handling syringes, especially with sharp needle tips, extra care should be taken to avoid poking or stabbing yourself.
- Use only blunt tip syringe needles for all bioprinting activities.
- No flammable liquids are to be used with the unit.
- For disposal and handling of biohazardous waste or contaminated items, please reference and follow the safety guidelines for the laboratory.

2.2 Protection

- The r3bEL bioprinter should not be exposed to excessive liquid or damage may occur.
- Do not shut down the bioprinter or pull out the microUSB cable when loading a digital model, or the model data may be lost.
- Do not load the syringe before homing the printer.
- When priming make sure there is a gap distance of at least 30 mm between the needle tip and bed to allow smooth flow of the material.

3 Accessory Checklist



Your r3bEL mini bioprinter will arrive with the following accessories:

1. User Guide and bed templates
 - One petri dish bed template
 - One well-plate bed template
2. Power supply cable
3. Accessory bag
 - 5 mL Syringe
 - 22 Gauge Needle
 - Micro USB Cable and SD card reader
4. Allen wrench

Be sure to remove all packaging from the bioprinter before use.

3.1 Additional Items

You will be provided with a 5 mL syringe and 22 gauge blunt-tip needle to use with your bioprinter for initial testing. You can purchase additional consumables at our website se3d.com

4 Software Installation

You can control the r3bEL mini bioprinter through a USB cable or wirelessly through Wi-Fi. Follow the instructions according to the operating system you have on your computer and the choice of USB or Wi-Fi connection to the r3bEL mini bioprinter.

4.1 USB Control

Complete all 3 steps for software installation to ensure that the bioprinter will connect to your laptop or computer. You can download all the software programs, print files and find our user manual including video instructions in the SE3D Portal - <http://portal.se3d.com>. Please create a user account to access all the supporting documentation and materials.

4.1.1 Step 1: Download Pronterface

Pronterface is a free open-source 3D printer control software that controls and operates a 3D printer. This software will be used to control the r3bEL mini bioprinter via USB.

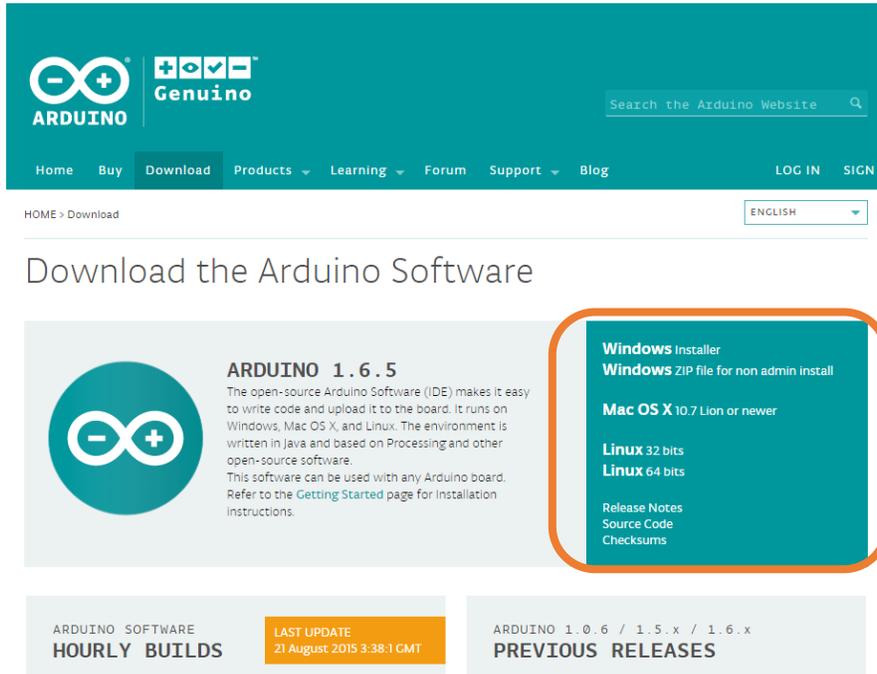
Follow these instructions to download the software:

1. Go to portal.se3d.com and click on Log In in the top right corner and register.
2. Once you have registered, you will get a confirmation email with a link to activate your account. After you activate your account, you will have access to Startup Guide and Troubleshooting sections.
3. On the portal main site, scroll down to Bioprinter Setup section and click on r3bel mini. Select the Startup Guide - r3bEL mini folder and click on “Enroll me”. Navigate to “Programs to Download section” and depending on the operating system of your computer download the PC or macOS folder by clicking on it.
4. Once the zip file is downloaded, extract the contents to a folder where you want the program to reside.
5. Next scroll down to the G-code test files section and download the “Bone-lotion.gcode” file.
6. Then download the Config files folder under the Slic3r config file section.

4.1.2 Step 2: Download and Install Arduino IDE

You must install the Arduino software *before* connecting to the printer, so that the correct device drivers are installed. For installation of Arduino IDE, you must go directly to their website:

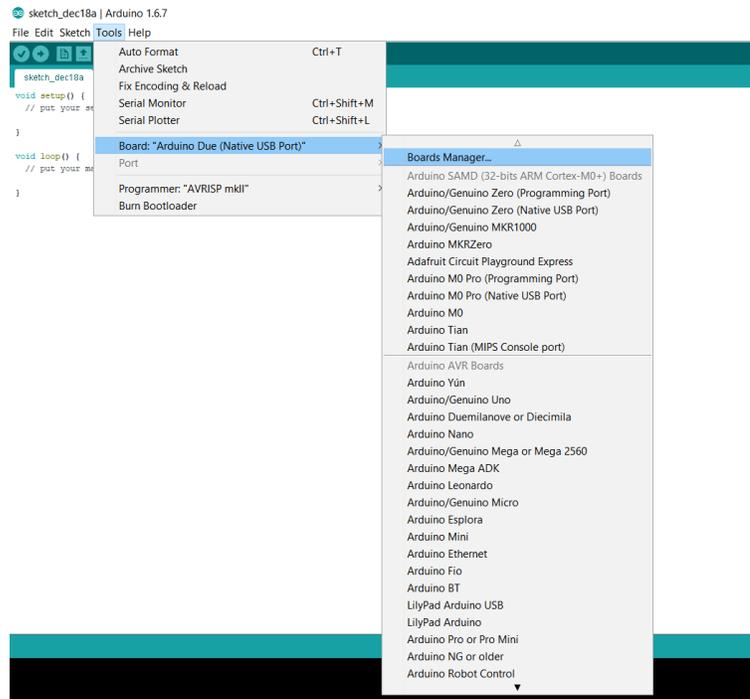
1. Go to <https://www.arduino.cc/en/Main/Software>
2. Choose your operating system from the box shown below:



3. Click “Just download” from the contribution page (unless you want to contribute).



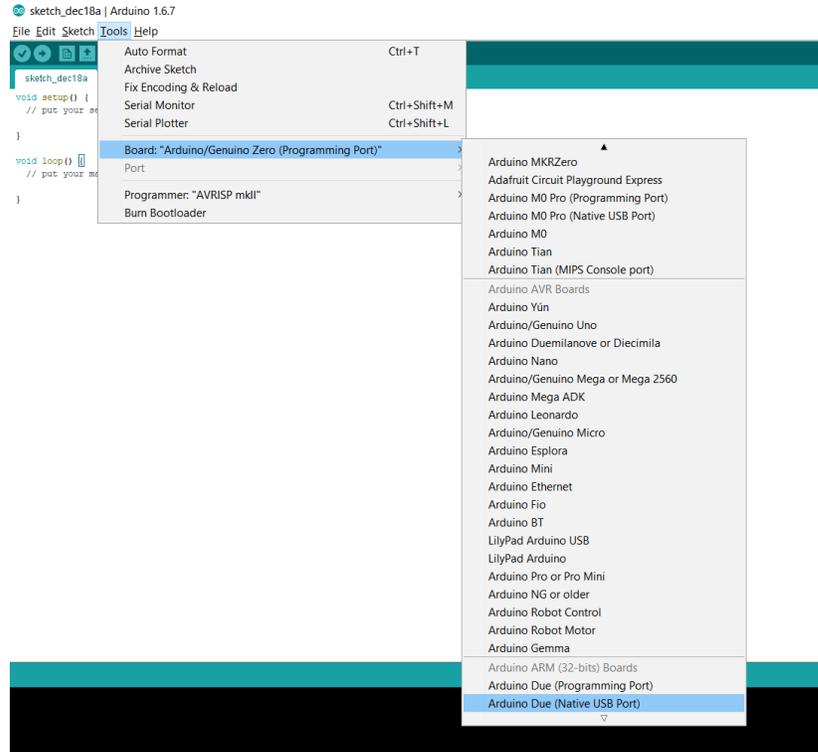
4. Once the file is downloaded, the contents of the folder must be extracted, which can be done in two ways:
 - a. Find the file in your Download folder. Right-click and select “Extract All,” then select a folder destination and click “Extract.”
 - b. Find the file in your Download folder. Open the zip file. Drag and drop the folder called “arduino 1. ...” to your Desktop.
5. The next step is to install the drivers. Go to Tools > Boards> Boards Manager



- a. In the Boards Manager pop-up window, type “Arduino Due” in the search box and select the result titled “**Arduino SAM Boards (32-bits ARM Cortex-M3)**” and click “Install” as shown below.



- Once the installation is complete, go to Tools > Board, scroll down and select “Arduino Due (Native USB port)”



4.1.3 Step 3: Download, Install and Configure Slic3r

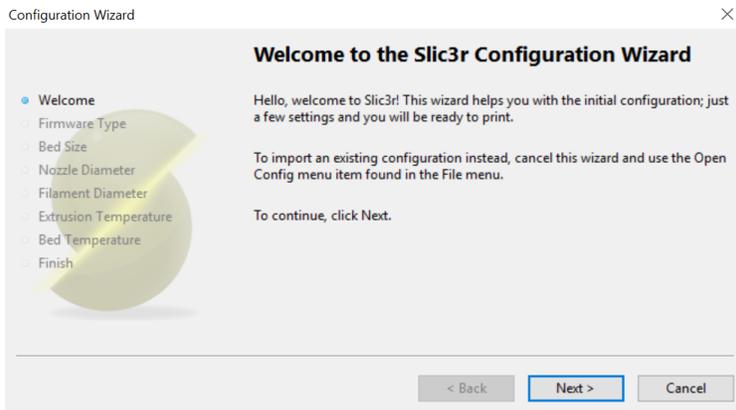
Slic3r is a free open-source slicing software that will slice a 3D model into g-code files for printing. This software can provide g-code files for creating 3D models to print on the r3bEL mini bioprinter. However, please note that the configuration files for bio-printed models are distinct from those used for regular 3D printing. *You must load the config file provided by SE3D* when using Slic3r. Follow the instructions below for installation of program and config files.

You should find the Slic3r program in the Windows zip file when you downloaded it from the portal.

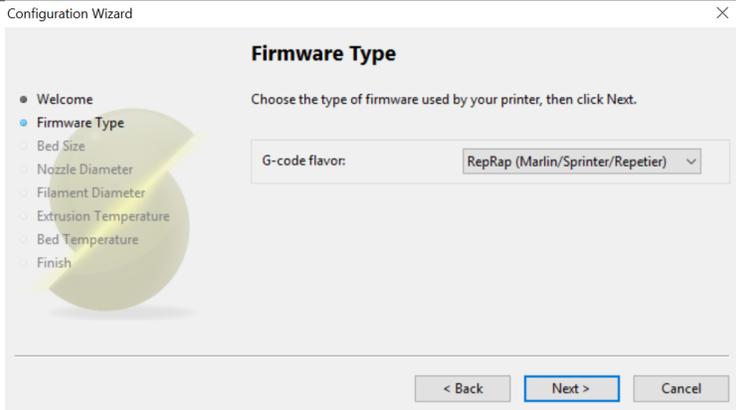
To download the Config files for Slic3r settings, go to Startup guide – r3bEL mini and click on the Config files folder to download this folder. Extract the contents to a folder in your computer.

Click on Slic3r to install the program. Once the Slic3r program installation is completed, for PC and macOS users, open the program and follow the configuration wizard:

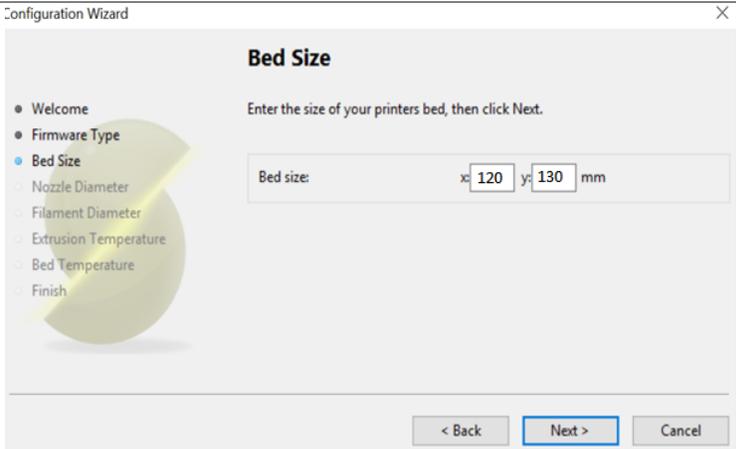
1. You will first be prompted with the Welcome screen. Click Next.



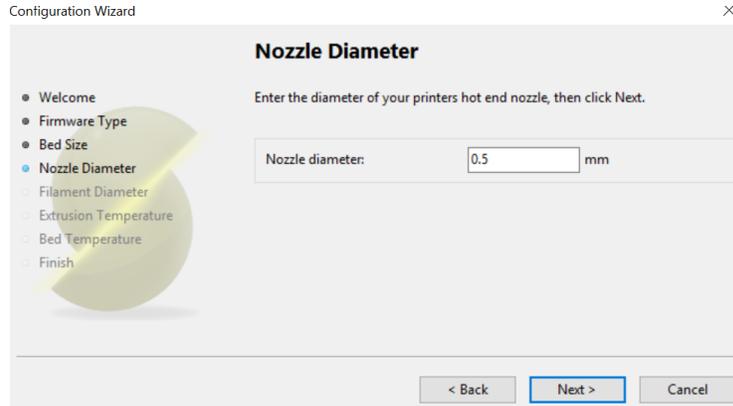
2. For G-code flavor, select RepRap (Marlin/Sprinter/Repetier).



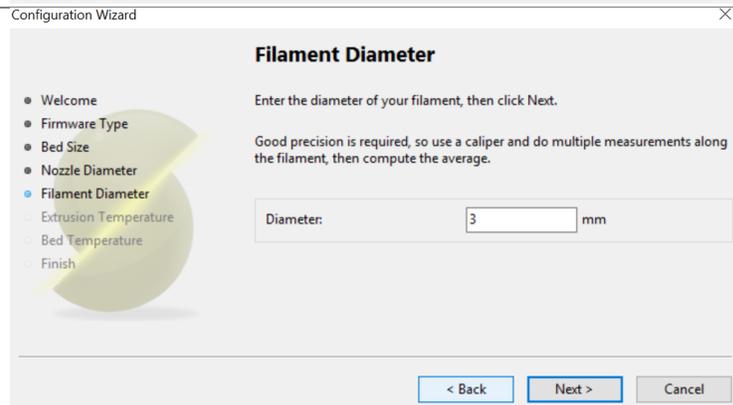
3. For Bed Size, set x = 120 and y = 130 since our print bed is 120 x 130mm. Then set the origin as X = 60 and Y = 65 as the origin is at the center of the bed.



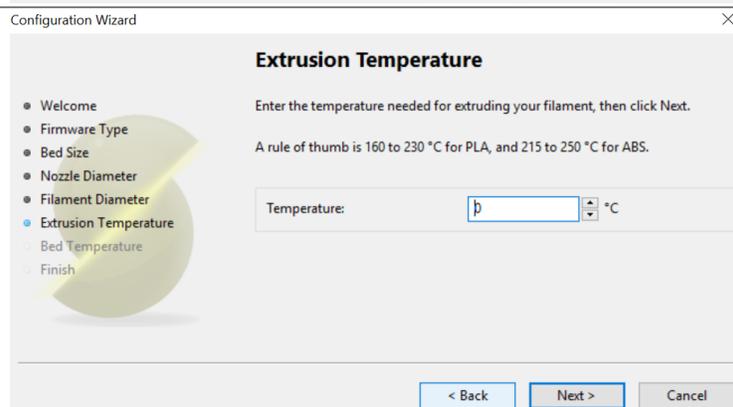
- Set the nozzle diameter to 0.5 mm.



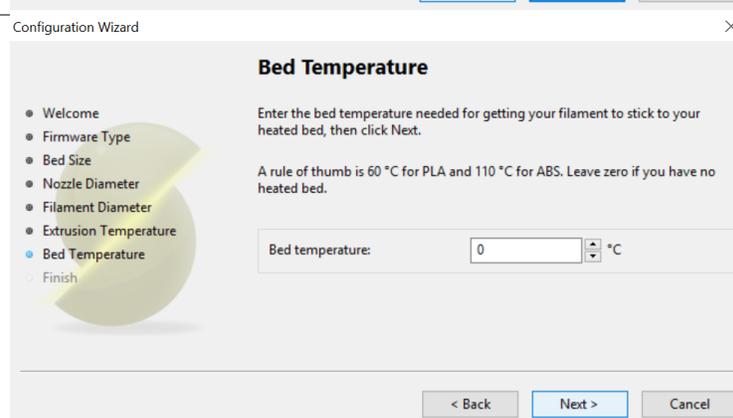
- Set the filament diameter to 3 mm.



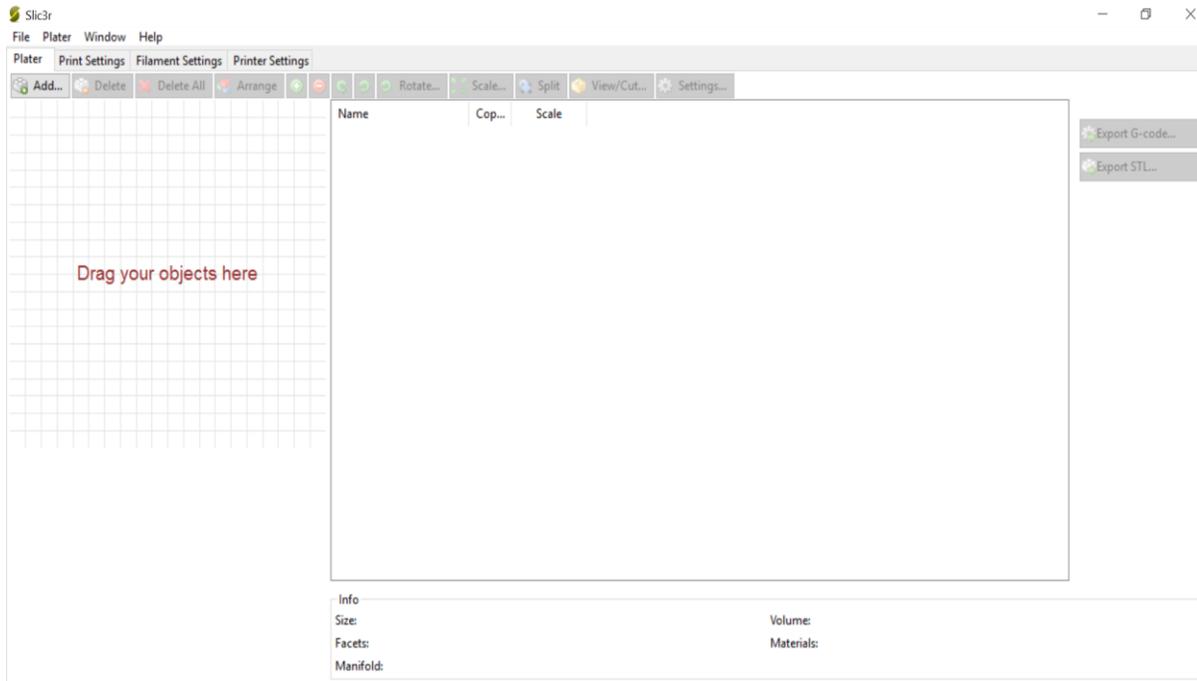
- Set extrusion temperature to 0°C since there is no heating element on the r3bEL mini bioprinter tool head.



- Set bed temperature to 0 and click next. Then finish.



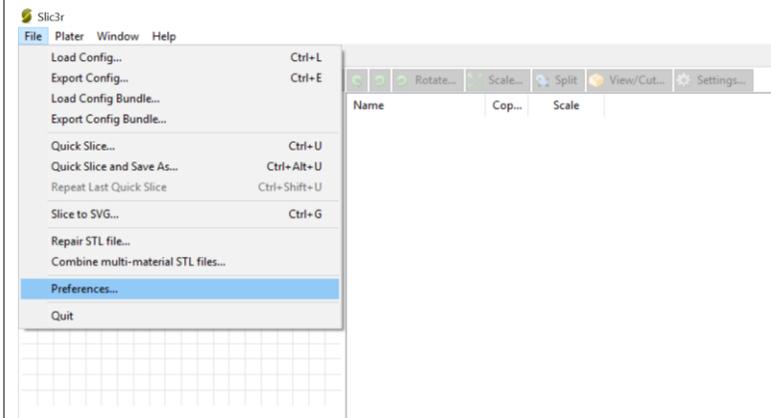
Once you have completed the configuration wizard, the Slic3r program should look like this:



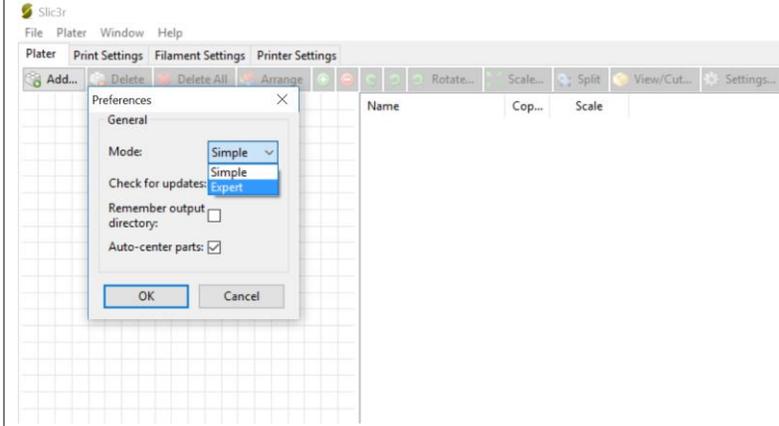
Now, to load the “**lotion**” config file by following these steps:

Note: we use lotion as the mock biomaterial to perform baseline tool calibration

1. Go to File > Preferences (for Windows users).
For macOS users, to go Slicer > Preferences

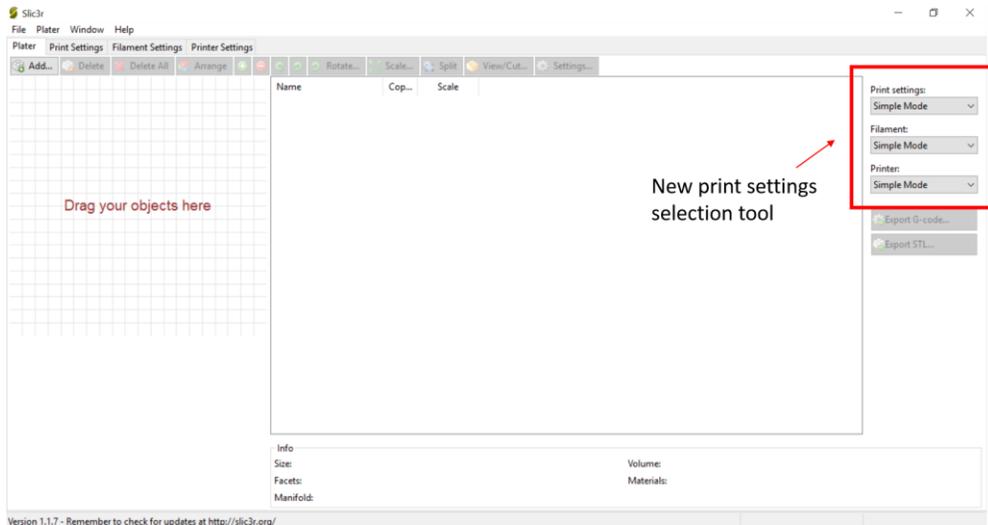


- The Preferences window will pop up. Under Mode, select Expert. Click OK to exit the window.



Once you have changed the preferences, you will need to restart the program for the changes to take effect. Close and relaunch the Slic3r program.

Notice that you now have a new print settings tool bar on your right panel after you restart the program (see below):



The default settings for Print settings, Filament and Printer are all currently set as Simple Mode when you first set up your bioprinter. We do not recommend using this config file to print any model at this point. Each material that you will use for the r3bEL mini bioprinter will require its own unique set of parameter settings. You will learn more about these features and parameters when you go through our bioprinter lab modules.

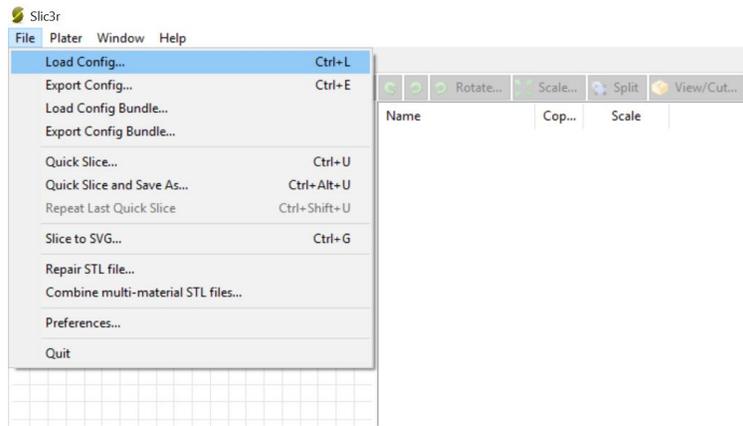
If you are a previous 3D printer user and already have Slic3r installed on your computer, please note the warning below:

WARNING

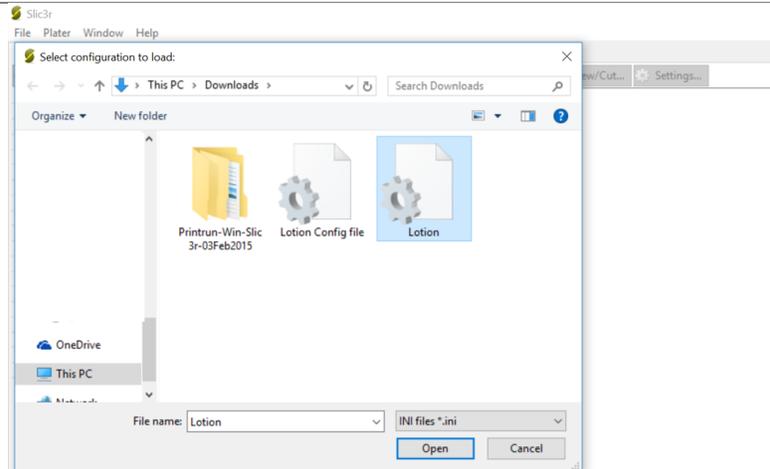
Do not use the default configuration settings in Slic3r. The default settings will cause the extruder to heat to high temperatures and melt your syringe. Ensure that you have loaded the “lotion.ini” config file prior to your first print.

Next, to load the “Lotion” config file (.ini file type) that you extracted previously. Follow steps below for installation:

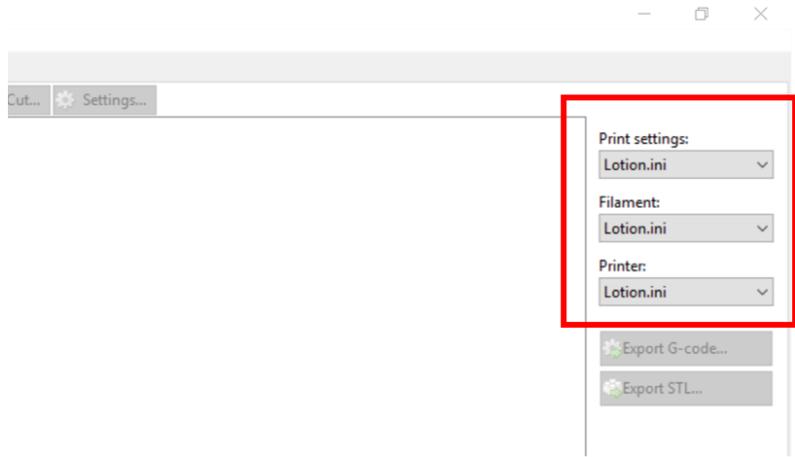
1. Go to File > Load Config...



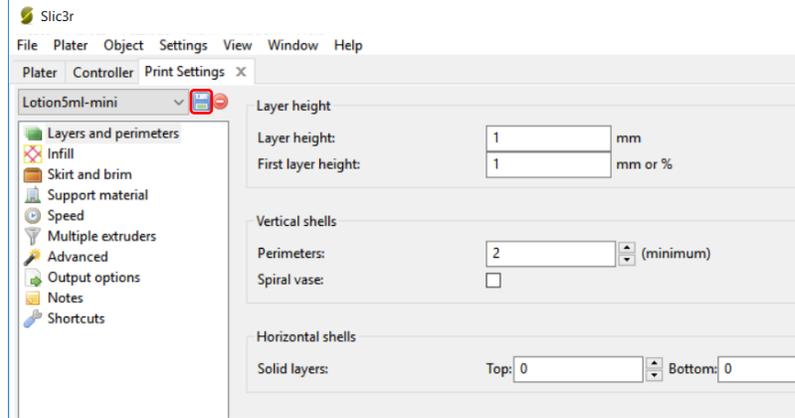
2. Select the Lotion.ini file and click Open.



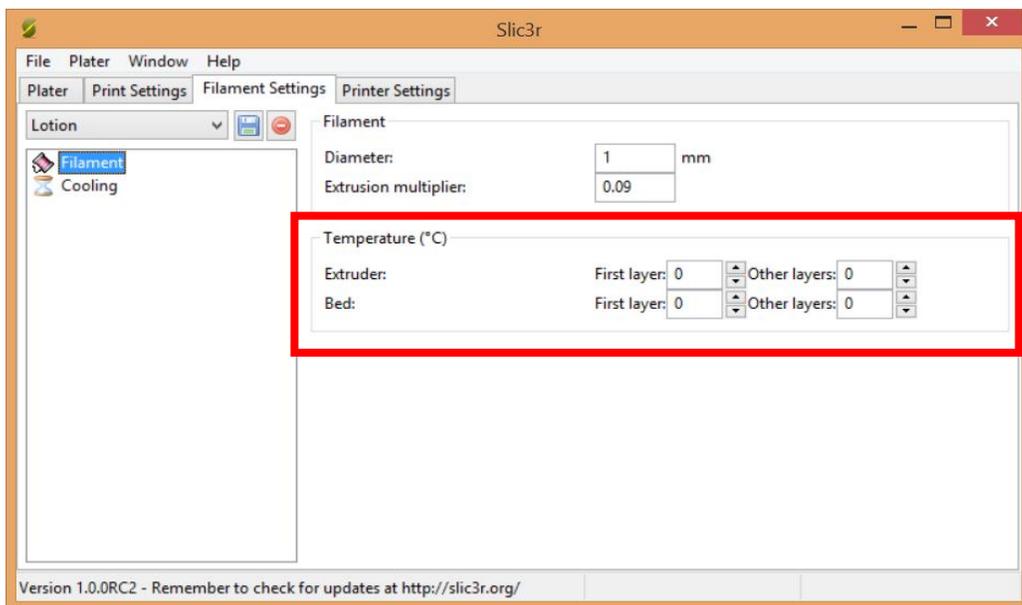
3. You should now see that your printer, filament and print settings on the right panel have all changed to Lotion.ini instead of the default settings.



4. Save the lotion settings in each Slic3r tab so that it becomes the default by clicking the save button in the upper left corner in each of the settings tabs.

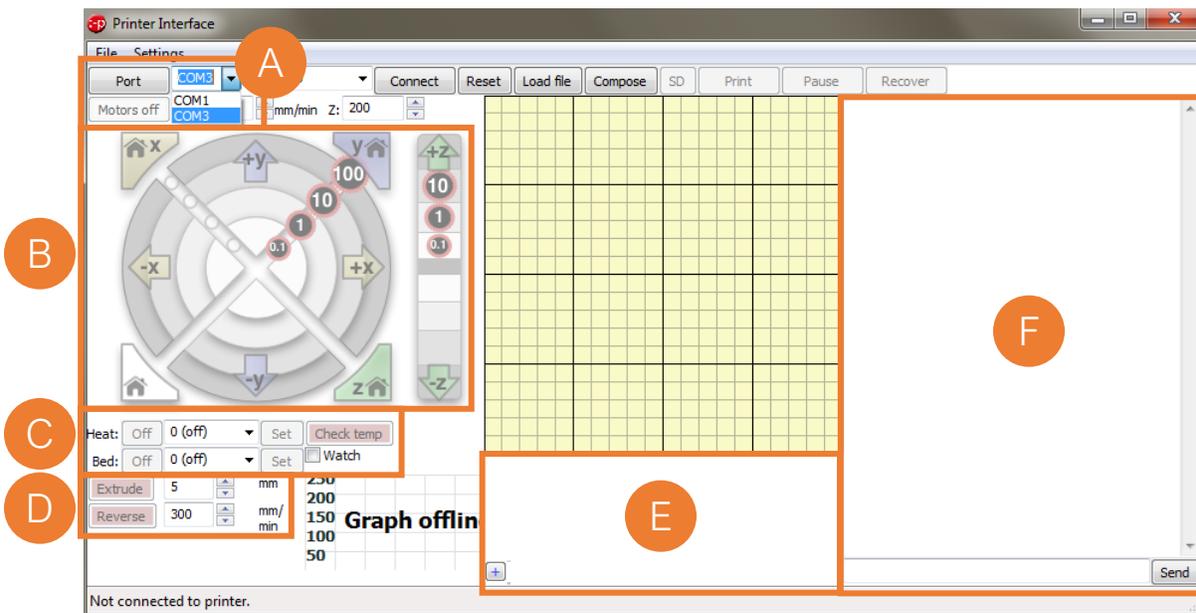


As a final check to ensure that your temperature settings on Slic3r is correct, click on the Filament Settings Tab. Make sure you are looking at the lotion config file and check that your temperature settings match the settings shown below:



4.2 Setting up Pronterface

1. Connect the provided power cable and microUSB cable to the power and microUSB ports on the rear of the bioprinter.
2. Turn on the bioprinter using the power switch.
3. Connect the microUSB cable to a USB port on your computer and wait for the device drivers to install.
4. Open Pronterface.
5. Familiarize yourself with the interface by recognizing each feature and function as listed below:



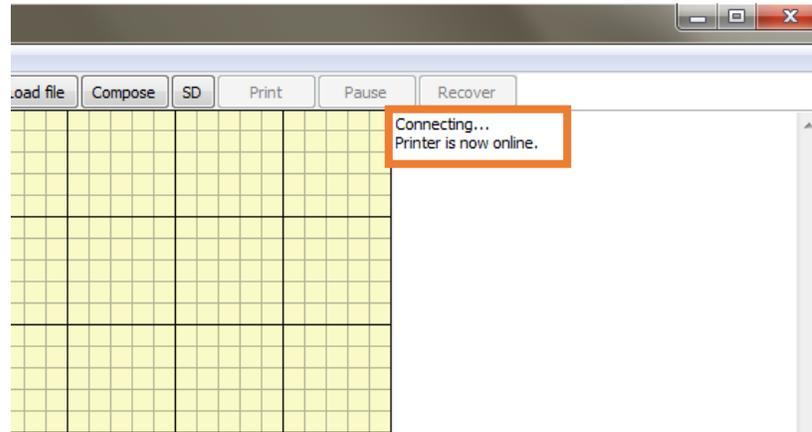
The different section in Pronterface are:

- A. Port selection
- B. X, Y, Z control panel
- C. Heater Control
- D. Extruder Control
- E. Custom Buttons Area
- F. Command line and command window

A. Port Selection:

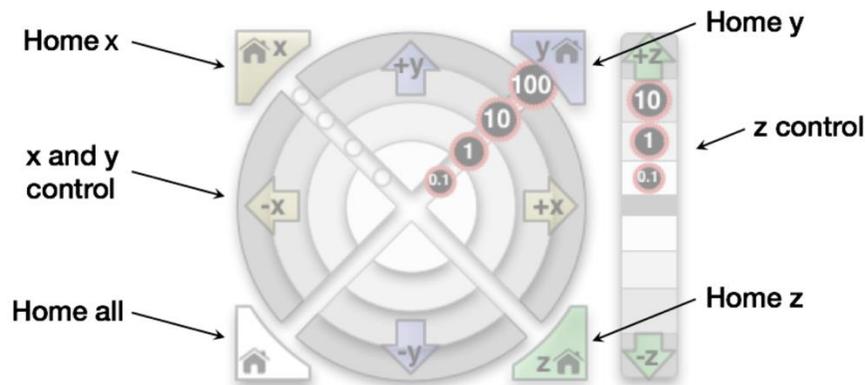
To connect the bioprinter to Pronterface, select the proper COM port. This will be whatever port your computer assigns the device to. In macOS, ports may have a different naming designation like `"/dev/ttyUSB0"` or `"/dev/ttyACM0."` Choose the right port number and click the "Connect" button.

If successful, the command window should display “Printer is now online” and the buttons should activate/no longer be grayed out.



B. XYZ Control Panel:

Use the control pad to move the motors manually in X, Y and Z direction. The 0.1, 1, 10, and 100 increments represent actual distances in millimeters.



X-Y-Z coordinate system on r3bEL mini

X-coordinate:

The X-motion moves the extruder head left or right. $+X$ will move the extruder head to the right relative to the user facing the front of the printer and $-X$ will move the extruder head to the left.

Y-coordinate:

The Y-motion moves the bed (**Note:** The motion of the bed is relative to the extruder head). $+Y$ will move the bed to the front relative to the head so the extruder head will shift toward the back of the bed and $-Y$ will move the bed to the back relative to the head, so the extruder head will shift toward the front of the bed.

Z-coordinate:

The Z-motion moves the bed up and down. Use the control bar on the right to move the platform in the Z direction. It is important to note that *+Z will cause the platform to move down*, increasing the distance between the extruder and the platform bed. *-Z will move the platform up*, decreasing the distance between the extruder and the platform bed.

Homing buttons:

Home All button at the bottom left of circular control pad will home all three axes of the printer simultaneously. This lets the printer know the end positions of each axis. You must home the printer every time you turn on and connect to the printer. **Note:** Home the printer before placing a syringe in the extruder unit.



Home X button will home the X axis of the printer.



Home Y button will home the Y axis of the printer.



Home Z button will home the Z axis of the printer.

C. Heater Control:

This section lets you set the temperature of the extruder and the bed. Since the r3bEL mini does not have a heater in the extruder or the bed you will not be using this feature.

D. Extruder Control:

This section lets you control the extruder movement. You can move the extruder by entering a value in the box and clicking on the extrude/ retract button. The recommended speed to move the extruder is 800 mm/min. You can also move the extruder using the custom extrude and retract buttons (refer sec. 4.3).

E. Custom Button area:

This is the section where you will add the custom buttons. Refer section 4.3 for instruction to add them.

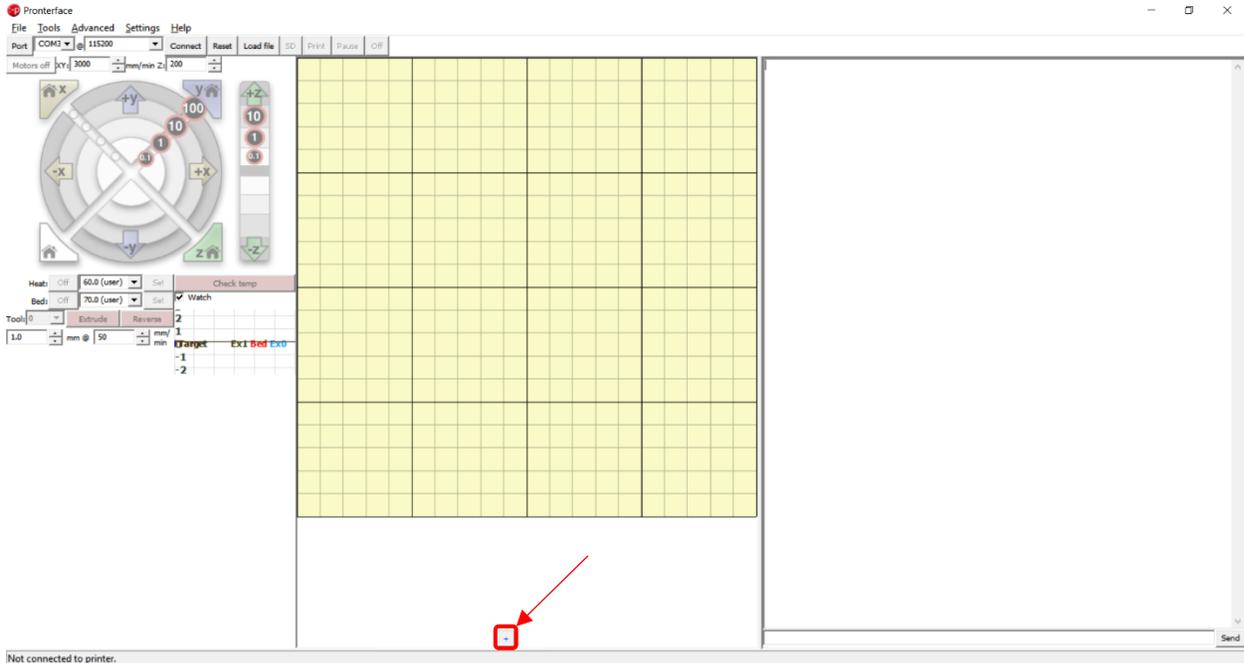
F. Command Line and Command Window:

The command line allows you to send G-codes to the printer and the command window displays the printer status, print information and any errors.

4.3 Custom Buttons

In Pronterface, you have the capability to create your own custom buttons. This will allow you to perform common tasks at the click of a button instead of having to manually enter codes every single time in the command line. Proceed to create these custom buttons for r3bEL mini.

To add a button, click on the “+” box in the custom button area (you will find this at the bottom of the yellow gridded print area shown below).



A text box will appear; fill in each setting accordingly to create customized buttons on your Pronterface software.

ROW 1

Button title: Set Home
 Command: G92 X0 Y0 Z0
 Color: #cccccc

Button title: Set Z0
 Command: G92 Z0
 Color: #cccccc

Button title: Get Position
 Command: M114
 Color: #cccccc

Button title: Move to Front
 Command: G1 X0 Y50 F2000
 Color: #cccccc

ROW 2

Button title: P0	Button title: P1
Command: G1 X-48 Y-52 F2000	Command: G1 X-48 Y52 F2000
Color: #66b3ff	Color: #66b3ff
Button title: P2	Button title: P3
Command: G1 X48 Y52 F2000	Command: G1 X48 Y-52 F2000
Color: #66b3ff	Color: #66b3ff

ROW 3

Button title: Extrude 150 mm	Button title: Extrude 50 mm
Command: G1 E150 F2000	Command: G1 E50 F2000
Color: #33cc33	Color: #5cd65c
Button title: Extrude 5 mm	Button title: Extrude 1 mm
Command: G1 E5 F2000	Command: G1 E1 F2000
Color: #85e085	Color: #c2f0c2

ROW 4

Button title: Retract 150 mm	Button title: Retract 50 mm
Command: G1 E-150 F2000	Command: G1 E-50 F2000
Color: #ff4d4d	Color: #ff6666
Button title: Retract 5 mm	Button title: Retract 1 mm
Command: G1 E-5 F2000	Command: G1 E-1 F2000
Color: #ff8080	Color: #ffb3b3

When you are finished, the final custom button setup should look like this:

Custom Button Setup

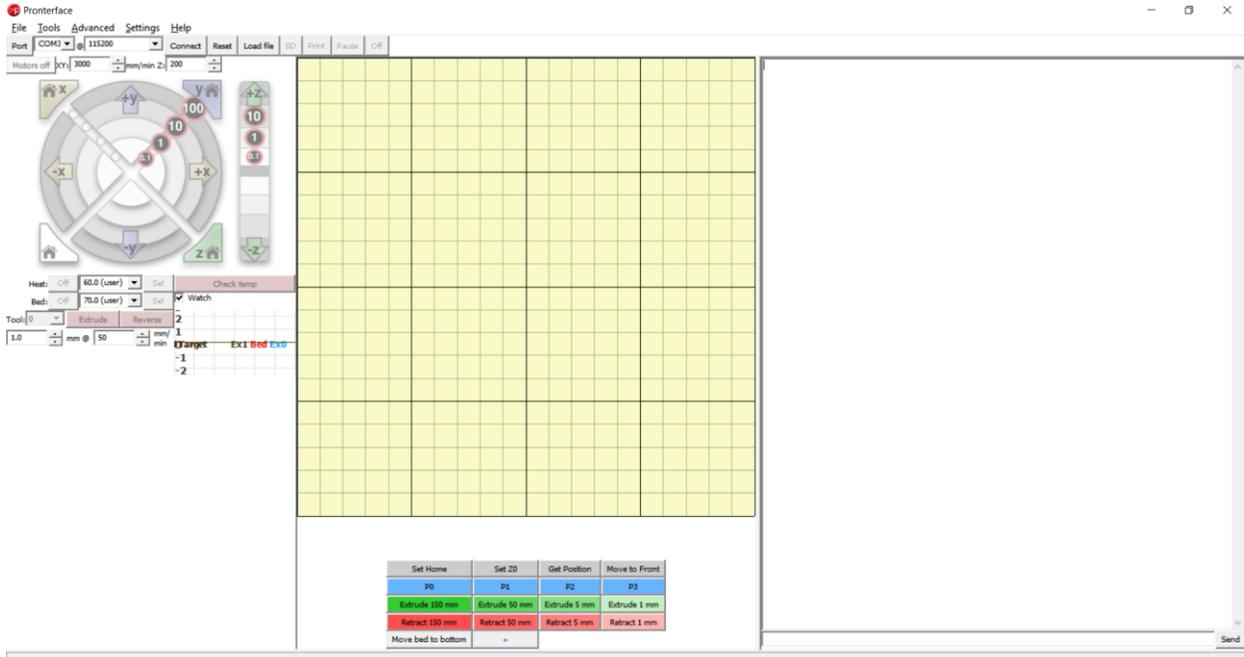
Set Home	Set Z0	Get Position	Move to Front
P0	P1	P2	P3
Extrude 150 mm	Extrude 50 mm	Extrude 5 mm	Extrude 1 mm
Retract 150 mm	Retract 50 mm	Retract 5 mm	Retract 1 mm

4.4 Understanding the Custom Button Functions

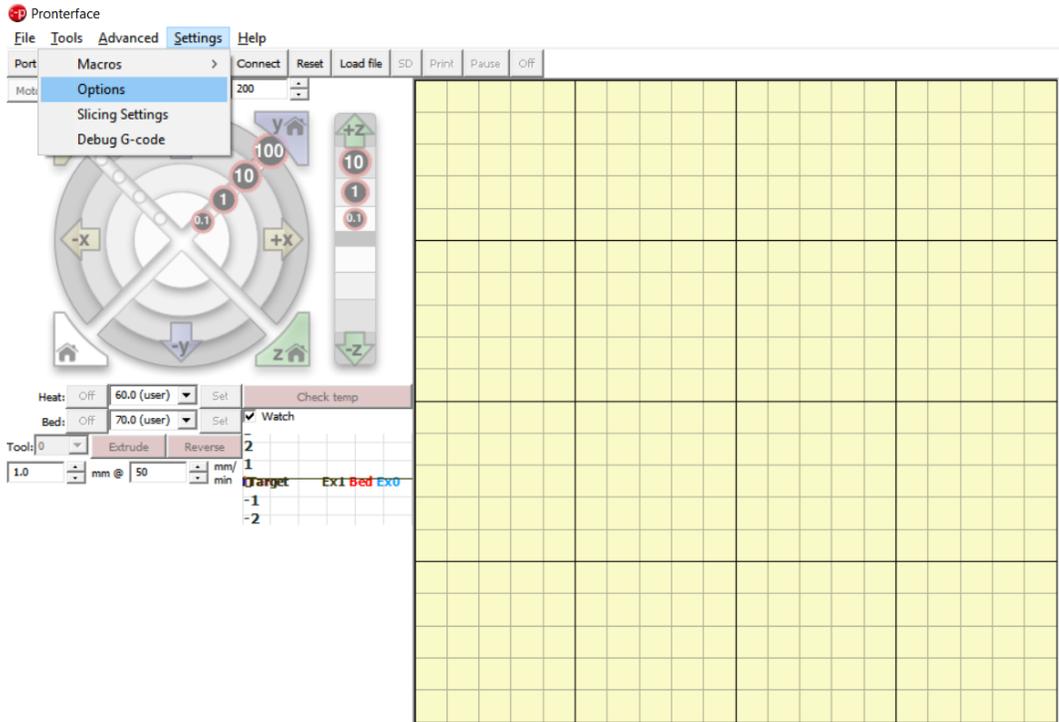
Button Name	Function
Set Home	This sets a new home (0,0,0) position for your r3bEL mini printer. This function serves as a manual override to the default setting, such as for adjusting the home position based on differences in needle tip heights. Note: This button is not same as the Home all button. Once you turn off the printer or use the Home All function, the home position will restore to the factory default.
Set Z0	The Set Z0 button adjusts the Z-height home position only but is similar to the Set Home button in that it serves as a manual override. Note that once you turn off the printer or use the Home All function, the Z0 position will restore to the factory default.
Get Position	This button provides the exact x, y and z position of your printer. The readout will appear in the command window.
Move to Front	This button moves the extruder to (0,52) along the xy plane.
P0, P1, P2 and P3	These buttons move the extruder to each of the 4 calibration points on the printer at the respective corner x-y positions. P0 is at (-48,-52), P1 is at (-48,52), P2 is at (48,52) and P3 is at (48,-52).
Extrude 150 mm	This button moves the extruder plunger down by 150 mm in distance, extruding whatever liquid or material is in the syringe.
Extrude 50 mm	This button moves the extruder plunger down by 50 mm in distance, extruding whatever liquid or material is in the syringe.
Extrude 5 mm	This button moves the extruder plunger down by 5 mm in distance, extruding whatever liquid or material is in the syringe. This is useful for priming the needle when the extruder plunger is already in contact with your syringe plunger.
Extrude 1 mm	This button moves the extruder plunger down by 1 mm and is useful for very small increments of extrusion.
Retract 150 mm	This button moves the extruder plunger up by 150 mm. This is often used when you want to unload a syringe.
Retract 50 mm	This button moves the extruder plunger up by 50 mm.
Retract 5 mm	This button moves the extruder plunger up by 5 mm. This is useful for alleviating pressure buildup in the syringe needle tip (for small needle tips). After a print, retracting by 5 mm can prevent material from dripping or oozing from the needle tip.
Retract 1 mm	This button moves the extruder plunger up by 1 mm for very small increments of motion.

4.5 Editing Graph dimensions

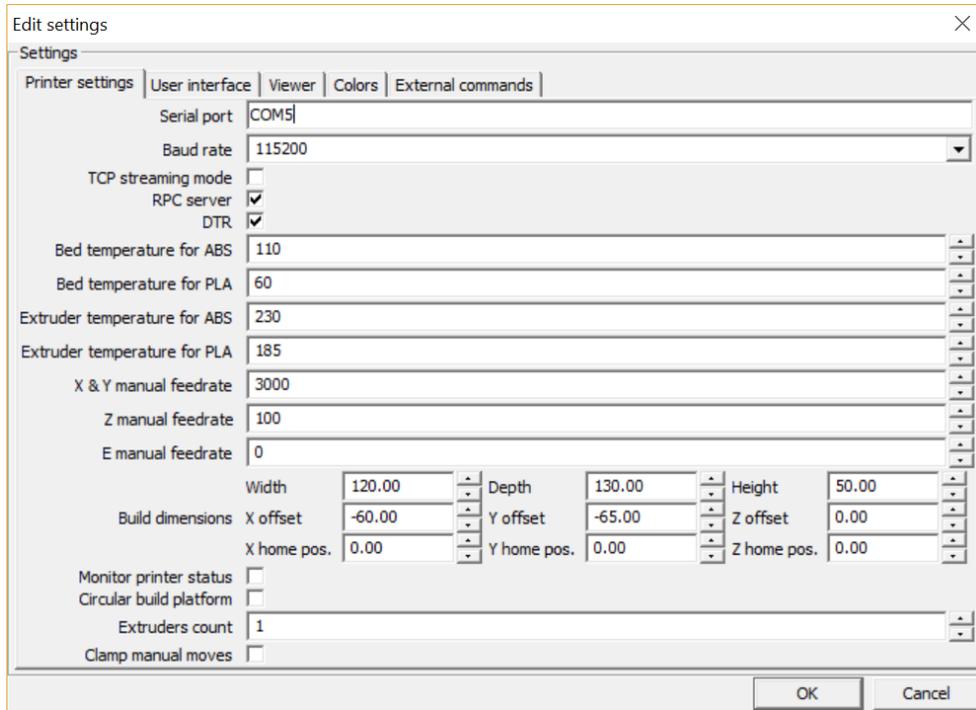
The default graph dimensions in Pronterface is X = 200mm, Y = 200mm, Z = 100mm as shown below.



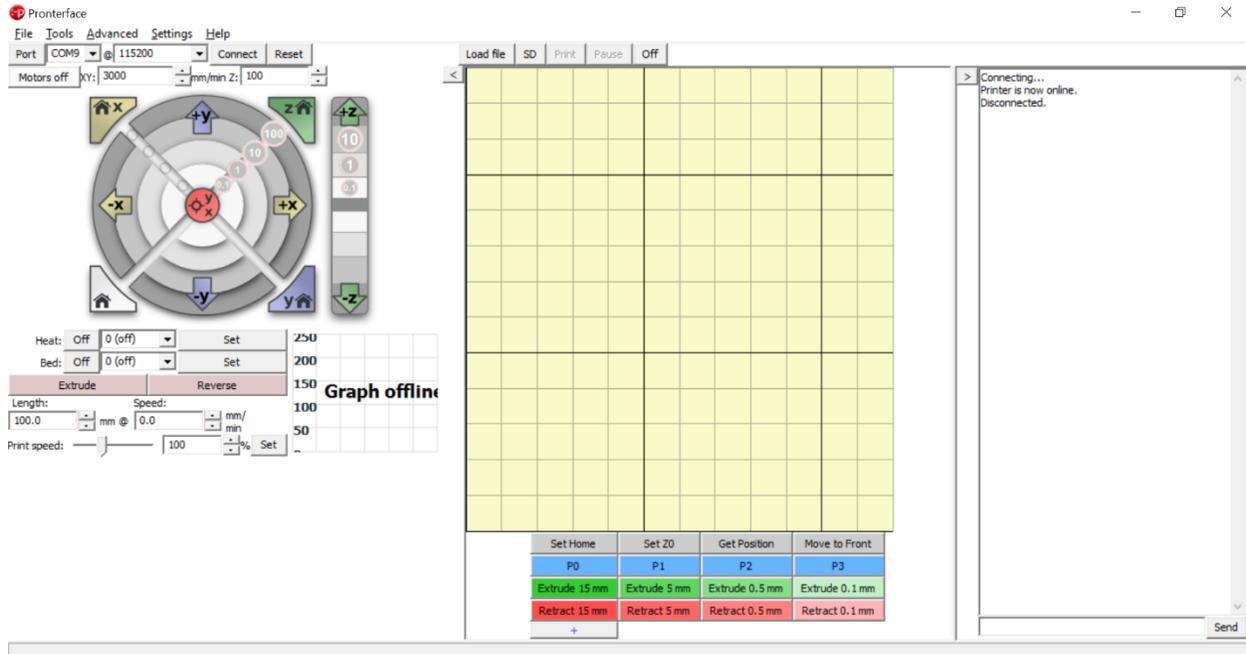
The bed dimension of r3bEL mini bioprinter is 120 x 130mm. To change the dimension, go to **Settings -> Options** as shown below.



In the pop-up window, under Print settings tab you will see the “Build Dimensions” section, change the **Width** to 120 mm, **Depth** to 130 mm and the **Height** to 50 mm as shown in the picture below. Then change the **X offset** to -60 and **Y offset** to -65 and click on OK.



You might have to close and reopen Pronterface for the changes to take effect. Once Pronterface opens the graph dimensions would be updated to 120mm x 130mm.



5 Your First Print

You are now ready to run your first test print. Follow the instructions below to perform the first print on your new r3bEL mini. We recommend doing this via USB connection using Pronterface since this will be your first time.

5.1 Required Items:

- r3bEL mini bioprinter
- Petri dish (100 mm diameter)
- 5 mL plastic syringe
- 22-gauge blunt-tip needle with Luer lock
- Lotion

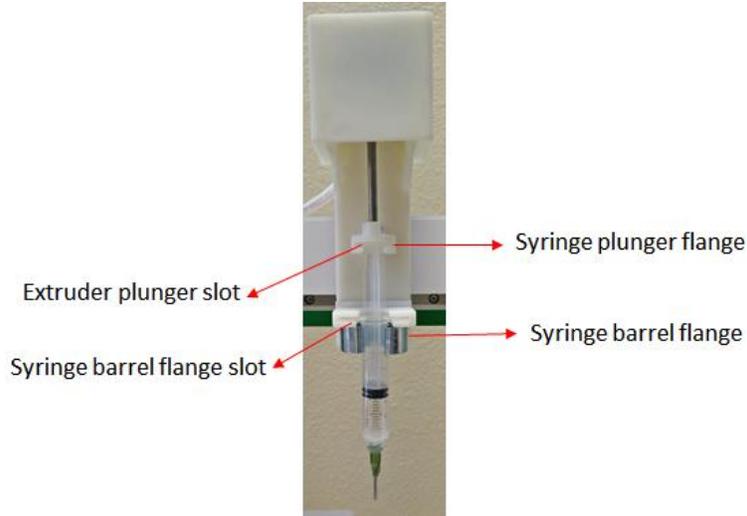
5.2 Loading and Unloading Syringes

Before loading or unloading syringes, ensure that the r3bEL mini bioprinter is connected to your computer via USB and open the Pronterface program.



5.2.1 Loading a syringe

1. Insert the barrel flanges into the barrel flange slot and try to align the syringe plunger to fit in the slot in the extruder (see figure below). If the extruder slot does not align with the syringe plunger move the extruder higher or lower by clicking on “extrude” or “retract” accordingly until the slot in the extruder is in line with the syringe plunger. Then slowly push the syringe in until it locks into position on the metal holder.
2. After the syringe is in place extrude in 5 or 1 mm increments until liquid is pushed out of the needle tip. This is referred to as “priming” the syringe. Wipe off any excess liquid before printing.

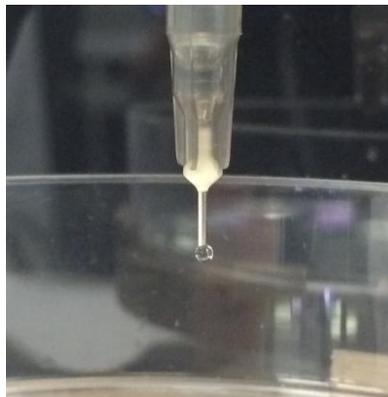


5.2.2 Unloading a syringe

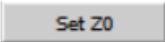
1. Retract the extruder by 5 mm or 1 mm to make sure that the syringe plunger is loose and not in contact with the top of the extruder.
2. Pull the syringe slowly and you should be able to get the syringe out smoothly.

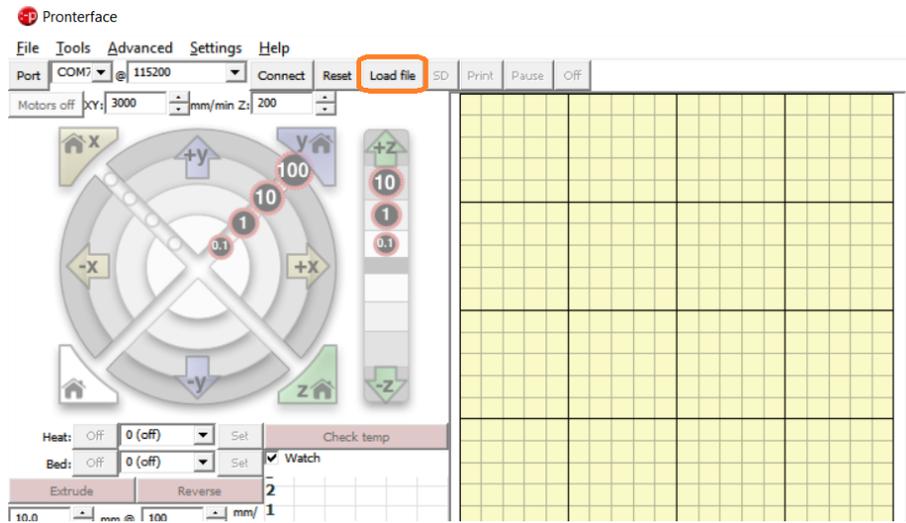
5.3 Procedure

1. Turn on the r3bEL mini bioprinter and connect via Pronterface.
2. Home the bioprinter using the Home All button .
3. Fill a 5 mL syringe with ~4 mL of lotion.
4. Load the syringe in the extruder as shown in the previous section.
5. Prime the syringe, which will help ensure print consistency. Manually extrude in small increments using the  or  button until lotion is pushed out of the needle tip. Wipe excess lotion away as necessary from the needle tip.



Priming the syringe

6. Manually move the bioprinter bed using the Z axis control buttons until it is almost in contact with, but not touching, the needle tip. Verify the positioning by sliding a piece of paper between the needle tip and bed. Adjust the bioprinter bed until the piece of paper can slide between the needle tip and bed with only minimal resistance, then Set the Z0 position using the  custom button. .
7. Download the ***Bone mini-5ml-22g.gcode*** file from the SE3D portal if you haven't already done so. This file can be found in the G-codes files section in the Startup Guide – r3bEL mini.
8. In the top toolbar of Pronterface, click Load File. Choose the ***Bone mini-5ml-22g.gcode*** file. To load and print your own files, simply use the Load File button, as shown in this example.



Click the Print button to start your print in Pronterface. The print should look like the picture below. **Note:** If the extruder or bed hits the Needle tip/Petri dish/Well plate or rams into the sides of the printer, turn off the main power switch in the bioprinter.



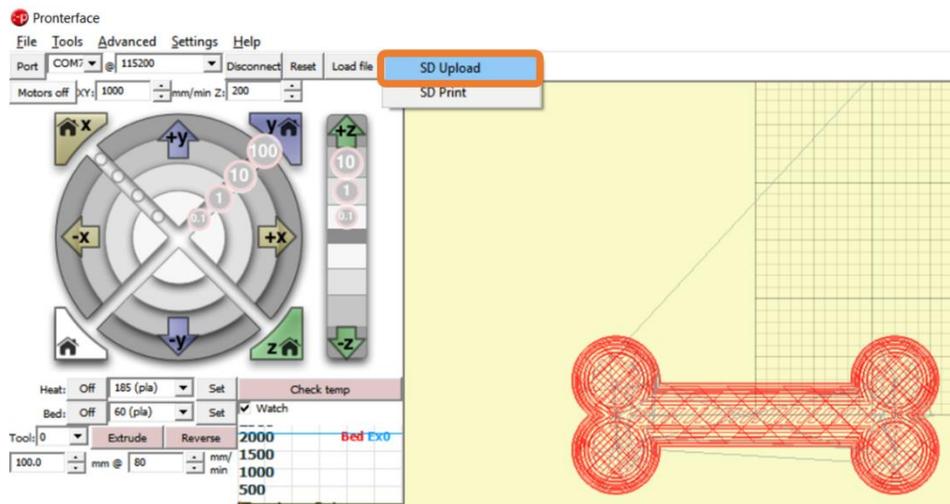
Bone lotion print

6 Printing from SD card

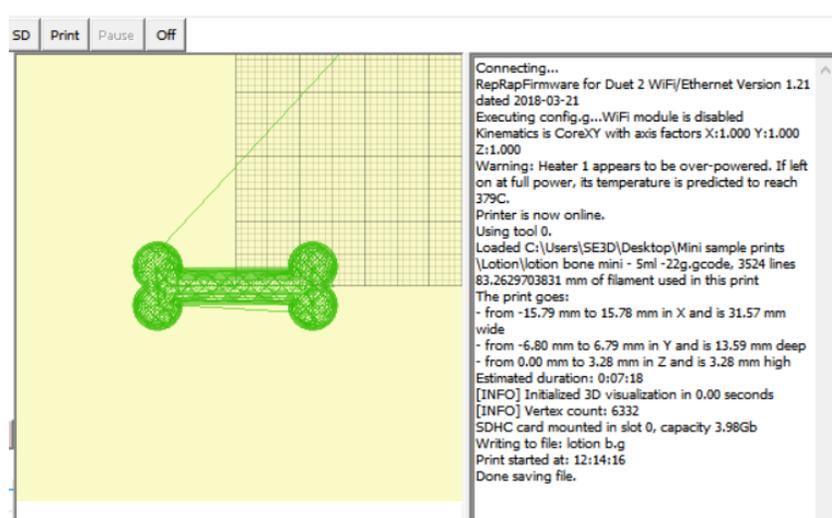
When printing using Pronterface it is important to note that the USB cable should always be connected to the printer and the computer and the computer should also be set that it does not go to sleep while you are printing.

The SD print allows you to disconnect from the printer once you have started the print in Pronterface. To do the SD print, follow the below steps:

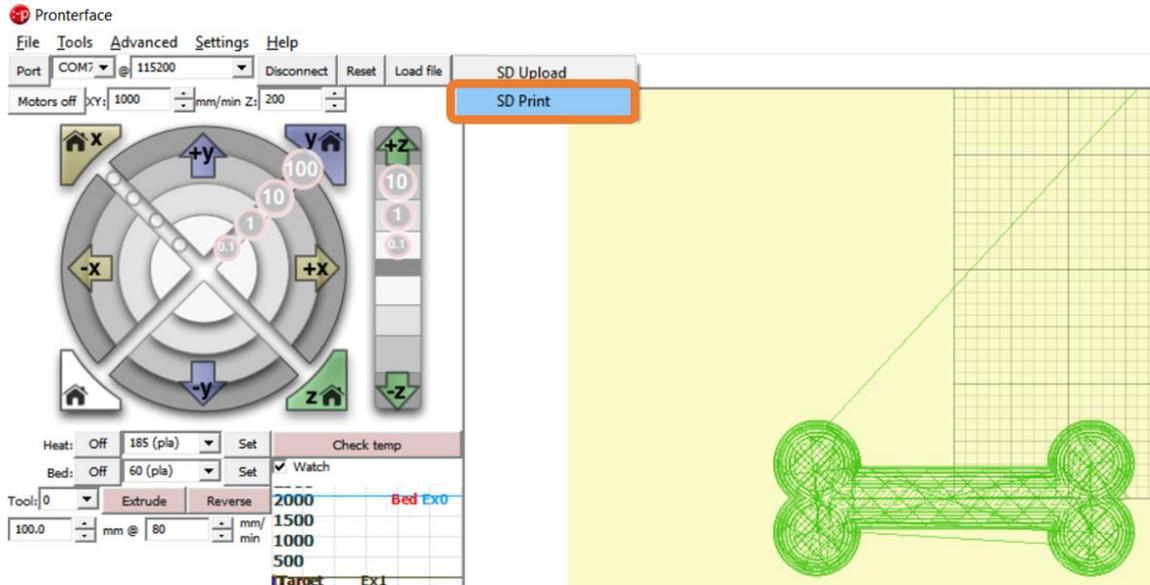
- The steps you did in previous section 5.3 till step 8 are the same.
- After loading the **Bone mini-5ml-22g.gcode** file on Pronterface, click on SD button next to load file button on the top toolbar and then click on SD upload in Pronterface.



- After clicking on SD upload Pronterface will upload the file to the SD card and it will prompt you to enter a filename. After entering the file name Pronterface will upload the file to the SD card. Wait till you get “Done saving file” output in the command window in Pronterface.



- To print the file just click on SD and then select SD Print and choose the file you just saved. The printer will start to print the model and you can disconnect your computer from the printer.



7 Shutdown Procedure

1. Click the Disconnect button on Pronterface, then exit the application.
2. Unplug the microUSB cable from your computer.
3. Turn off the bioprinter.

EMERGENCY SHUTDOWN: In the event of an emergency, use the power switch on the back of the bioprinter. Turn off the bioprinter immediately for any of the following reasons:

- Extruder is repeatedly ramming into sides of printer
- Extruding excessive amount of liquid
- Extruding or retracting past the limits of the extrusion unit
- Extrusion unit is moving past its limits (hitting sides of printer)
- Heater malfunction (too hot, burnt smell, etc.)
- Wiring malfunction (short circuit, burnt smell, etc.)
- Any other situation that could harm the printer or user

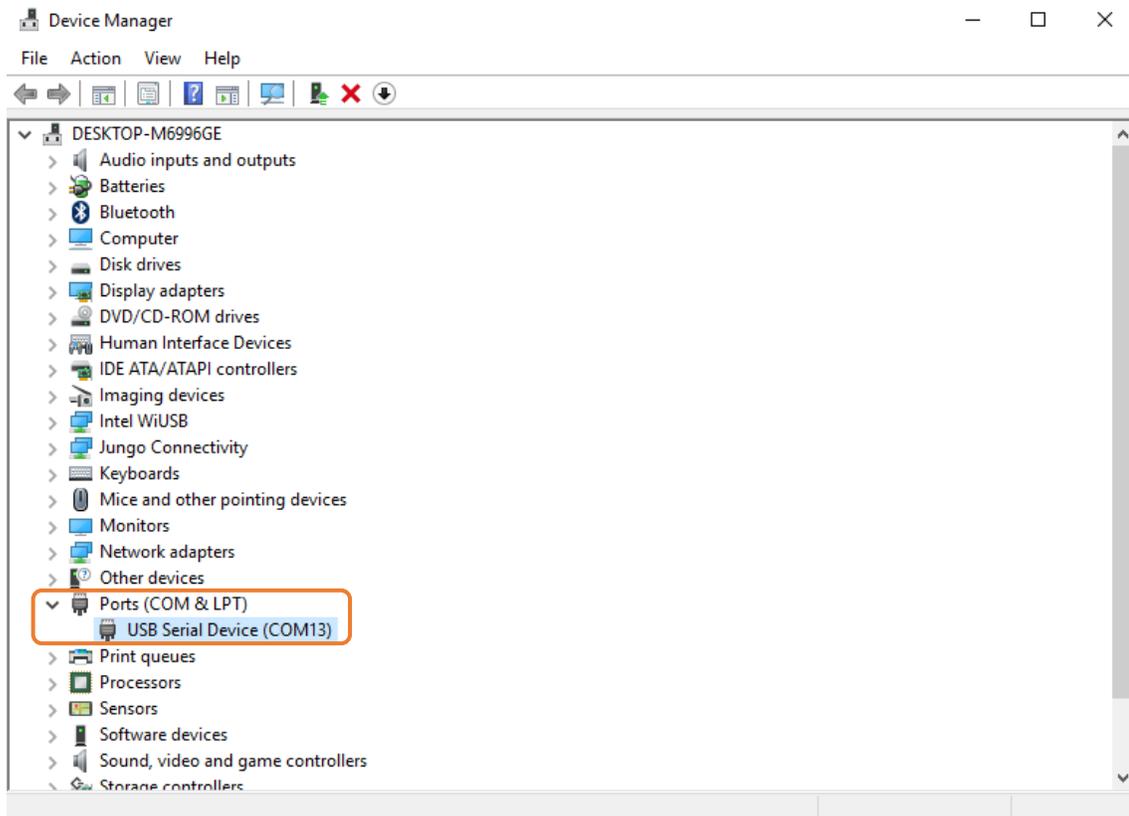
Warning: When you turn off the power to the printer, the bed will drop down immediately.

8 Connect via Wi-Fi

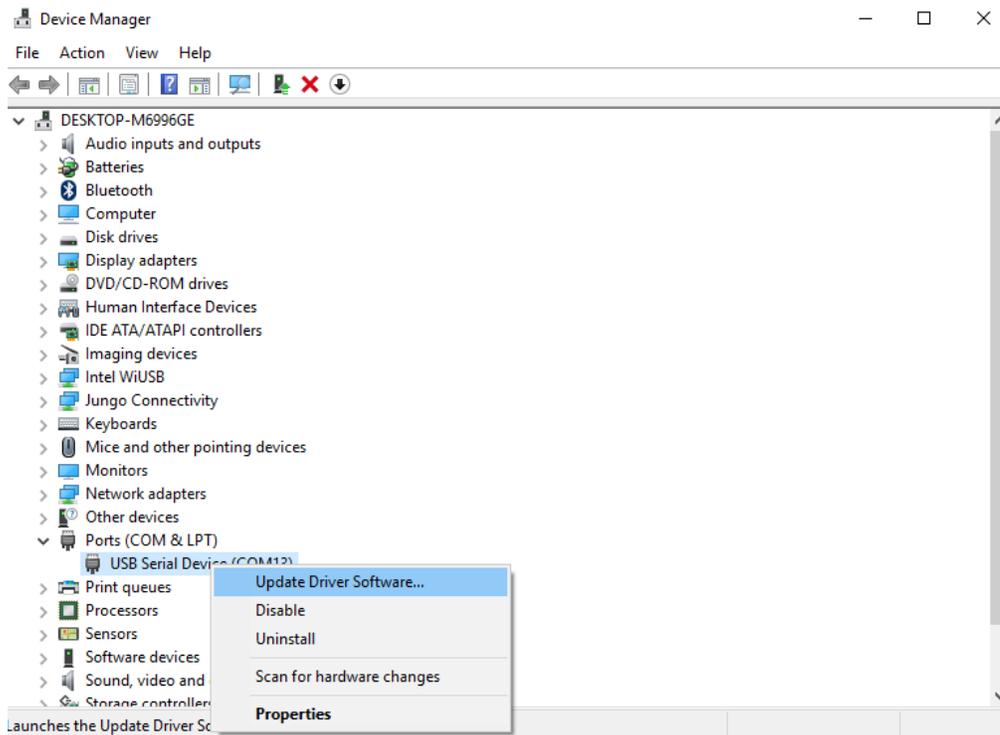
8.1 Printer Driver Installation (Windows)

The Duet drivers ensure that the computer recognizes the bioprinter and that you do not have any connection issues when you connect the printer. If you are running Windows operating system follow the steps below, omit this step if your computer runs on operating system other than Windows.

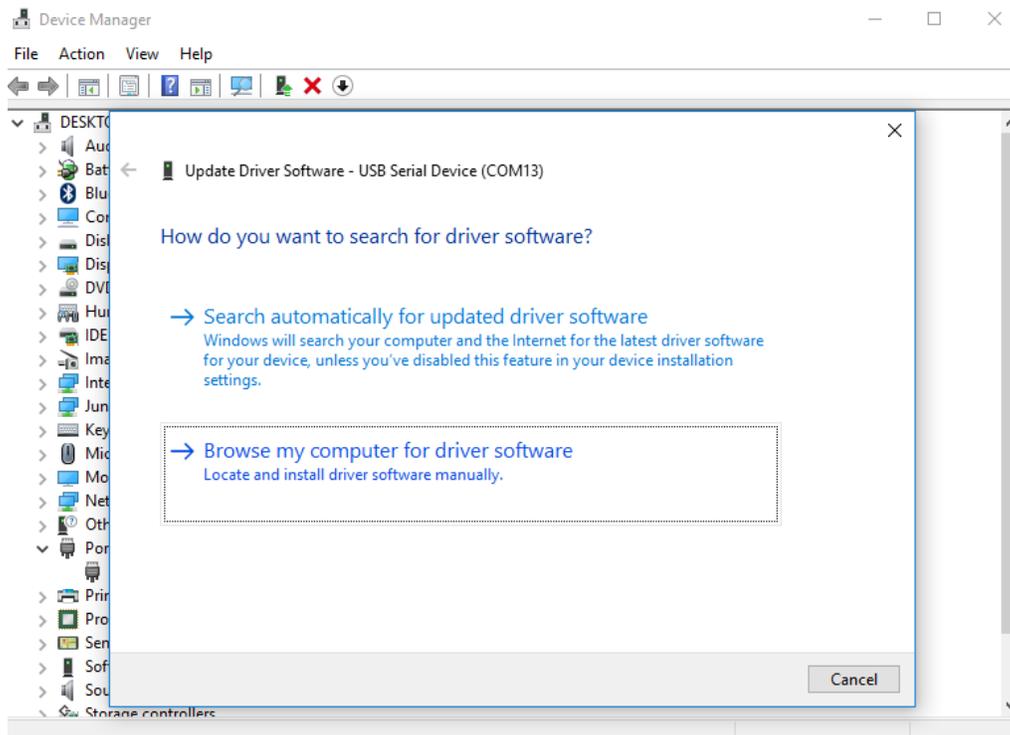
1. To download the Duet driver files, go to the Startup-guide – r3bEL mini, scroll to the “Programs to download” section and download the Duet Driver file. Unzip the two files (duet.inf and duetinf.cat) to a local folder on your PC.
2. Connect the Duet to your PC using the USB cable.
3. Open **Device Manager**. Find the Ports section and identify the device that shows up when you connect the bioprinter.



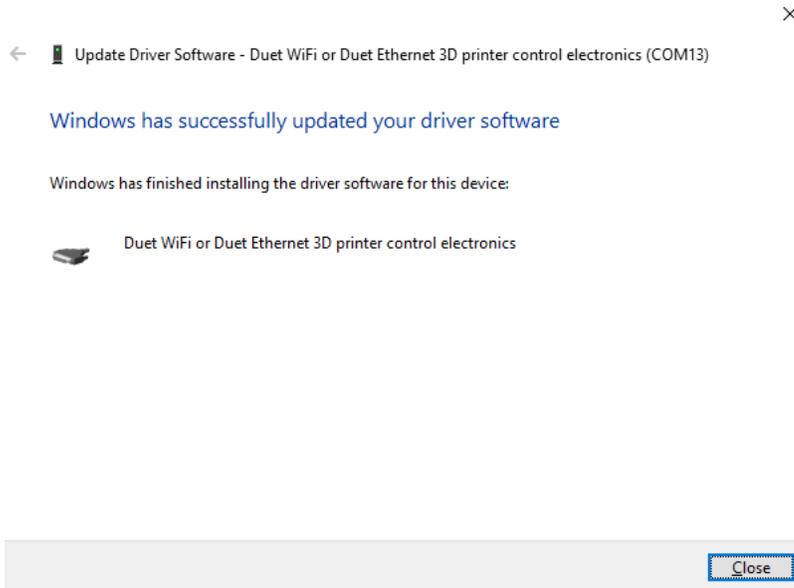
- Right-click on the Device and select **Update Driver Software** as shown below.



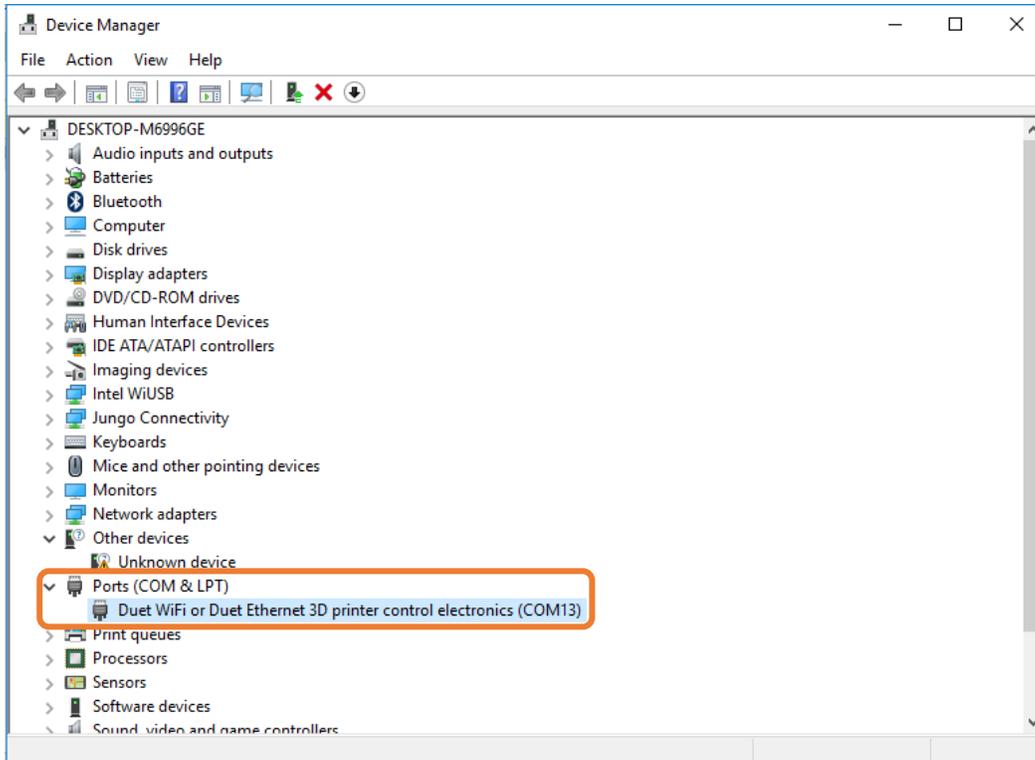
- Click on **Browse my computer for driver software** option and choose the folder where you extracted the files from the DuetWiFi driver.zip folder and click on Next.



- You will get a Windows installer pop-up window click on Install and wait until it says **Windows successfully updated the driver software** and click on close.



- Once you close the window you should see that the Unknown device should show up as **DuetWifi or Duet Ethernet 3D Printer control electronics (COM)**.



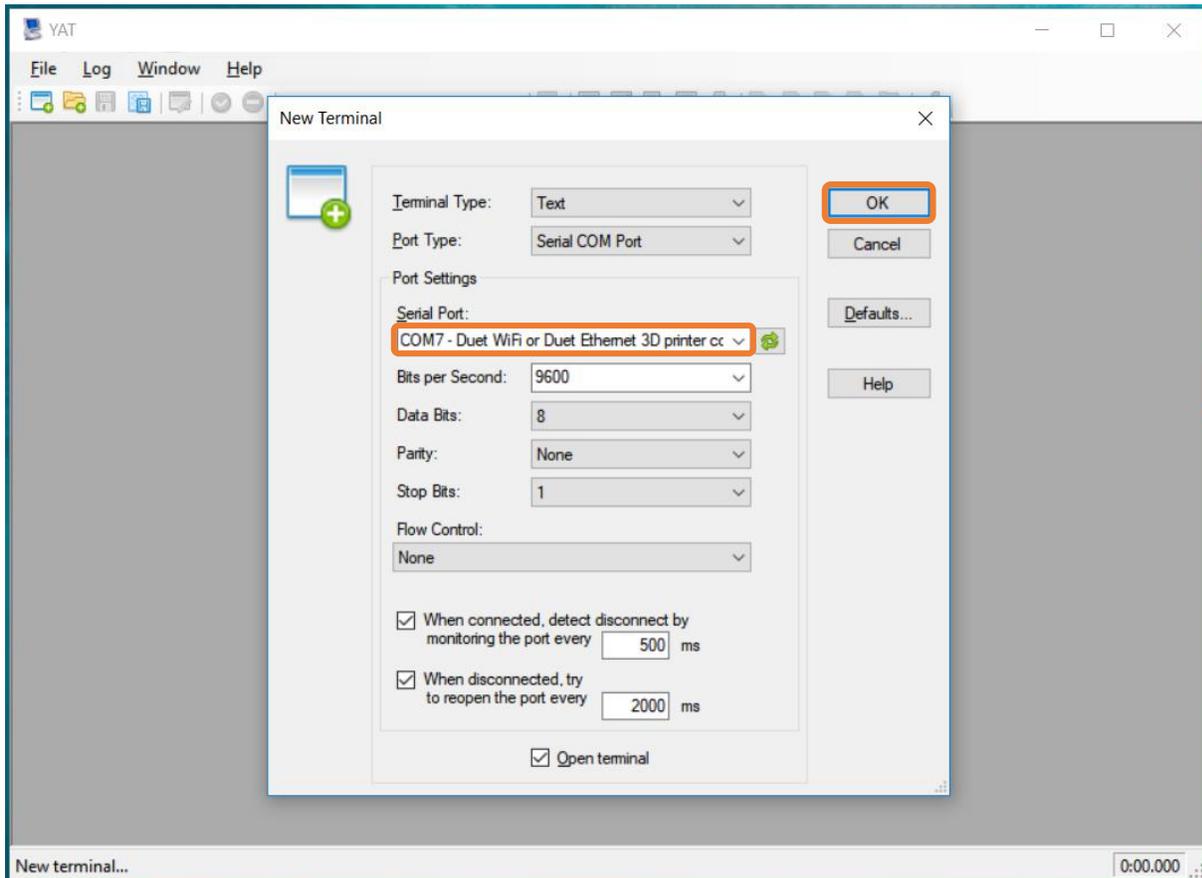
8.2 Configuring the Wi-Fi

To setup the Wi-Fi connection you must download YAT terminal (for Windows) or Coolterm (for macOS) depending on the operating system of your computer. Windows users can follow the instructions listed under section 7.2.1 YAT Terminal and macOS users can skip to section 7.2.2 for instructions.

8.2.1 YAT Terminal (Windows)

YAT terminal software is used to configure the Wi-Fi module on the bioprinter. If you are running a Windows operating system follow the steps below:

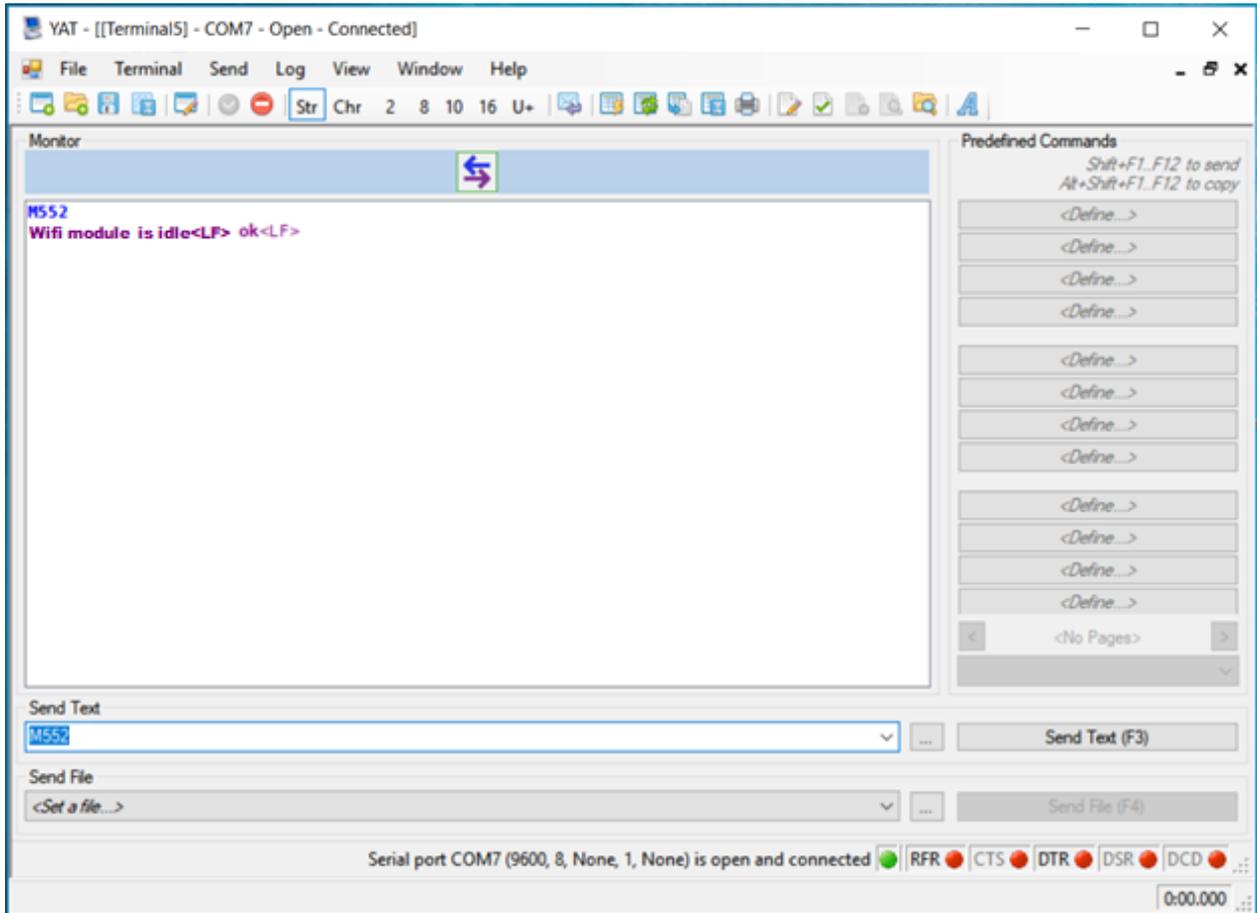
1. Download the Terminal Emulator program YAT from the link <https://sourceforge.net/projects/y-a-terminal/> and install the software.
2. Make sure that the bioprinter is connected to the computer using the USB Cable.
3. Open the program and click on OK in the New Terminal window. Make sure that the board is recognized in the pop-up window as shown below.



- You will now be able to send commands to the board by typing it in the **Send Text** command box. Send the following command:

M552

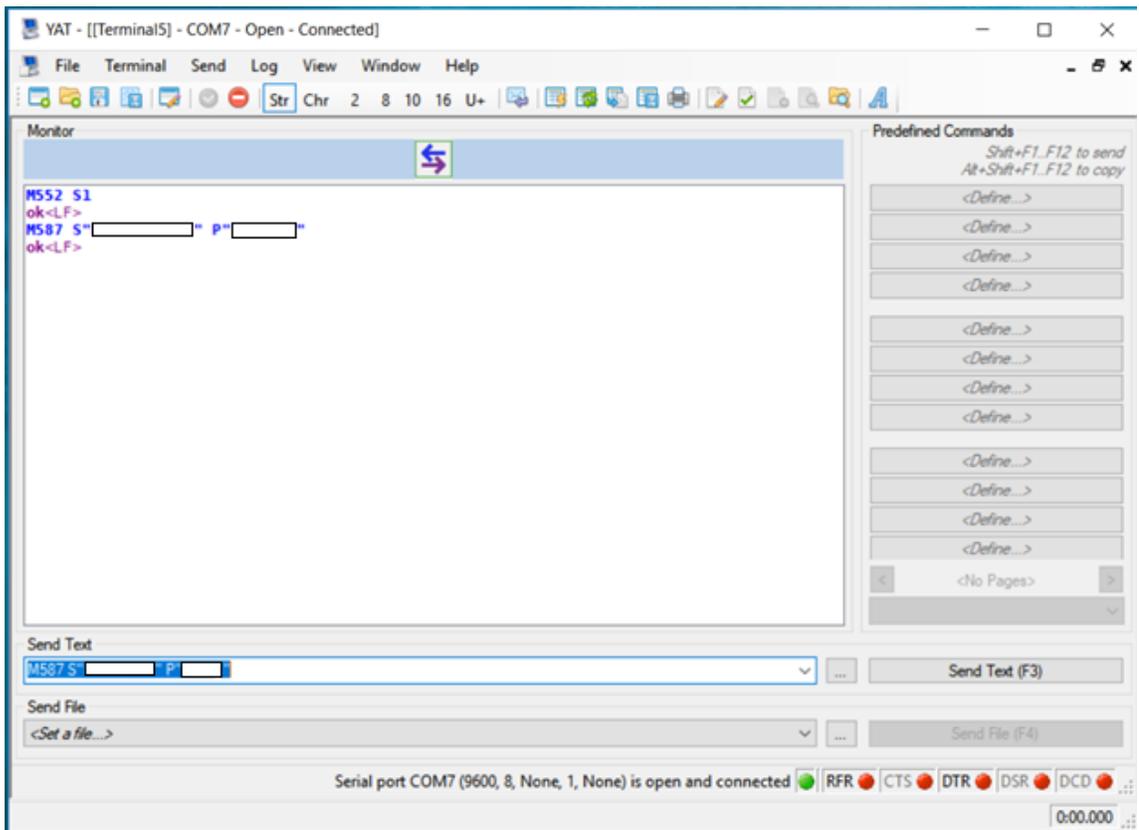
Wait until you get the "*Wi-Fi module is idle*" reply:



- Next, send the following command to save the access point parameters:

M587 S"Name of the Wifi you want to connect to" P>Password for the network"

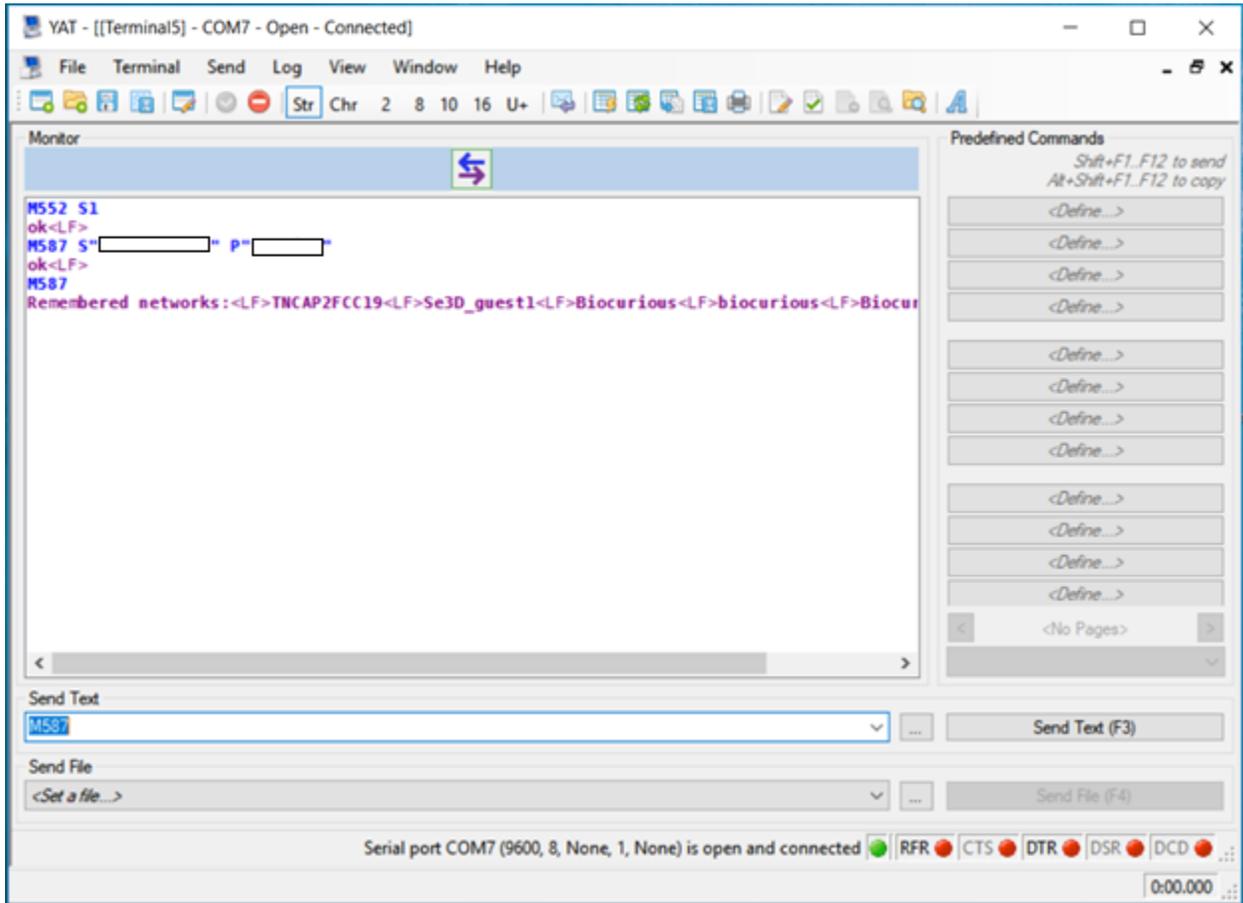
Note: The Wi-Fi module operates at 2.4 Ghz not 5 Ghz. Make sure you enter the details for the 2.4 Ghz network. The Name and Password for the network are case sensitive so make sure that you enter the details carefully!



6. To verify that the network you entered has been stored, send:

M587

This command will display a list of networks it has been connected, the last one is the most recent network. You can set up connection to additional access points in the same way if you wish.

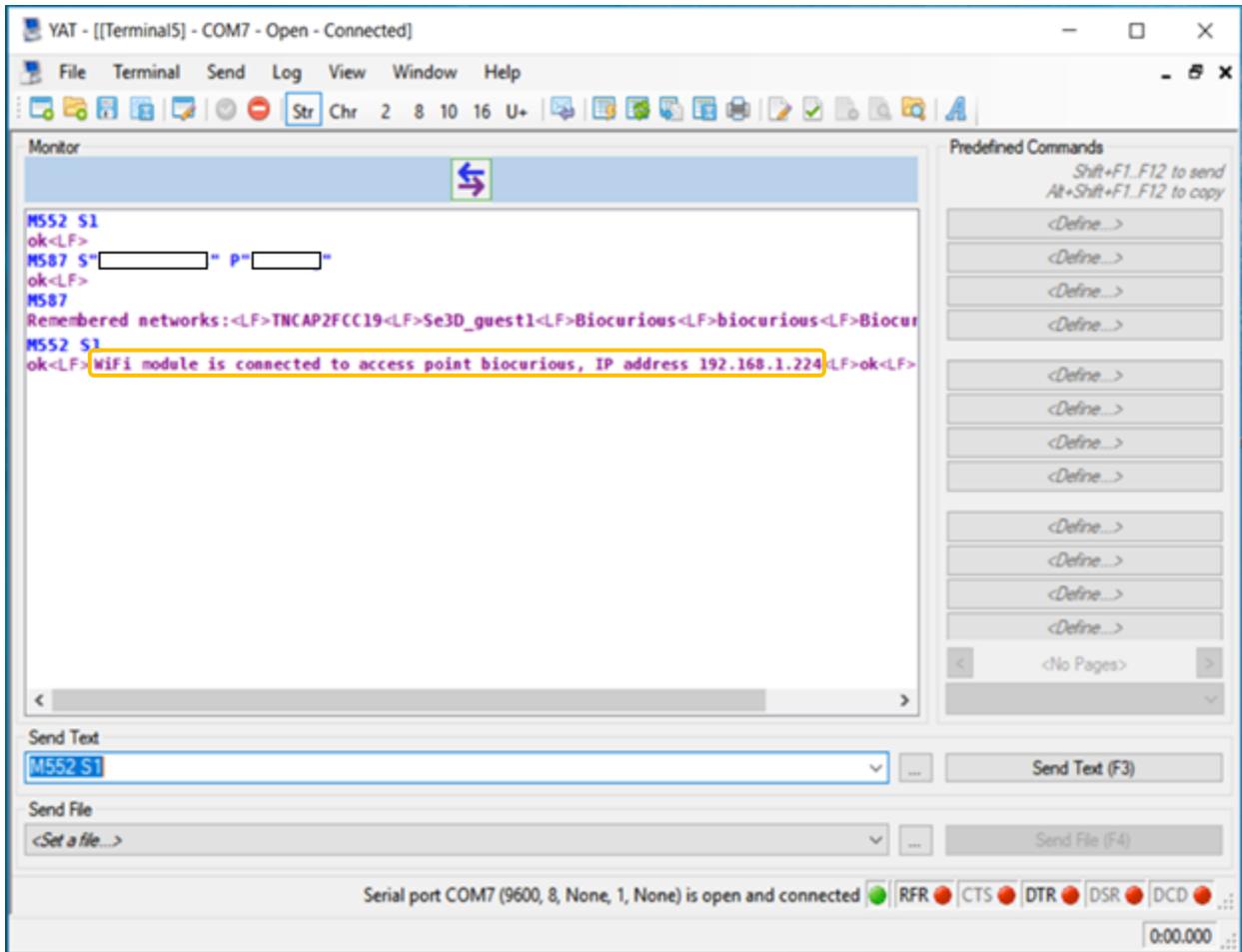


7. Send the following command to connect to the access point:

M552 S1

After a few seconds, it should confirm the connection and give you an IP address. If you have configured multiple access points and more than one is in range, the bioprinter will connect to the strongest one.

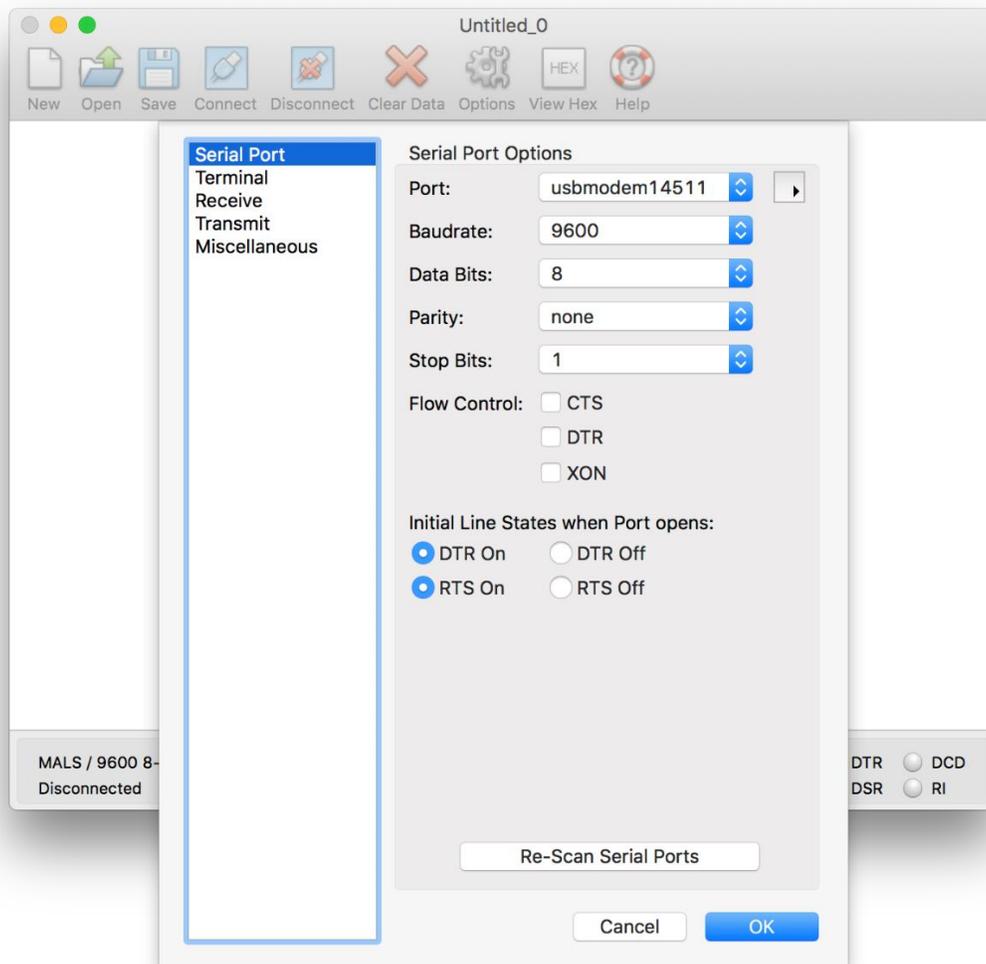
Note: Remember to take down this IP address since you will need it to connect to the printer.



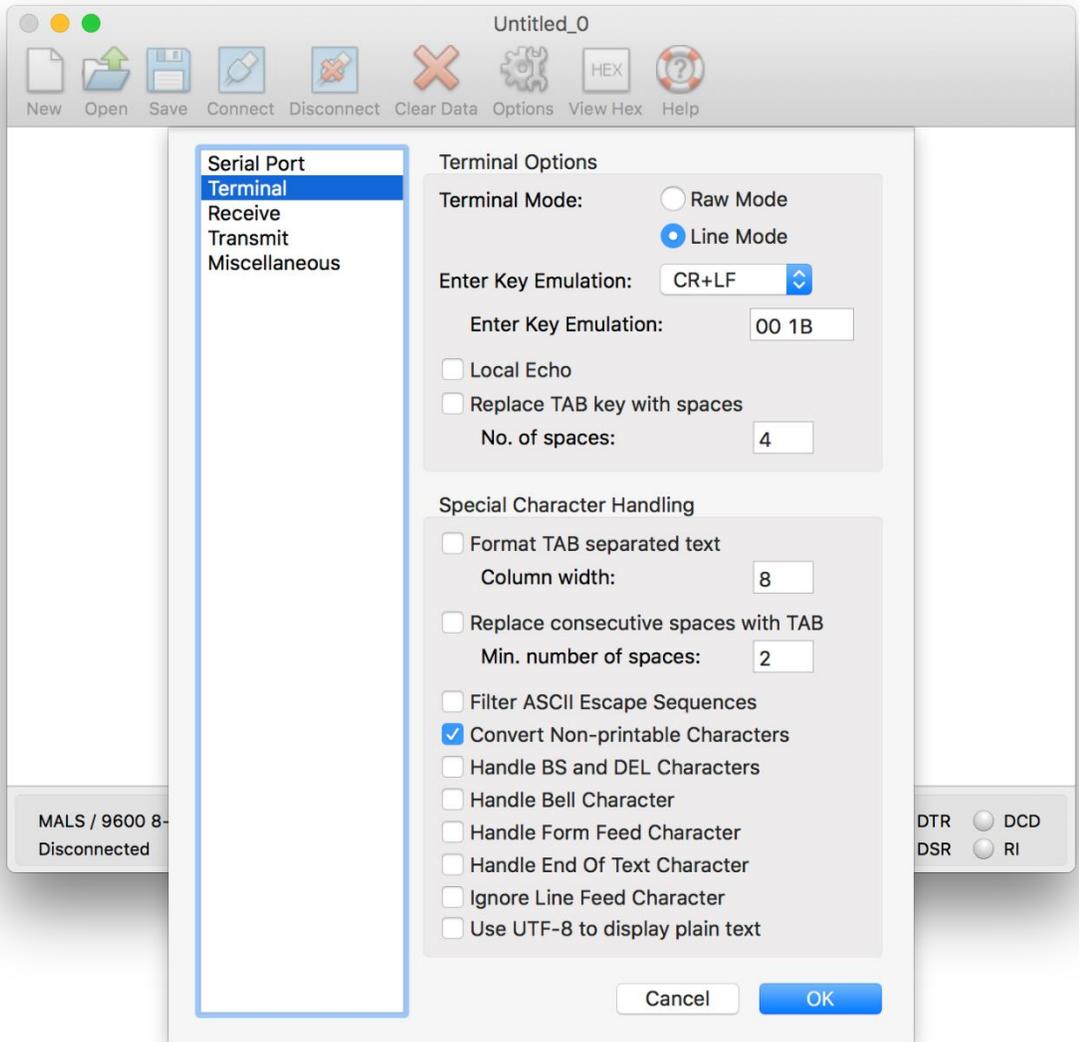
8.2.2 Coolterm (macOS)

Coolterm is used to configure the Wi-Fi module on the bioprinter for MacOS users. If you are running a MacOS operating system follow the steps below:

1. Download the MacOS version of the Terminal Emulator program Coolterm from the link <http://freeware.the-meiers.org/> and extract the contents to a local folder. If you get an error **“can’t be opened because it is from an unidentified developer”** when you try to open the software, go to Settings>Security/Privacy and you should have an option to allow all apps, this will make it a trusted app.
2. Make sure that the bioprinter is connected to the computer using the USB Cable.
3. Open the program and click on options. Select the dropdown in the Port option and choose the one with the name similar to “usbmodem145411”. The numbers might differ each time.

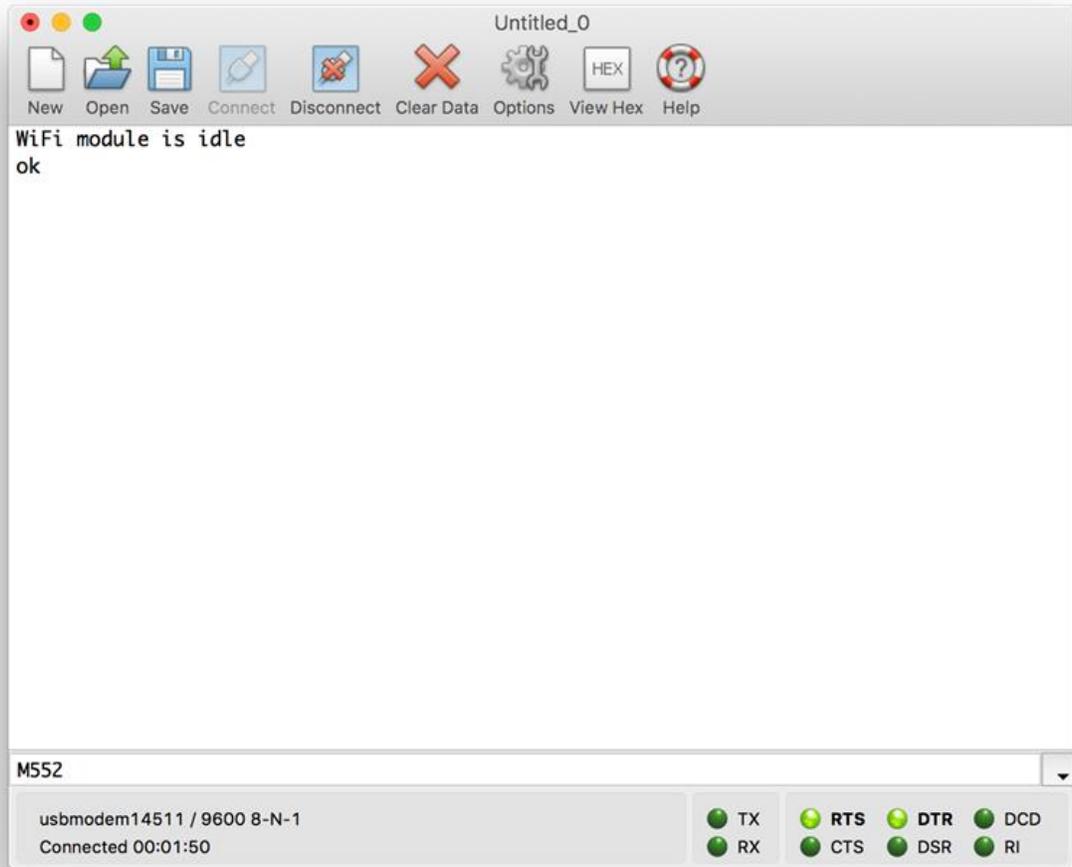


4. Choose the Terminal section and under Terminal Mode choose the **Line mode** and click on OK.



5. Click on **Connect** in the main window and send the following command and wait till you get the output “Wifi module is idle”:

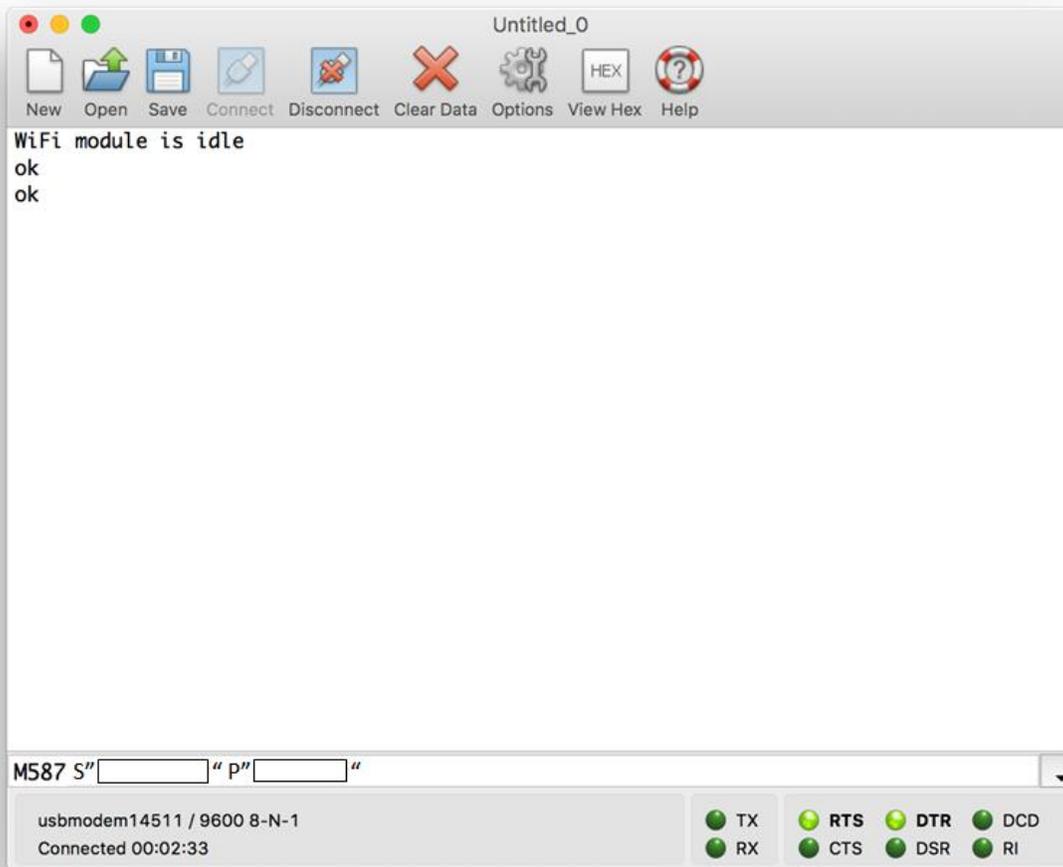
M552



- Next, send the following command to save the access point parameters:

M587 S"Name of the Wi-Fi you want to connect to" P>Password for the network"

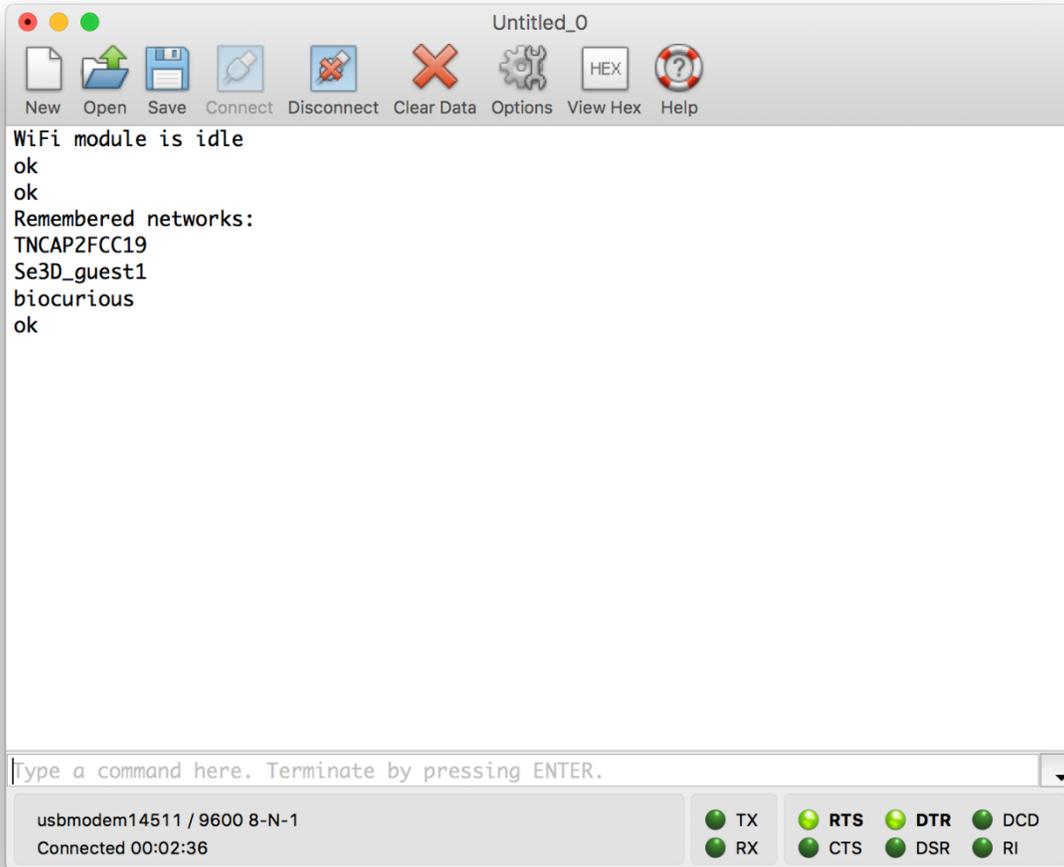
Note: The Wi-Fi module operates at 2.4 Ghz not 5 Ghz. Make sure you enter the details for the 2.4 Ghz network. The Name and Password for the network are case sensitive make sure that you enter the details carefully.



7. To verify that the network you entered has been stored, send:

M587

This command will display a list of networks it has been connected, the last one is the most recent network. You can set up connection to additional access points in the same way if you wish.

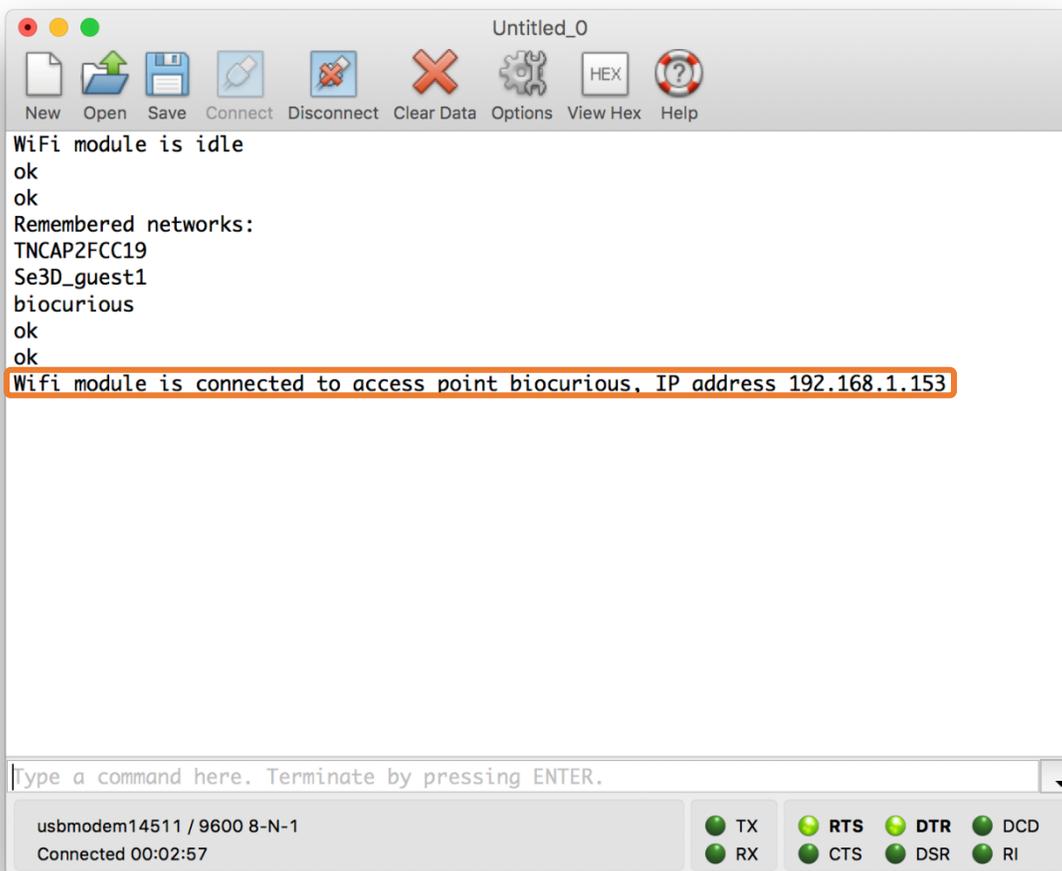


- Send the following command to connect to the access point:

M552 S1

After a few seconds, it should confirm the connection and give you an IP address. If you have configured multiple access points and more than one is in range, the bioprinter will connect to the strongest one.

Note: Remember to take down this IP address since you will need it to connect to the printer.



The screenshot shows a terminal window titled "Untitled_0" with a menu bar containing "New", "Open", "Save", "Connect", "Disconnect", "Clear Data", "Options", "View Hex", and "Help". The terminal output is as follows:

```
WiFi module is idle
ok
ok
Remembered networks:
TNCAP2FCC19
Se3D_guest1
biocurious
ok
ok
Wifi module is connected to access point biocurious, IP address 192.168.1.153
```

The last line of output is highlighted with an orange box. Below the terminal area, there is a status bar showing "usbmodem14511 / 9600 8-N-1" and "Connected 00:02:57". To the right of the status bar are several status indicators: TX, RX, RTS, CTS, DTR, DSR, DCD, and RI, each with a green dot next to it.

8.3 Web Control Interface

Enter that IP address you got when you configured the Wi-Fi in the browser address bar on your PC, tablet or smartphone to connect. The web control works best in Google Chrome and Firefox. When you connect, it will prompt you for a password, enter **se3d** and hit enter. The interface will look like:

The screenshot shows the REBEL web control interface. At the top, there are controls for Disconnect, Send G-Code, Send, and Upload & Print. The main area is divided into several sections:

- 1. Machine Control Sidebar:** A vertical sidebar on the left containing links for Machine Control, Print Status, G-Code Console, G-Code Files, Macros, Filaments, and Settings.
- 2. Head Movement:** A central panel with buttons for Home All, Home X, Home Y, and Home Z. Each home button has sub-buttons for X-100, X-10, X-1, X-0.1, X+0.1, X+1, X+10, and X+100. Similar buttons are provided for Y and Z axes. An 'Auto Bed Compensation' dropdown is also present.
- 3. Extruder Control:** A panel below Head Movement with input fields for 'Feed amount in mm' (values: 100, 50, 20, 10, 5, 1) and 'Feederate in mm/sec' (values: 60, 30, 15, 5, 1). It includes 'Retract' and 'Extrude' buttons.
- 4. User-Defined Macros:** A panel on the right listing 16 macros, such as '1.1 Set Home', '2.1 P0', '3.1 Extrude 150 mm', and '4.4 Retract 1 mm'.

Familiarize yourself with the Web control options:

- 1. Web control tabs:**
 - a. Machine control: Enables you to control the Printer and extruder movements
 - b. Print Status: Shows the status of the file being printed. Enables you to pause/resume your prints.
 - c. G-code console
 - d. G-code files: The g-code files uploaded in the SD card
 - e. Macros: User defined custom macros
- 2. Printer movement control:** You can control the movement of the printer in X, Y and Z axis. The co-ordinate system is similar to the system explained in section 4.2
- 3. Extruder control:** This section lets you control the extruder motion. You can selection the amount you want to retract under feed and choose 30 mm/sec as the federate. You can extrude or retract by clicking on the button on the side accordingly.
- 4. User defined custom buttons:** This section has a list of pre-installed buttons that can be used to perform specific tasks.

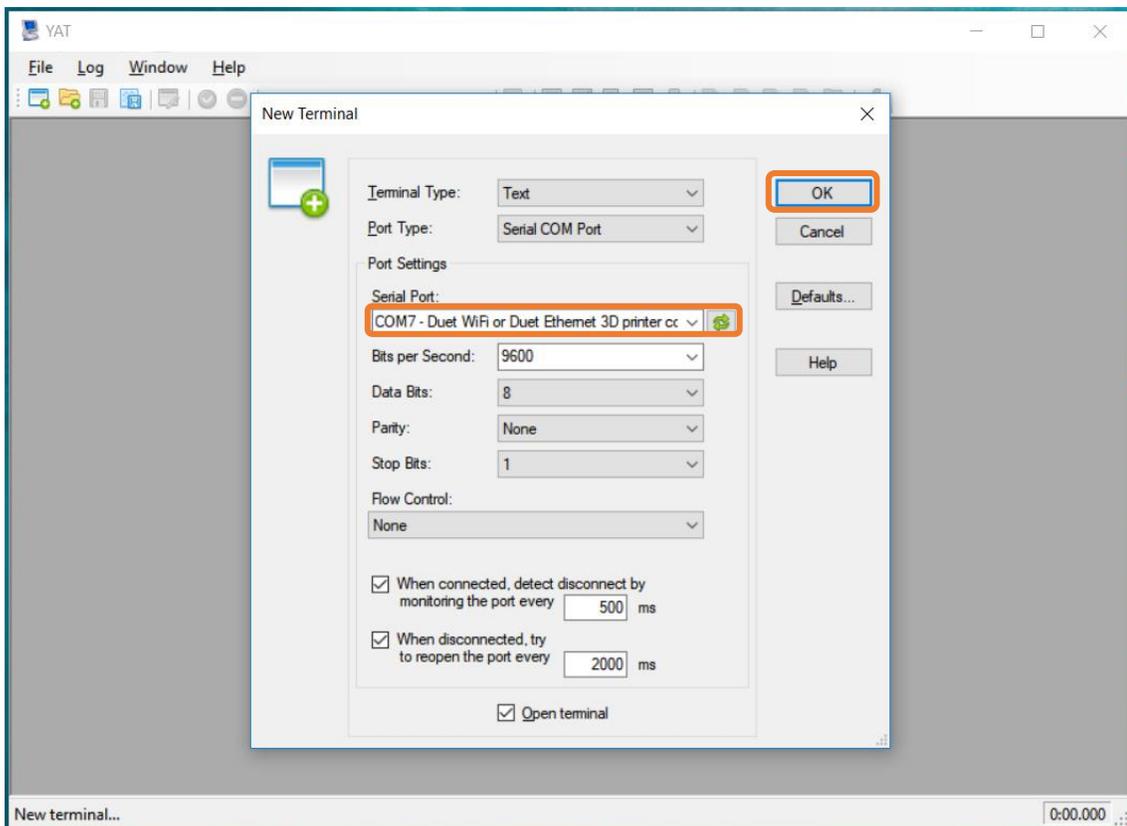
9 Connecting to Rebel Mini in access point mode

If you have issues connecting to the printer after you the IP address from the previous section, it might be due to firewall restrictions or the printer IP address might keep changing frequently. To fix this issue you can turn your bioprinter into a WiFi access point and connect to it the way you connect to a modem. The steps on how to configure the printer in access point mode is explained in the below section for both Windows and Mac users.

9.1 Windows Users

To connect to the Printer in access point mode follow the below steps:

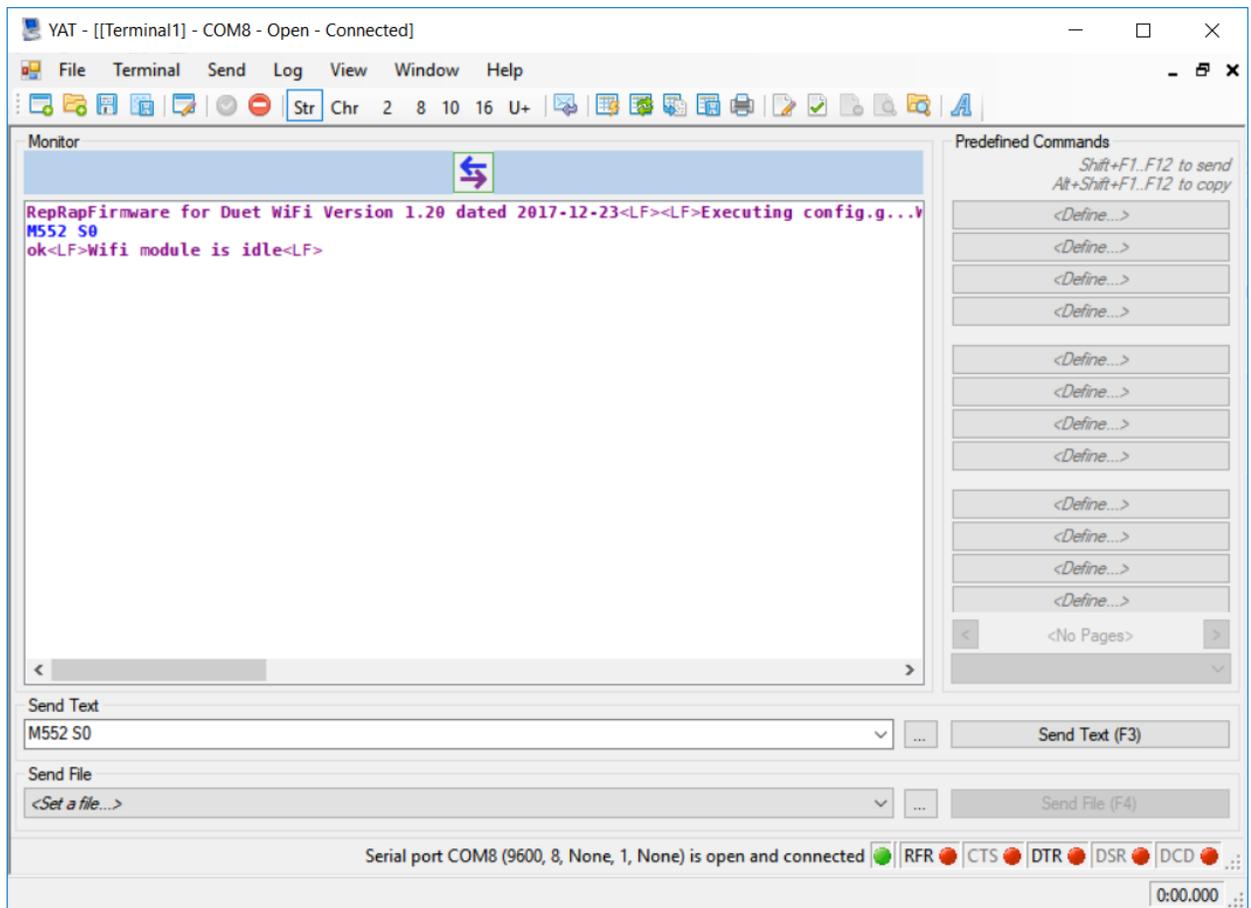
1. Connect the bioprinter to the computer using the USB Cable
2. Open YAT and click on OK in the New Terminal window. Make sure that the board is recognized in the pop-up window as shown below.



- You will now be able to send commands to the board by typing it in the **Send Text** command box. Send the following command:

M552 S0

Wait until you get the "*Wi-Fi module is idle*" reply:

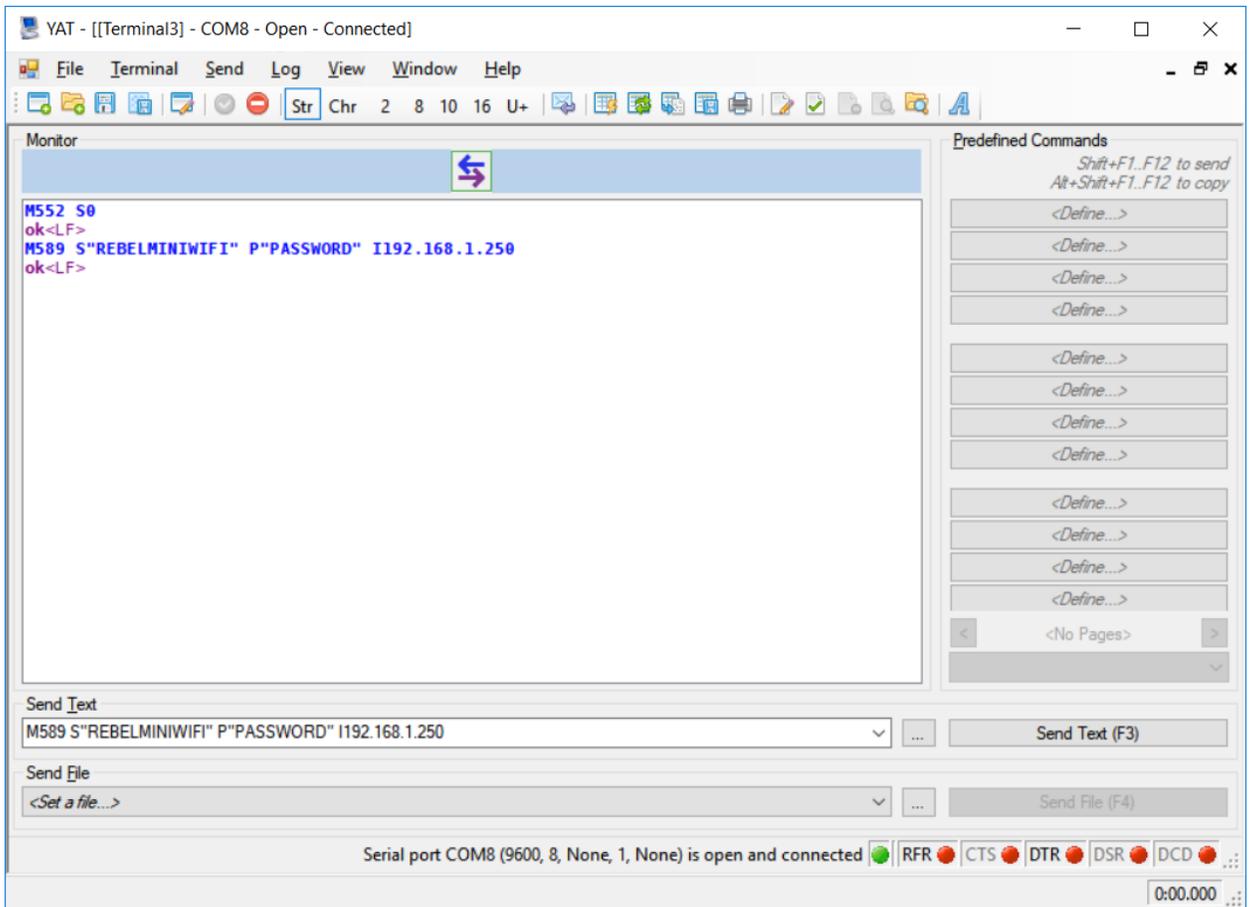


4. Enter the following command to configure the access point parameters for the printer:

M589 S"Name for the Rebel Mini WiFi" P"Password" I192.168.1.250

Note: Make sure that the Name and the password are all **Uppercase** and have **no spaces** as shown in the image. The password should be at least 8 characters long.

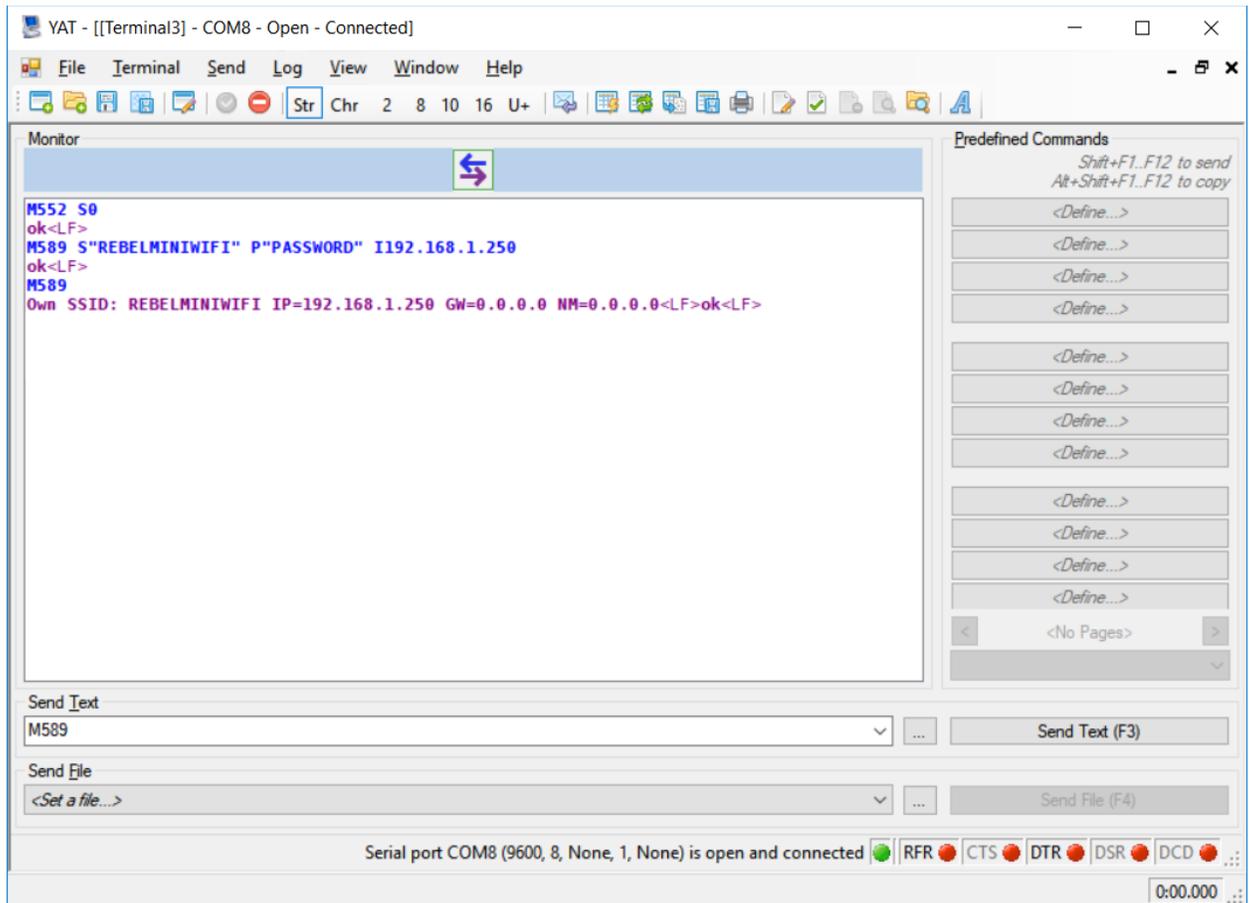
Also make a note of the Wifi name, password and the IP address as you will need the information to connect to the printer as you configure it.



5. To verify that the network you entered has been stored, send:

M589

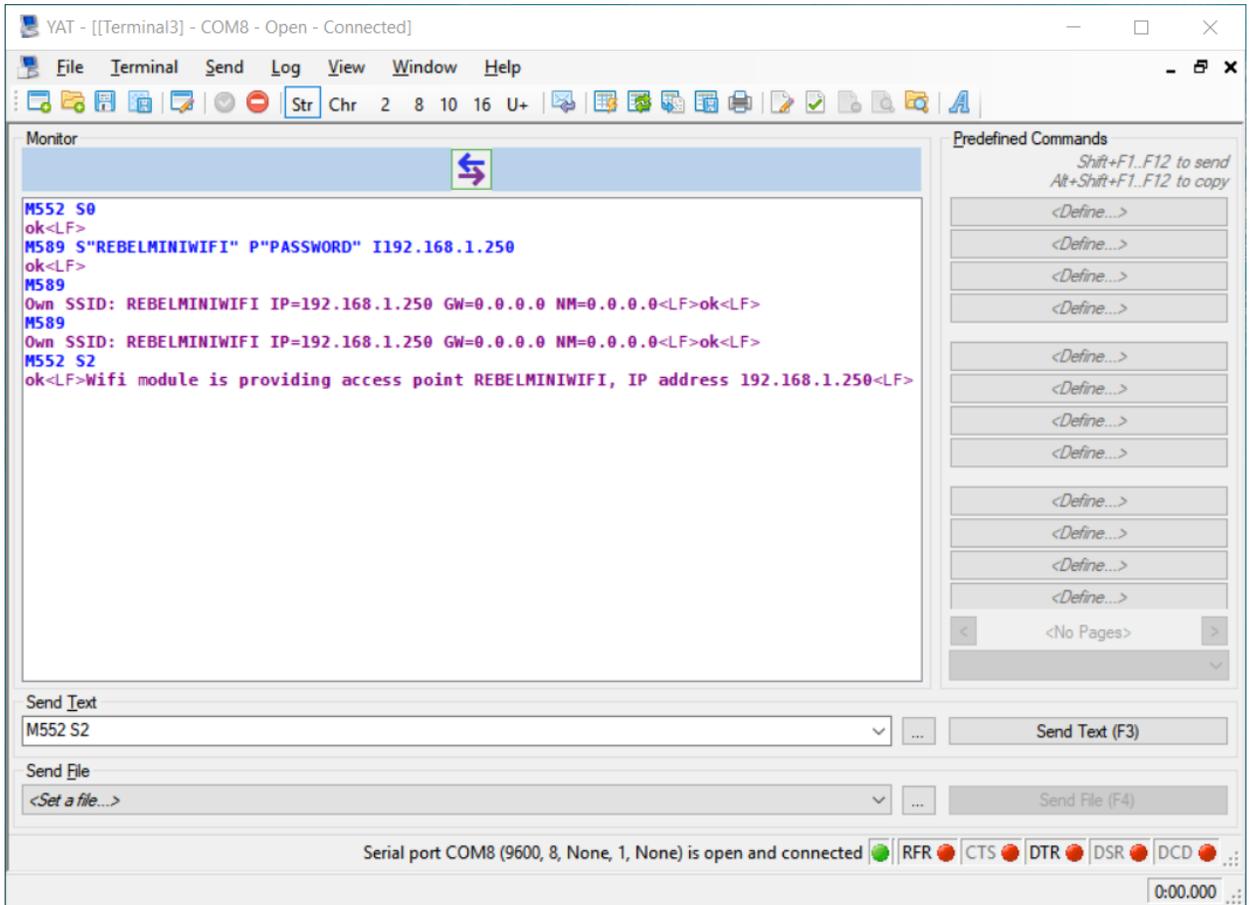
This command will display the WiFi name and the IP address you entered before.



6. Enter the following command to start the printer in access point mode:

M552 S2

Wait till you get the output ***“ok<LF>Wifi module is providing access point REBELMINIWIFI, IP address 192.168.1.250<LF>”***. If you get an error that says ***“Failed to connect”*** wait for few seconds and resend the above command.



The screenshot shows a terminal window titled "YAT - [[Terminal3] - COM8 - Open - Connected". The terminal displays the following sequence of commands and responses:

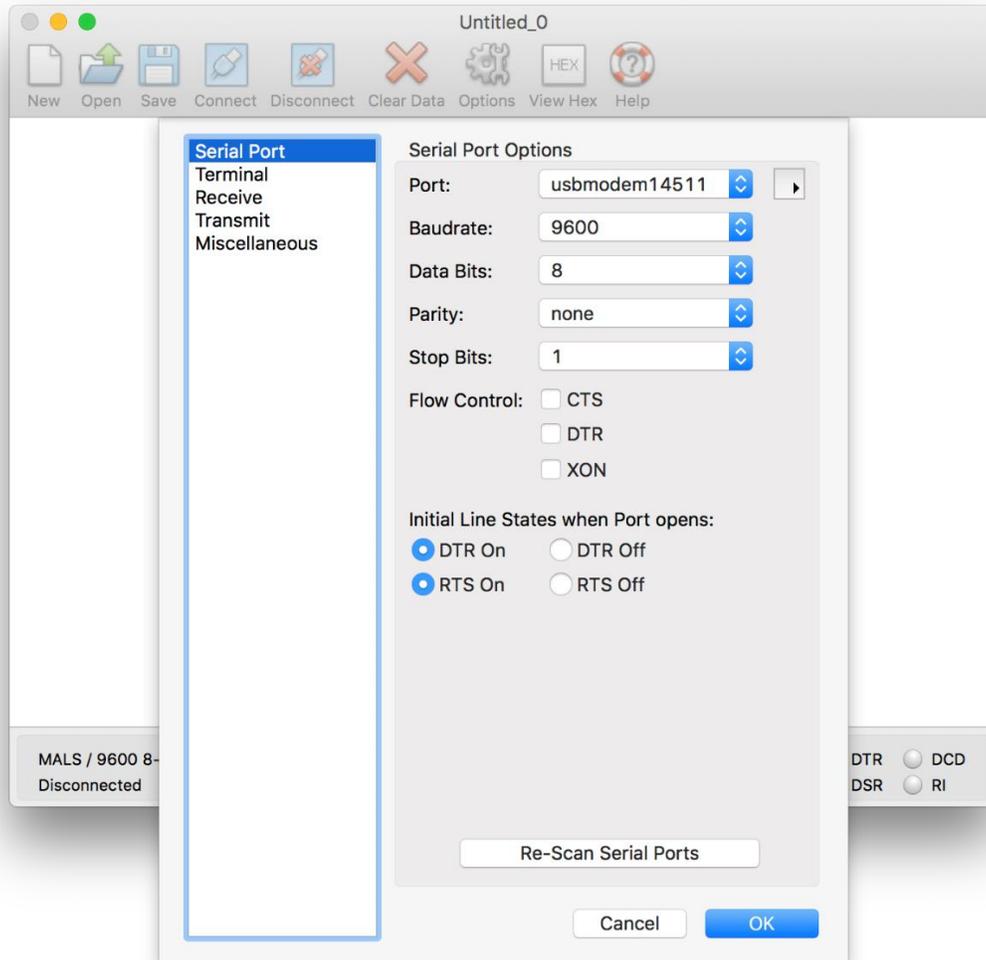
```
M552 S0
ok<LF>
M589 S"REBELMINIWIFI" P"PASSWORD" I192.168.1.250
ok<LF>
M589
Own SSID: REBELMINIWIFI IP=192.168.1.250 GW=0.0.0.0 NM=0.0.0.0<LF>ok<LF>
M589
Own SSID: REBELMINIWIFI IP=192.168.1.250 GW=0.0.0.0 NM=0.0.0.0<LF>ok<LF>
M552 S2
ok<LF>Wifi module is providing access point REBELMINIWIFI, IP address 192.168.1.250<LF>
```

The terminal interface includes a menu bar (File, Terminal, Send, Log, View, Window, Help), a toolbar with various icons, and a "Monitor" section. Below the terminal output, there are fields for "Send Text" (containing "M552 S2") and "Send File" (containing "<Set a file...>"). A "Predefined Commands" panel on the right side of the terminal window contains several "<Define...>" buttons. At the bottom of the terminal window, a status bar indicates "Serial port COM8 (9600, 8, None, 1, None) is open and connected" with various status icons (RFR, CTS, DTR, DSR, DCD) and a counter showing "0:00.000".

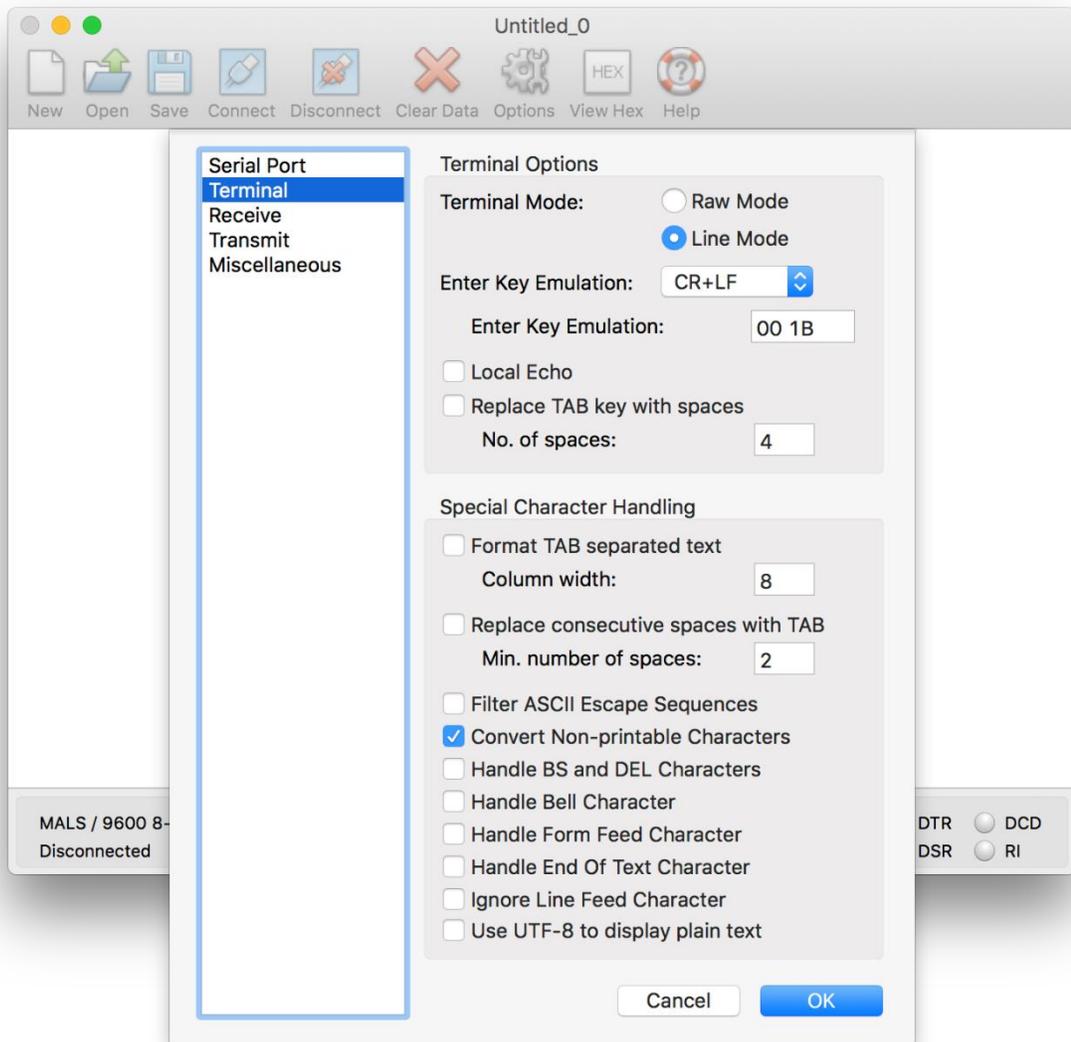
9.2 macOS computer

To connect to the Printer in access point mode follow the below steps:

1. Connect the bioprinter to the computer using the USB Cable
2. Open Coolterm and click on options. Select the dropdown in the Port option and choose the one with the name similar to “usbmodem145411”. The numbers might differ each time.

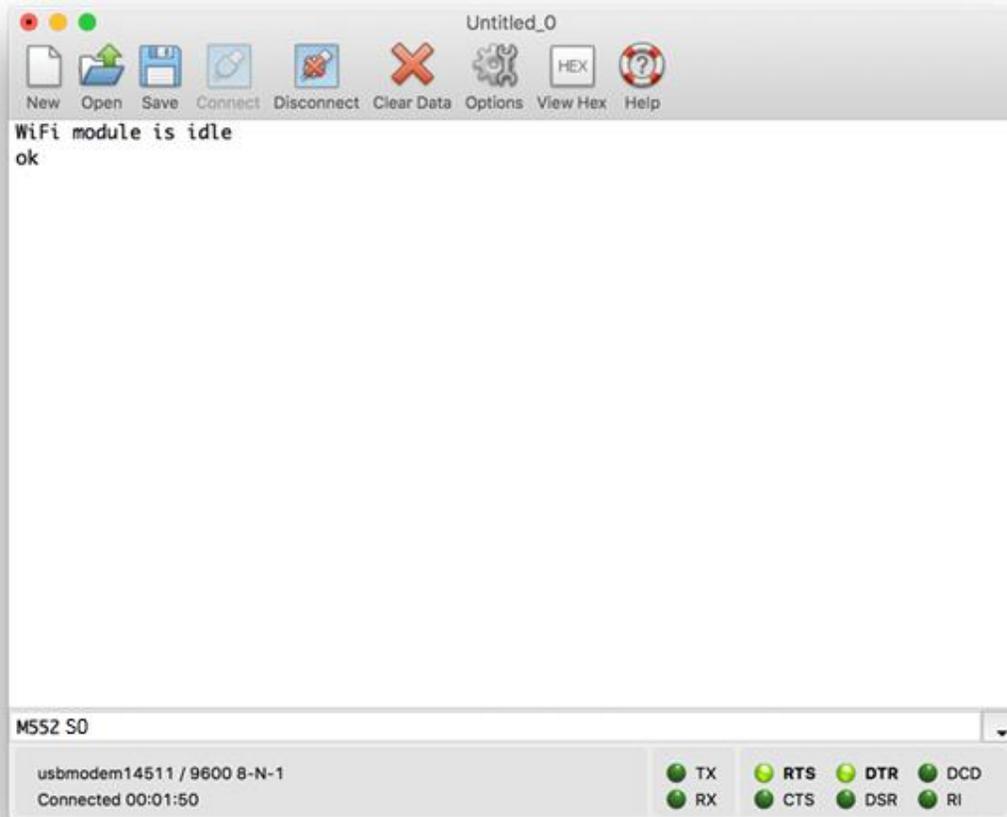


3. Choose the Terminal section and under Terminal Mode choose the **Line mode** and click on OK.



4. Click on **Connect** in the main window and send the following command and wait till you get the output “Wifi module is idle”:

M552 S0

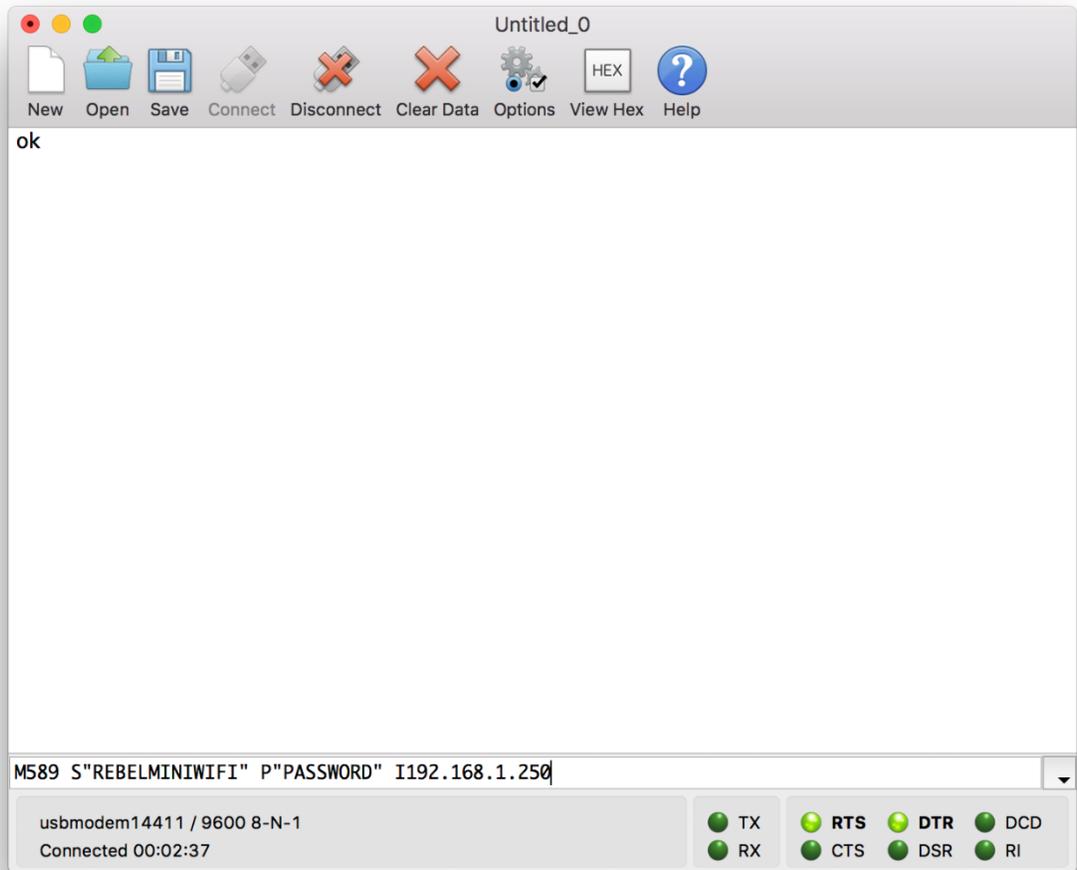


5. Enter the following command to configure the access point parameters for the printer:

M589 S"Name for the Rebel Mini WiFi" P>Password for the WiFi" I192.168.1.250

Note: Make sure that the Name and the password are all **Uppercase** and have **no spaces** as shown in the image. The password should be at least 8 characters long.

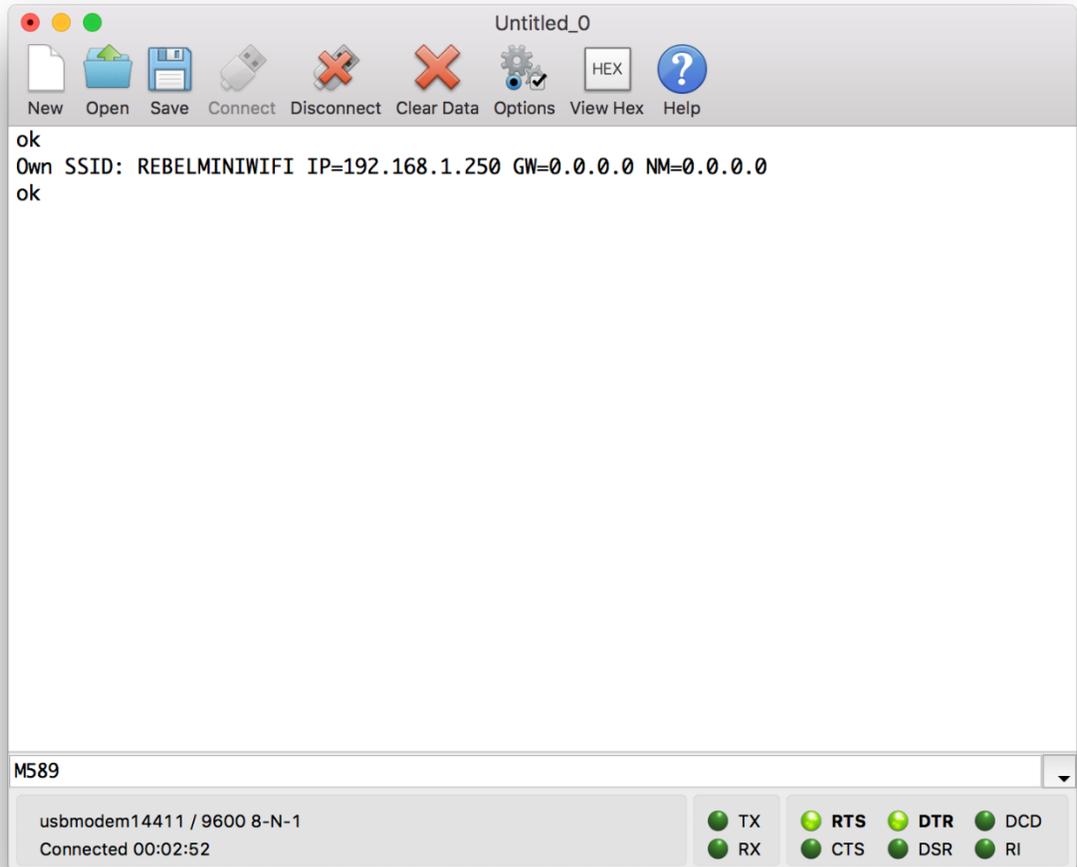
Also make a note of the Wifi name, password and the IP address as you will need the information to connect to the printer as you configure it.



6. To verify that the network you entered has been stored, send:

M589

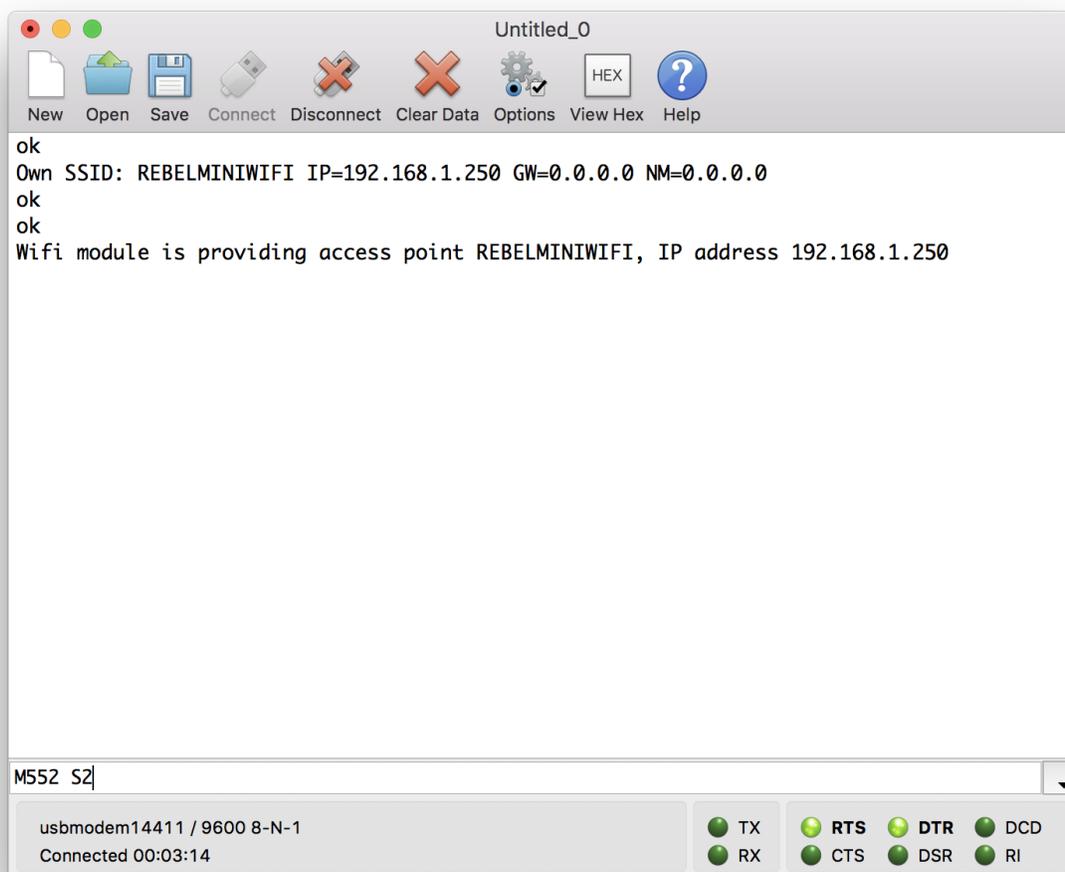
This command will display the WiFi name and the IP address you entered before.



7. Enter the following command to start the printer in access point mode:

M552 S2

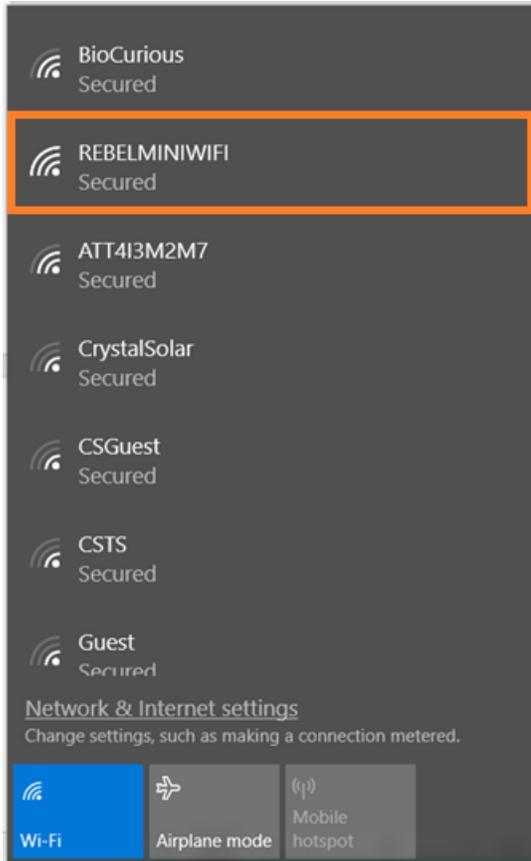
Wait till you get the output “*ok Wifi module is providing access point REBELMINIWIFI, IP address 192.168.1.250*”. If you get an error that says “*Failed to connect*” wait for few seconds and resend the above command.



9.3 Connecting to Web Control:

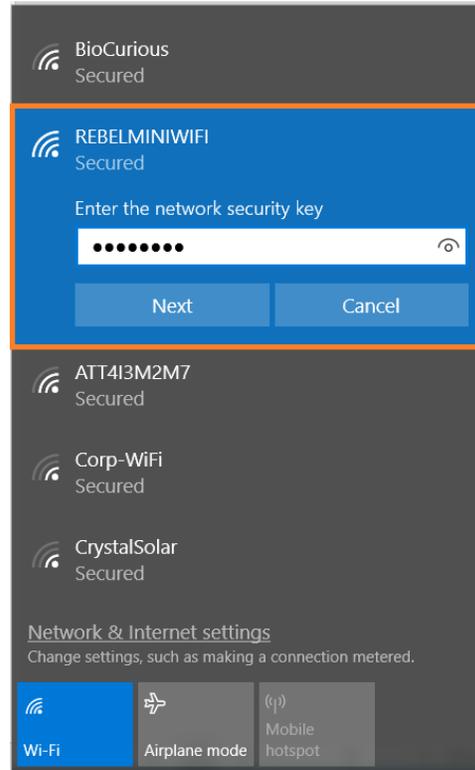
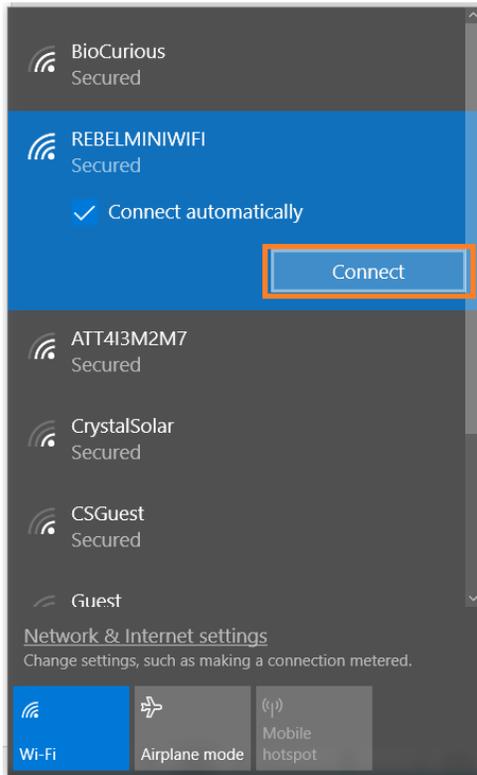
Once you have configured the bioprinter to run in the access point mode, the next step is to connect to the printer. The steps to connect to the printer for both Windows and Mac are explained below:

1. After the printer has started in the access point mode you will be able to see the Bioprinter network in your computer along with the other networks as shown below:

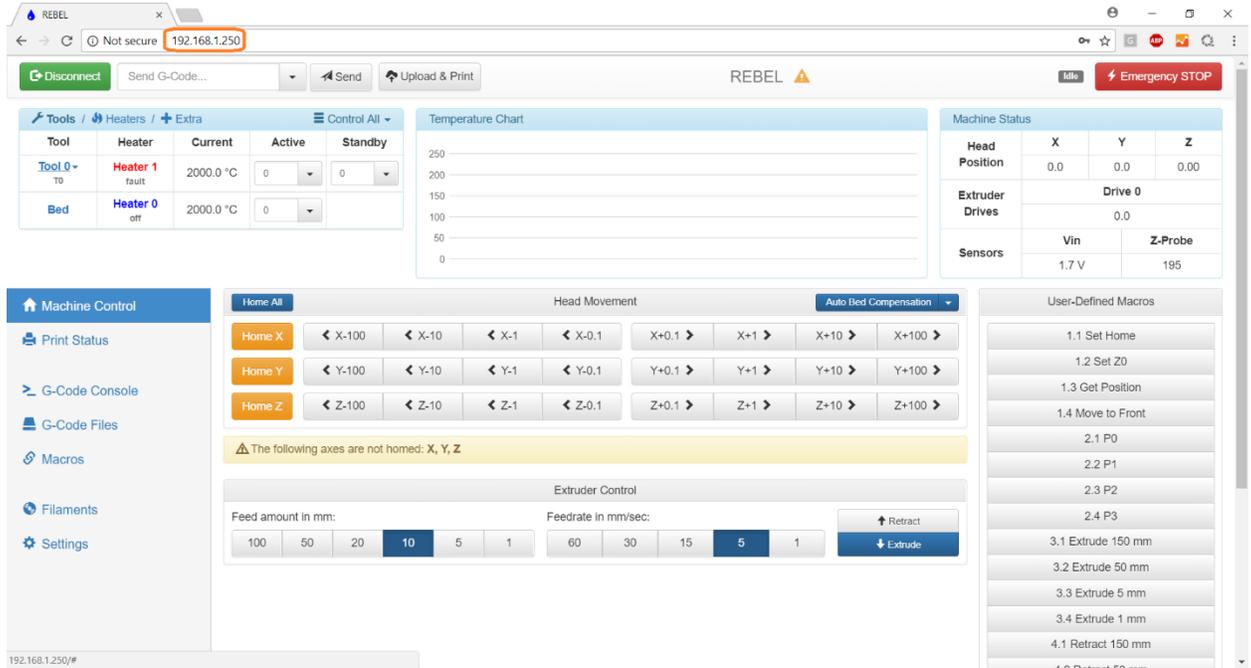


2. Choose the network and click on connect. It will prompt for a password. Enter the password you entered in the **M589** command and you will be connected to the printer.

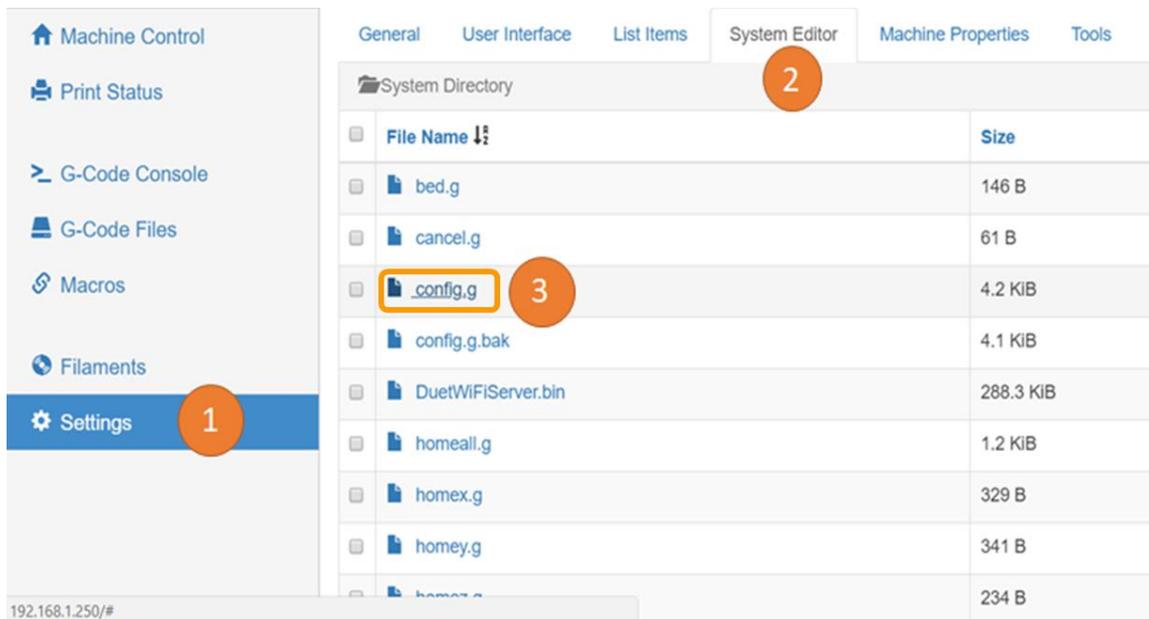
Note: Sometimes the cellphone or iPad or computer may complain that there is no Internet access, and as a result may try to reconnect to another WIFI network instead. You may have to stop it connecting to your router to get it stay connected to the printer WIFI.



- Once you are connected to the network you will be able to connect to your printer with the IP address that you have entered in the **M589** command. Enter that IP address in the browser address bar on your PC, tablet or smartphone to connect to the printer. When you connect, it will prompt you for a password, enter **se3d** and hit enter.



- To make sure that the printer always starts in the access point mode click on the **Settings** -> **System Editor** and click on **config.g** file and it will open a window as shown in below..



- Once the config file is opened; under the “Adjust IP address” section you will see the command in the first line is M552 S1. You need to change it to **M552 S2** and click on save changes. It will then ask if you want to restart the Duet, click Yes. Now the printer will start in access point mode every time you turn on the printer.

Editing 0:/sys/config.g

```

; Ormerod 2 config file for dc42 Duet firmware

M111 S0                ; Debug off
M550 PREBEL           ; Machine name (can be anything you like)
M551 Pse3d            ; Machine password (used for FTP connections)
M540 P0XB:E:0XEF:0XDE:0XAD:0XFE:0XED ; MAC Address

;*** Adjust the IP address and gateway in the following 2 lines to suit your network
M552 S1                ; Turn network ON
;M552 P0.0.0.0         ; IP address (0 = use DHCP)
;M554 P192.168.1.1    ; Gateway
;M553 P255.255.255.0  ; Netmask
M555 P2                ; Set output to look like Marlin
G21                   ; Work in millimetres
G90                   ; Send absolute coordinates...
M83                   ; ...but relative extruder moves

; Machine configuration
M569 P0 S0            ; Drive 0 goes forwards (change to S0 to reverse it)
M569 P1 S0            ; Drive 1 goes forwards
M569 P2 S0            ; Drive 2 goes forwards
M569 P3 S1            ; Drive 3 goes forwards
M569 P4 S1            ; Drive 4 goes forwards
; If you use an endstop switch for Z homing, change Z0 to Z1 in the following line, and see also M558 command later in this file
M574 X1 Y1 Z2 S1     ; set endstop configuration (X and Y and endstops only, at low end, active high)
;M667 S1              ; set CoreXY mode
M906 X600 Y600 Z900 E300 ; Set motor currents (mA)

```

Cancel Save Changes

Editing 0:/sys/config.g

```

; Ormerod 2 config file for dc42 Duet firmware

M111 S0                ; Debug off
M550 PREBEL           ; Machine name (can be anything you like)
M551 Pse3d            ; Machine password (used for FTP connections)
M540 P0XB:E:0XEF:0XDE:0XAD:0XFE:0XED ; MAC Address

;*** Adjust the IP address and gateway in the following 2 lines to suit your network
M552 S2                ; Turn network ON
;M552 P0.0.0.0         ; IP address (0 = use DHCP)
;M554 P192.168.1.1    ; Gateway
;M553 P255.255.255.0  ; Netmask
M555 P2                ; Set output to look like Marlin
G21                   ; Work in millimetres
G90                   ; Send absolute coordinates...
M83                   ; ...but relative extruder moves

; Machine configuration
M569 P0 S0            ; Drive 0 goes forwards (change to S0 to reverse it)
M569 P1 S0            ; Drive 1 goes forwards
M569 P2 S0            ; Drive 2 goes forwards
M569 P3 S1            ; Drive 3 goes forwards
M569 P4 S1            ; Drive 4 goes forwards
; If you use an endstop switch for Z homing, change Z0 to Z1 in the following line, and see also M558 command later in this file
M574 X1 Y1 Z2 S1     ; set endstop configuration (X and Y and endstops only, at low end, active high)
;M667 S1              ; set CoreXY mode
M906 X600 Y600 Z900 E300 ; Set motor currents (mA)

```

Cancel Save Changes

Note: To connect to the printer, you need to connect to the printer WiFi first before you enter the IP address you noted down in the browser.

Since you are connected to the printer through WiFi you will not have access to the internet.

10 First Print using Web Interface

You are now ready to run your first test print using the web interface. Follow the instructions below to perform the first print on your new r3bEL mini.

10.1 Required Items:

- r3bEL mini bioprinter
- Petri dish (100 mm diameter)
- 5 mL plastic syringe
- 22-gauge blunt-tip needle with Luer lock
- Lotion

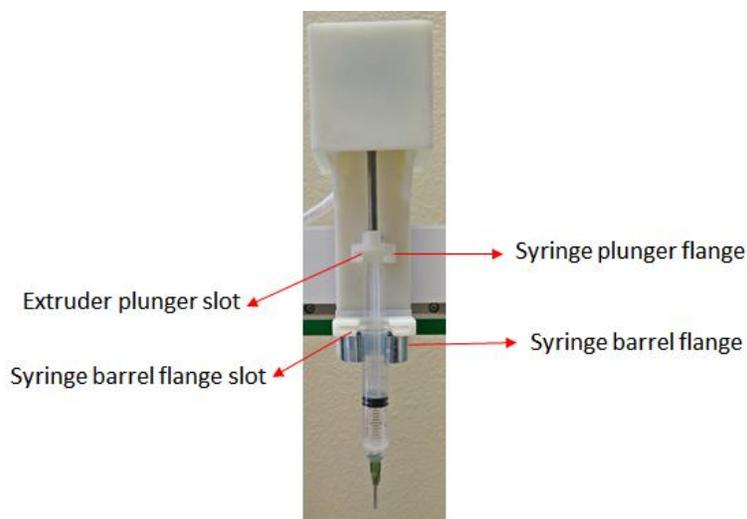
10.2 Loading and Unloading Syringes

Before loading or unloading syringes, ensure that the r3bEL mini bioprinter is connected to your computer via USB and open the Pronterface program.



10.2.1 Loading a syringe

1. Insert the barrel flanges into the barrel flange slot and try to align the syringe plunger to fit in the slot in the extruder (see figure below). If the extruder slot does not align with the syringe plunger move the extruder higher or lower by clicking on “extrude” or “retract” accordingly until the slot in the extruder is in line with the syringe plunger. Then slowly push the syringe in until it locks into position on the metal holder.
2. After the syringe is in place extrude in 5 or 1 mm increments until liquid is pushed out of the needle tip. This is referred to as “priming” the syringe. Wipe off any excess liquid before printing.

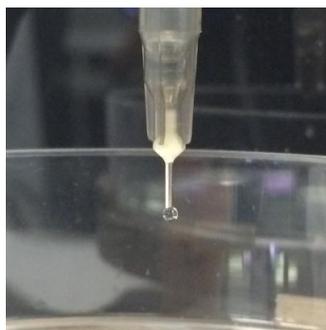


10.2.2 Unloading a syringe

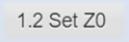
1. Retract the extruder by 5 mm or 1 mm to make sure that the syringe plunger is loose and not in contact with the top of the extruder.
2. Pull the syringe slowly and you should be able to get the syringe out smoothly.

10.3 Procedure

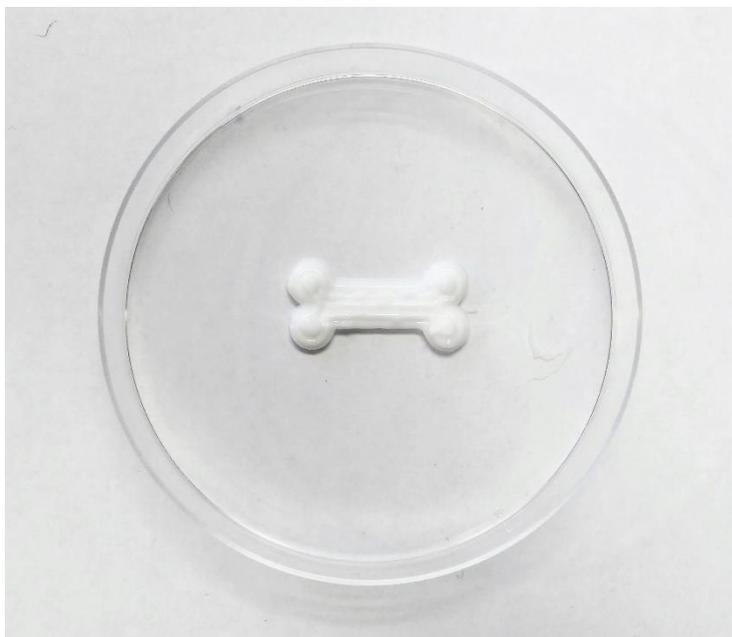
1. Turn on the r3bEL mini bioprinter and enter the IP address you got from the previous section in the browser and connect to the printer.
2. Home the bioprinter using the [Home All](#) button.
3. Fill a 5 mL syringe with ~4 mL of lotion.
4. Load the syringe in the extruder as shown in the previous section.
5. Prime the syringe, which will help ensure print consistency. Manually extrude in small increments using the [3.3 Extrude 5 mm](#) or [3.4 Extrude 1 mm](#) button in the User-Defined Macro section. Move until lotion is pushed out of the needle tip and wipe excess lotion away as necessary from the needle tip.



Priming the syringe

6. Manually move the bioprinter bed using the Z axis control buttons until it is almost in contact with, but not touching, the needle tip. Verify the positioning by sliding a piece of paper between the needle tip and bed. Adjust the bioprinter bed until the piece of paper can slide between the needle tip and bed with only minimal resistance, then set the Z0 position using the  custom button in the User-Defined Macro section.
7. Download the ***Bone mini-5ml-22g.gcode*** file from the SE3D portal if you haven't already done so. This file can be found in the G-codes files section in the Startup Guide – r3bEL mini.
8. In the top toolbar of the web control, click on  button. Choose the ***Bone mini-5ml-22g.gcode*** file. The print should look like the picture below.

Note: If the extruder or bed hits the Needle tip/Petri dish/Well plate or rams into the sides of the printer, click the  button on the top right corner in the web control or turn off the main power switch in the bioprinter.



Bone lotion print

11 Maintenance

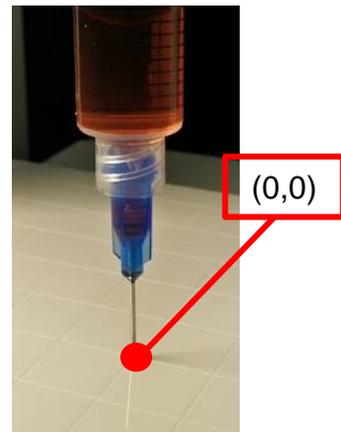
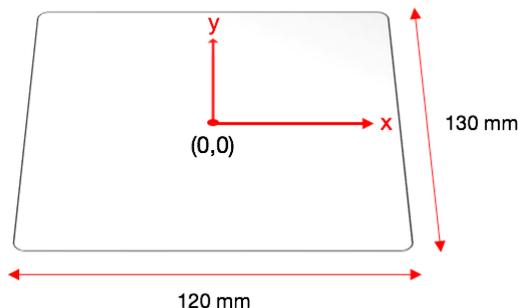
11.1 Calibration Guide

The HOME position is set to be the center of the bed, and is defined as (0, 0, 0). When you HOME the bioprinter and the X, Y and Z axes do not align properly or if you wish to recalibrate the bioprinter, follow the steps below to properly set new XYZ coordinates for your printer. This guide will also cover resetting the bed leveling plane.

Resetting XYZ Coordinates

To reset the XYZ coordinates, you will need to be connected to your bioprinter via Pronterface and have your microSD card adapter ready.

1. Home all axes by clicking the Home All button  in Pronterface.
 2. In the G-code console command line, type the following command:
G92 X0 Y0 Z0
This will manually set this position to (0,0,0), but will not return a response in the command window. Proceed to next step to check that it was successful.
 3. Press the Get Position button to check the position. This should return the following:
>>>M114
SENDING:M114
X:0.00 Y:0.00 Z:0.00
- Verify the values as are shown in the highlighted portion above.
4. Using the control pad, move the extruder along the X and Y axes such that the physical position is at (0,0) as shown below



- Then, move the bioprinter bed up (-Z) or down (+Z) until it is at the height shown:



- Click the Get Position custom button to obtain the actual physical position of (0, 0, 0) relative to the previous incorrect position of (0,0,0). For example:

```
>>>M114  
SENDING:M114  
X:1.1 Y:0.7 Z:-0.9 .....
```

Record the results below:

X _____ Y _____ Z _____

- Turn off the bioprinter and unplug the microUSB cable. Remove the microSD card from the controller board and using the provided microSD card adapter, plug it into your computer.
- In the microSD card's sys folder, open the config file (sys > config.g) in a text editor program.
- Navigate to the M208 commands, which should be clearly labeled in the CALIBRATION section of the file:

```
;;;;;;;;;;;;;;;;;;;;;;;;;CALIBRATION;;;;;;;;;;;;;;;;;;;;;;;;;  
  
M208 X60 Y65 Z46 ; set axis maxima  
M208 X-48.9 Y-72.5 Z-10 S1 ; set axis minima  
  
;;;;;;;;;;;;;;;;;;;;;;;;;END_CALIBRATION;;;;;;;;;;;;;;;;;;;;;;;;;
```

- a. There will be two M208 lines:
 - i. The top line is used to adjust the Z height
 - ii. The bottom line is used to adjust the X and Y coordinates
 - b. For the Z height, subtract the value you recorded in step 5 from 0 and add it to the existing value. For example, if you have “-0.9” listed above and the value in the file is “Z46”, you will subtract -0.9 from 0 which is 0.9 and add it to “Z46” and the new value is “Z46.9”.
 - c. For the X and Y positions, subtract the value you recorded in step 5 from 0 and add it to the existing value like you did for the Z axis. For example, if you have “1.1” listed above and the value in the file is “X-48.9”, you will subtract 1.1 from 0, which is -1.1 and add it to “X-48.9” and the new value is “X-50”.
10. Save the file and place the microSD card back in the controller board.
 11. Restart the bioprinter and reconnect in Pronterface. Click the Home All button and verify that the bioprinter has homed correctly. If it is still not at the correct position, repeat steps 2-10.

11.2 Resetting Bed Leveling Plane

To reset the bed levelling plane, you will need to be connected to your bioprinter and have your microSD card adapter ready.

1. Home all axes by clicking the Home All button in Pronterface. This will bring the extruder to (0,0,0). Press on the P0 button under the user defined macros section and it will move the head to (-48,-52,0).
2. Ensure you are at the right position by clicking the Get Position custom button and verifying the response in the command window.
3. To obtain and record the Z values at 4 probe points around the bed for resetting the bed levelling plane follow the below steps and use the space below to record your Z values:

P0 0.0 P1 P2 P3

- a. Manually decrease the Z height (-Z) until the needle tip is just touching the bed. Click on **Set Z0** and make sure that the value at P0 is 0 by clicking on **Get position** button.
- b. Manually lower the bioprinter bed (+Z) by 3mm using the control panel.
- c. Press the custom button P1 to move the extruder to the first probe point.
- d. Manually decrease the Z height (-Z) until the syringe tip is just touching the bed (same needle height as at P0).
- e. Click the Get Position button and record the Z height for P1.

- f. Increase the Z height 3mm, press the P2 button to move to P2, and lower the Z height until the syringe tip reaches the same height as the other two points. Click Get Position and record the Z height for P2.
 - g. Increase the Z height 3mm, press the P3 button to move to P3, and lower the Z height until the syringe tip reaches the same height as the other two points. Click Get Position and record the Z height for P3.
4. Turn off the bioprinter and unplug the microUSB cable. Remove the microSD card from the controller board and using the microSD card adapter, plug it into your computer.
 5. In the microSD card's sys folder, open the bed.g file in a text editor program. To correct the bed levelling add the value that you noted at the corresponding point with the Z value that is already in the file. For example, if the Z value that you noted down at P1, P2, P3 were "-1.2", "0.6" and "0" and the Z value in the file were "-0.5","-2.6","-2.5", then new Z value will be "-1.7","-2.0","-2.5". An example of the bed.g gcode file before and after making the changes shown below:

```
G30 P0 X-48 Y-52 Z0.0 ; Set
G30 P1 X-48 Y52 Z-0.5 ; Bed
G30 P2 X48 Y52 Z-2.6 ; Leveling
G30 P3 X48 Y-52 Z-2.5 S ; Plane
```

Before

```
G30 P0 X-48 Y-52 Z0.0 ; Set
G30 P1 X-48 Y52 Z-1.7 ; Bed
G30 P2 X48 Y52 Z-2.0 ; Leveling
G30 P3 X48 Y-52 Z-2.5 S ; Plane
```

After

6. Save the file and place the microSD card back in the controller board.
7. Restart the bioprinter and reconnect via Pronterface. Click the Home All button. Verify that the bioprinter bed levelling is correct. If not, repeat steps 2-7.

11.3 Cleaning the printer

Follow the below steps to clean the printer:

1. For general cleaning, use a dampened cloth to clean the outer panels of the printer. In the event it gets soiled or stained, you can use a mild detergent (preferably diluted) to clean off any stain.
2. Do not spray the cleaning solution or water directly on the printer. Spray it on a paper/cloth and use it to clean the outer panels.
3. If you wish to sterilize the bioprinter for tissue culture purposes, you can use 70% ethanol to wipe down the surfaces. Spray on a paper towel and use this to wipe down the printer exterior.
4. You can wash the acrylic bed with warm water and soap in the event it gets soiled. If you wish to sterilize it, you can spray it with 70% ethanol or autoclave the acrylic bed templates.

12 Advanced Settings

12.1 G-code Adjustments

G-code is a programming language that allows your computer to communicate with your 3D printer, it provides the instructions to tell the 3D printer what to do and how to move. This section outlines the relevant commands used to control the r3bEL mini bioprinter.

A full reference guide for G-codes can be found at <http://reprap.org/wiki/G-code>.

G1: Move

Usage

G1 Xnnn Ynnn Znnn Ennn Fnnn Snnn

Parameters

Not all parameters need to be used, but at least one has to be used

Xnnn (The position to move to on the X axis)

Ynnn (The position to move to on the Y axis)

Znnn (The position to move to on the Z axis)

Ennn (The amount to extrude between the starting point and ending point)

Fnnn (The feedrate per minute of the move between the starting point and ending point, if supplied)

Example

G1 X10 Y15 (Move to position X=10 and Y=15)

G4: Wait

Usage

G4 Pnnnn

Parameters

Pnnn Time to wait, in milliseconds

Example

G4 P2000 (Wait 2000 milliseconds (2 seconds) before next command)

G21: Set Units to Millimeters

Example

G21 (The software default is in millimeters, but this is still good to know)

G90: Set Absolute Positioning

Example

G90 (All coordinates from now on are absolute relative to the origin of the machine)

G91: Set Relative Positioning

Example

G91 (All coordinates from now on are relative to the last position)

G92: Set Position

Usage

G92 Xnnn Ynnn Znnn Ennn

Parameters

This command can be used without any additional parameters.

Xnnn new X axis position

Ynnn new Y axis position

Znnn new Z axis position

Example

G92 X0 Z0 (Set X position to 0 and Z height to 0)

12.2 G-code Customization**For Array Printing**

To customize your own G-code files for new materials or to adjust existing files, here are some basic guidelines you can follow. In general, higher viscosity fluids will require larger extrusion amounts to release a droplet from the needle tip and more time for the droplet to release.

Below is a table of recommended extrusion commands to have a droplet release from the needle tip for different materials. All testing was done for printing a 3x3 array using a 22-gauge needle tip.

The parameters being changed are extrusion volume (G1 E#### F###), extrusion speed (G1 E### F###), retraction volume (G1 E-### F###), retraction speed (G1 E-### F###), and wait time between drops (G4 P#####).

Water	G1 E1.6 F200 G1 E-0.3 F50 G4 P1000
Alginate (1% w/v)	G1 E2.4 F200 G1 E-0.8 F200 G4 P3000
ABTS solution	G1 E1.7 F200 G1 E-0.4 F50 G4 P1000

After adjusting your G-code file for the new material or protocol, test it out on the bioprinter and observe the prints. If you still experience some issues as those described below, follow the instructions to troubleshoot and modify your protocol.

Drop not releasing from needle tip

This indicates that there isn't enough liquid is being pushed out of the syringe. This can be fixed by increasing the E distance in the G1 command.

Two drops releasing from needle tip

This problem can happen for two reasons:

Problem	Solution
The previous drop did not release	See issue above
The E amount is too high	Decrease the E amount in the G1 command

Can't get consistent droplets even with new values

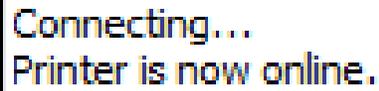
If this is the case, then it is probably a good idea to adjust the retraction amount. The retraction command is used to stop the excess flow of liquid after the drop has released. For different material properties, this value might need to be adjusted. Increase or decrease the negative E distance in the retraction command to achieve the desired retraction amount.

13 Troubleshooting guide

Issue	Solution
No power / XYZ axis does not move	<p>Is the small green light on the power adapter turned on?</p>  <p><u>YES</u></p> <ol style="list-style-type: none"> 1. Check if the all three lights on the Circuit board lights up when turn ON the power to the printer.  <p><u>NO</u></p> <ol style="list-style-type: none"> 1. Contact SE3D or email us at support@SE3D.com

No connection to computer

To check if your computer is connected to the controller board, check the red light next to the Micro USB connector is lit up. The Pronterface application should also display the following:



Connecting...
Printer is now online.

Almost all connection problems can be solved by following these steps in order:

1. Turn off printer
2. Unplug USB cable from computer
3. Close Pronterface application
4. Plug USB cable into printer and computer
5. Open Pronterface application
6. Connect to printer

If the problem is still not solved, check the following settings in Pronterface:

1. The correct port is selected
2. The Baudrate is set to 115200 (250000 should also work)

For further issues, you will need to use the Arduino IDE to troubleshoot:

1. With the power to the printer turned off, connect the controller board to your computer.
2. Select the "Arduino Due (Native USB Port)" from the list of board (Tools > Board).
3. Select the correct COM port (Tools > Port).
4. Open the Serial Monitor and check that the Baudrate is set to 115200
5. Using the command line, enter M114 (upper case M)
 - The response should be similar to this:
"ok X0 Y0 Z0"
6. If you received a response, then the printer and computer are communicating.

Extruder does not retract or extrude / Extruder moves randomly

If you pause or stop a print in the middle of its run, the printer settings can sometimes be in the relative rather than absolute mode, so it may not respond accordingly when you press the retract or extrude button. Simply reset the printer settings by using the command M83. Type M83 on the command line and press send.

Droplet “skidding” across Petri dish after it is printed	If you observe water droplets skidding across the petri dish after it is being printed, first check and see if the table surface where the printer is sitting on is flat. Next check to make sure that the table is stable. We highly recommend that the printer is placed on a fixed table and not one on wheels or movable.
Misprints during a print	<p>If you run into “misprint” issues i.e. one or more droplets in the run did not get printed, it may be a needle issue due to a clogged or dirty needle. Remove old needle and use a new one. Calibrate new Z0 again before starting the new print.</p> <p>You should also check that there are no air bubbles in your syringe. If there is, turn your syringe upside down with needle facing up toward the ceiling and slowly push out the air bubble. Repeat priming step to ensure you have a tiny bulb of liquid at the tip of your needle before you begin, the run the protocol again.</p> <p>If problem persists, you can try to adjust the protocol itself depending on what the actual problem is. We recommend that you consult one of our technical staff who can provide recommendations and help you through the process.</p>
Printing issue related to droplets	For printing issues related to droplet not forming or 2 droplets being released as one time, please reference the G-code Adjustment section above.
Material not Extruding	Be sure to have manually “primed” the syringe. For instructions on how to do this, see step 3 on page 26.
Attempting to extrude with no tool selected	This usually happens when you stop mid-print. Type T0 in the command bar and send it.
Macro file homeall.g not found.	<p>This usually happened when the SD card in the board is little loose or is not recognized properly. To fix this issue:</p> <ol style="list-style-type: none"> 1. Turn off the printer 2. Disconnect the printer in Pronterface/ Web control 3. Unplug the USB cable from the computer 4. Take the SD card out from the slot in the board and put it back in. 5. Plug USB cable back into computer 6. Open Pronterface/ Web control application 7. Connect to printer

14 Technical support

For more technical support or issues, please email us at support@SE3D.com

15 Specifications

WEIGHT AND DIMENSIONS	Print bed area	120 mm x 130 mm
	Printer dimensions	18.41 cm x 25.4 cm x 34.3 cm
		(7.25 in x 10.0 in x 13.5 in)
	Printer weight	4.5 kg (10 lbs)
PRINT TECHNOLOGY	Technology	Extrusion-based printing system
	Extruder units	Single extruder head
	Extruder temperature range	N/A
	Syringes	5 mL standard disposable syringes 10 mL standard disposable syringes
	Needle tips	14 – 32 gauge with Luer lock
	Minimum volume	1.0 μ L (CV = 5% at 5.0 μ L)
	Viscosity range	1– 200,000 cP
	Step resolutions	10 microns
OPERATING ENVIRONMENT	Power requirements	110 – 240V AC 1.5A 50/60 Hz
SOFTWARE	Printer control software	Pronterface or Duet web control
	Operating system	Windows or macOS
	Connectivity	microUSB or Wi-Fi
PRINT COMPATABILITY	Print Files	STL and G-code
	Materials	Liquids and gel-based materials Hydrogels and biomaterials Food materials (icing, etc.)