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Emergence PRO™ 3D Printer

Operation Manual

Revision F

Precision Valve & Automation
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Halfmoon, NY 12065

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Table of Contents

1. Introduction 6
1.1 PVA Contact Information 6
1.2 Document History 6
1.3 Safety 7
1.4 Best Practices 9
2. Getting Started 10
2.1 Unboxing 10
2.2 Local Ventilation Disclaimer 12
2.2.1 Exhaust Flange Installation 12
2.3 Initial Setup 14
2.3.1 Printer Tool Kit 14
2.3.2 Setting Up the Printer 16
2.4 Emergence PRO™ Setup 19
2.4.1 Printer Control Screen 19
2.4.2 Level Print Surface Relative to Gantry 21
2.4.3 Install and Gap Hot End 22
2.4.4 Load Filament 24
2.4.5 Load Filament Mid-Print 29
2.4.6 Unload Filament 29
2.4.7 Remove Hot End 30
2.4.8 Setting Up the Emergence PRO™ Network Connection 32
3. Print 34
3.1 Print Screen 34
3.2 Starting the Print 35
3.2.1 Pre-Print Checklist 35
3.2.2 MicroSD 36
3.2.3 Internet Upload 39
3.2.4 G-code Files 40
3.2.5 Run Test Prints 41
3.2.6 Run G-Codes 43

3.3 Monitoring the Print Process 44
3.3.1 First Layer 44
3.3.2 Next Layers 44
3.3.3 Opening the Door and Pausing the Print 44
3.3.4 Filament Break Detection System 44
4. Helpful Recommendations 45
4.1 Best Practices 45
4.1.1 Filament Storage and Drying 45
4.1.2 Tracking Filament 45
4.1.3 Hot End 46
4.1.4 Touch Probe 46
4.1.5 Print Bed 46
4.1.6 Printer 46
4.1.7 Spare Parts Kit 46
4.1.8 Standby Temperature Tool 47
4.1.9 Installing Nozzle and Melt Zone Extender 49
4.1.10 Removing Nozzle and Melt Zone Extender 49
4.2 Cleaning and Maintenance 50
4.2.1 Hot End Cleaning and Maintenance 50
4.2.2 Bed Maintenance 50
4.2.3 Dehumidifier Charging 50
4.2.4 Rail Maintenance 51
4.2.5 Belt Maintenance 53
4.3 Check for Quality 54
4.3.1 Quality Checklist 54
4.4 Quick Tips 56
4.4.1 Changing Print Speed 56
4.4.2 Changing Flow Rate 56
4.5 Frequently Asked Questions 57
4.5.1 Under Extrusion 57
4.5.2 Over Extrusion 57
4.5.3 First Layer Not Sticking to Bed/Print Lifting from Bed 57

4.5.4 Print Sagging or Drooping 58
4.5.5 Print Appears Cloudy 58
4.5.6 Layer Shift 58
4.5.7 Clogged Nozzle 59
4.5.8 Materials Errors 60
4.5.9 Printer Warning Messages and Remedies 60
5. APPENDIX A 61
5.1 Printing Terminology 61
6. APPENDIX B 62
6.1 Printer Dimensions and Parts 62
6.1.1 X-/Y-Assembly 63
6.1.2 Z Assembly 64
6.1.3 Print Head 65
6.2 Technical Specifications and Warnings 66
6.2.1 Warnings 66
7. APPENDIX C 67
7.1 Recommended Maintenance Schedule 67
8. Table of Figures 68
9. Warranty 70
9.1 PVA Warranty Policy 70

1. Introduction

Before you operate this system, read the operation and setup manual. This will help you to become familiar with the product and ensure successful operation.

If any questions or problems arise, contact PVA's Technical Support department.

1.1 PVA Contact Information

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1.2 Document History

Revision	Revision Date	Reason for Changes
REV F	July 2023	Emergence PRO™ V3 Updates
REV E	August 2021	WalkStrong Updates
REV D	April 2021	Printer Tool Kit Note
REV C	November 2020	Updated Getting Started and Print sections
REV B	July 2020	Emergence PRO™ V2 Updates
REV A	December 2019	Initial Release

Note: All photographs and CAD model representations in this document are a "general representation" of the system and its components. The actual appearance of the system and its components can differ based upon customer specific configuration.

1.3 Safety

Certain warning symbols are affixed to the machine and correspond to notations in this manual. Before operating the system, identify these warning labels and read the notices described below. Not all labels may be used on any specific system.

Always wear approved safety glasses when you operate or work near the workcell.

Before you operate the system, read and understand the manuals provided with the unit.

Never put hands or tools in areas with this symbol when the machine is in operation. A dangerous condition may exist.

Read and understand the manuals provided with the unit before any repairs or maintenance is done. Only a qualified individual should do service.

Use caution when there are pressurized vessels. Find and repair any leaks immediately. Always wear appropriate safety equipment when you work with pressurized vessels or vessels that contain chemicals.

Shear hazard from moving parts. Avoid contact.

Do not remove protective guarding.

In situations where inattention could cause either personal injury or damage to equipment, a warning notice is used.

Do not smoke near the machine. Always have a fire extinguisher available for emergency use.

Before performing any repairs or maintenance to the system, turn off power and lock out the power disconnect switch.

Warning notices are used to emphasize that hazardous voltages, current, temperatures, or other conditions that could cause personal injury exist in this equipment or may be associated with its use. Only qualified personnel should enter areas designated with this symbol.

Laser light source present. Do not stare directly into the beam. Do not use in the presence of highly reflective surfaces

Pinch hazard from moving parts. Avoid contact.

Hot surface. Avoid contact.

Warning, Ultraviolet (UV) light hazard. Do not look directly at the UV light source.

1.4 Best Practices

- Do not wear loose clothes or jewelry when you operate the printer
- Do not touch the print head while it is moving
- Immediately engage the Emergency Stop button if personnel is in danger
- Locate and define all safety labels on and around the printer before you turn the machine “On”
- Dispose of all used parts and materials in accordance with local laws and regulations

Safety is a joint responsibility between the OEM and the end-user. All precautions and practices should be in accordance with local regulations.

Do Not: Use incompatible tools, remove door interlocks or bypass safety devices, make custom mechanics or change material from the original design.

2. Getting Started

2.1 Unboxing

1. Remove the packaging straps from the shipping crate.
2. Open the shipping crate by first taking the lid off and then removing the sides.
3. Remove plastic wrapping around the metal ramp and any additional items that may be included.

Figure 1: Remove Plastic Wrapping

4. Remove the four metal plates around each of the wheels by removing the lag screws using a 9/16" socket wrench.

Figure 2: Remove Metal Plates

5. Secure the metal ramp to the wooden pallet on the side of the printer with lag screws from prior step.

6. Offload the 3D printer using the metal ramp with two people—one person in front of the printer and one person in the back.

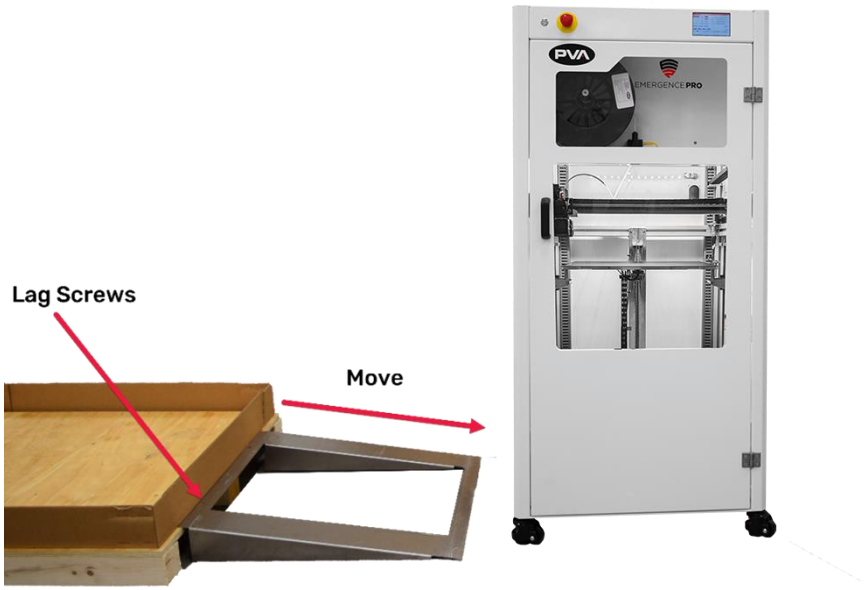


Figure 3: Secure Metal Ramp to Wooden Pallet and Move Printer

7. Move the printer to its location and position the printer on level ground.

8. To level the printer, lower the feet by turning the red knob on each leg to stabilize the 3D printer. Turning the knob to the left lowers the foot and turning the knob to the right raises the foot.

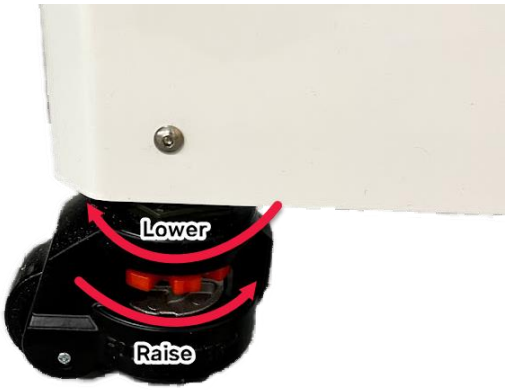


Figure 4: Raise and Lower Feet

2.2 Local Ventilation Disclaimer

IMPORTANT: End user should consult manufacturer safety data sheets to identify if local ventilation is required for their application and proceed as recommended. For composite materials please consult local regulations (OSHA PELs, NIOSH RELs, and/or ACGIH) for the particular materials being used and monitor locally to identify if local ventilation is required.

2.2.1 Exhaust Flange Installation

If local ventilation is required, follow the steps below to install the exhaust flange.

1. Remove cover from exhaust flange mount in the top rear corner of the machine.

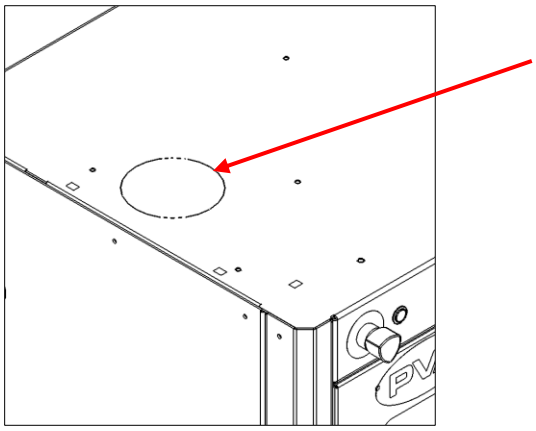


Figure 5: Remove Exhaust Flange Cover

2. Locate the 4-inch exhaust flange provided with the machine.

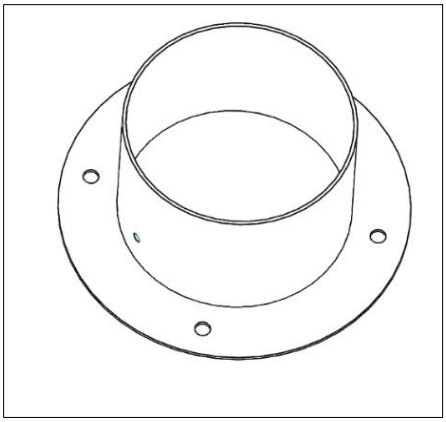


Figure 6: Exhaust Flange

3. Install exhaust flange through top hole and secure with four (4) M6X1 hex nuts.

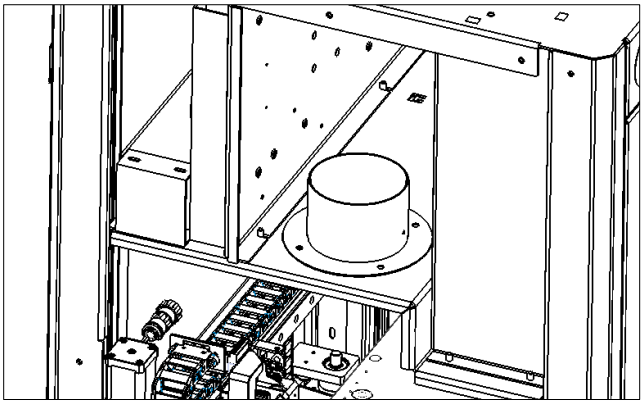


Figure 7: Secure Exhaust Flange

2.3 Initial Setup

2.3.1 Printer Tool Kit

Note: The printer tool kit is specific to orthotics and prosthetics and available for printer sales through PVA Med.

Before starting the setup process, locate the Tool Kit included with your printer. The following items are included.

Figure 8: Tool Kit

Item	Description
1	Grease cartridge
2	Lubricant
3	7 mm nut driver
4	10 mm nut driver
5	Bubble level
6	Tweezers
7	Wire brush
8	Spade/Putty knife
9	Side cutters
10	SD card and converter
11	Hex keys
12	Toolbox
13	Storage container
14	Renewable mini dehumidifier
15	1.1 mm drill bit
16	Grease gun

Figure 9: Tool Kit Contents

2.3.2 Setting Up the Printer

1. Remove additional packing material from the outside of the printer.
2. Remove the key tied to the handle on the front door. The key is for the back door.
3. Open the front door and remove the brackets securing the print head for shipment using a 4 mm hex key.

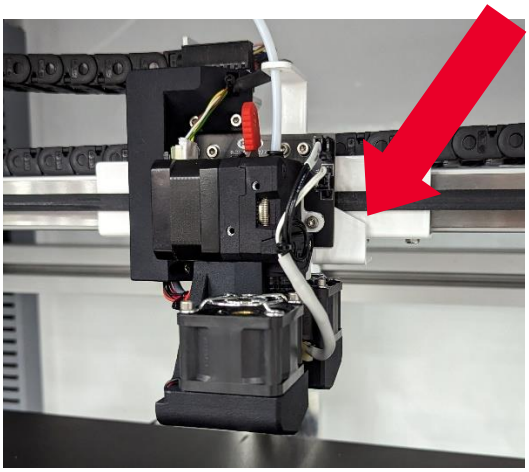


Figure 10: Remove Bracket from Print Head

4. Remove the brackets attached to the front rail and print bed using a 4 mm hex key.

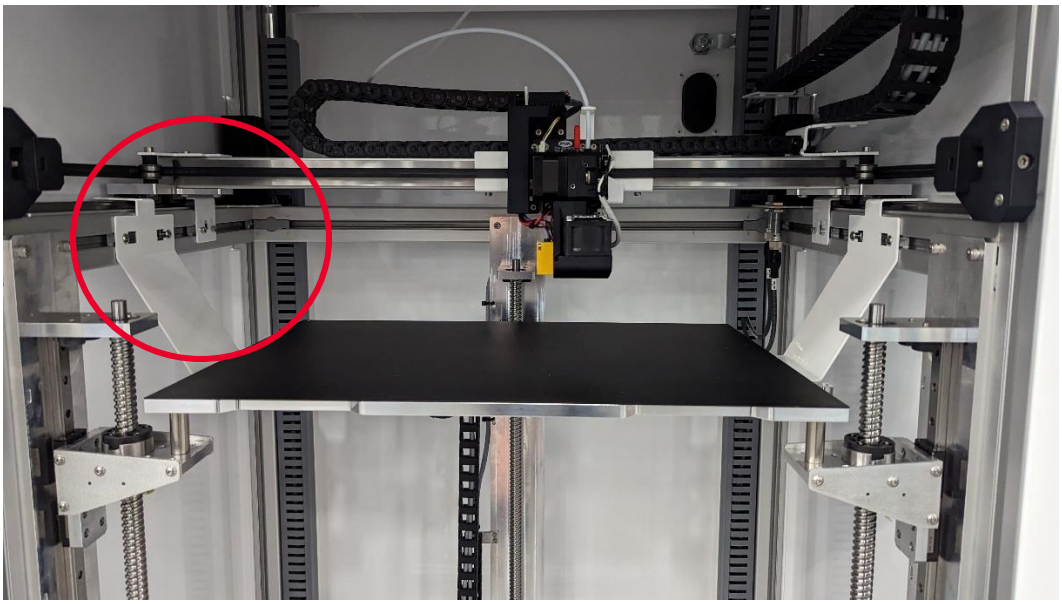


Figure 11: Remove Brackets from Print Bed

5. Install the nozzle brush in the hole on the front right of the print bed.

Figure 12: Install Nozzle Brush

6. Insert the dehumidifier into the dehumidifier holding brackets.

Figure 13: Insert Dehumidifier

7. Plug the power cord located in the back of the printer in the appropriate 120/220V* outlet. **Refer to the machine serial tag.*

8. Plug the provided ethernet cable into the ethernet port located in the back of the printer and connect to the facility's network.

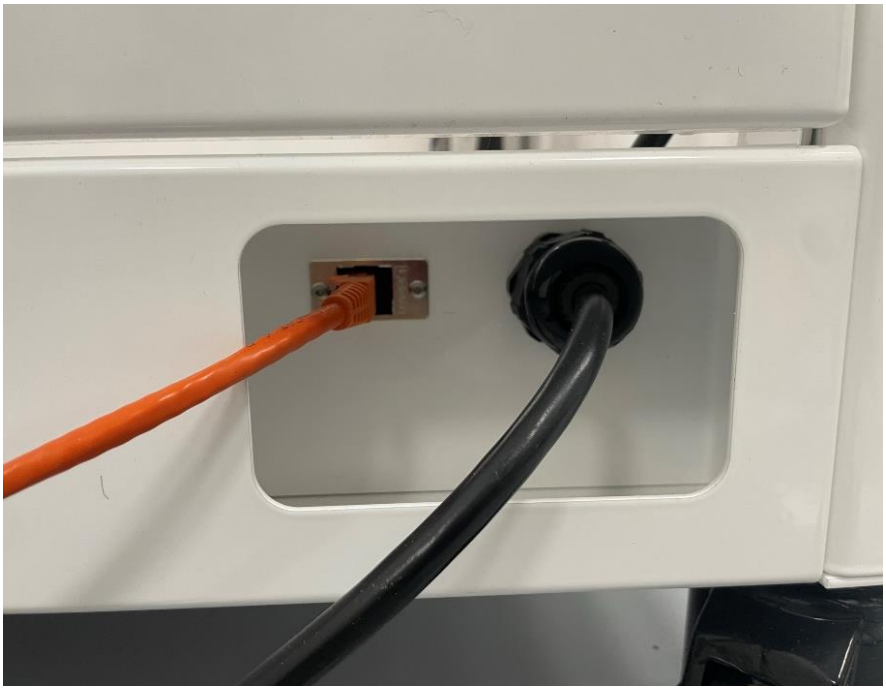


Figure 14: Connect Power Cord

2.4 Emergence PRO™ Setup

2.4.1 Printer Control Screen

The printer control screen is a touch screen controller consisting of four screens: Control, Print, Console, and Setup. See image on next page.

1	**Stop Button**	Stops and reboots printer.
2	**Bed Button**	Sets bed to active state or standby.
3	**Hot End Button**	Sets hot end to active state or standby.
4	**Current Temperature**	Displays current tool temperature.
5	**Active Temperature**	Set point for active tool temperature.
6	**Standby Temperature**	Set point for standby tool temperature.
7	**Print Head Position**	Displays position of print head.
8	**Axes Homing Buttons**	Homes the print head in all axes or in an individual axis. • Auto homing -- button on the far left • X-axis -- button in the middle left • Y-axis -- button in the middle right • Z-axis -- button on the far right
9	**Bed Level**	Probes bed and level print surface.
10	**File Selection**	Displays available prints.
11	**Move Selection**	Allows movement of print head • X-axis -- negative moves left, positive moves right • Y-axis -- negative moves towards front of the machine, positive moves towards rear of the machine • Z-axis -- negative moves up, positive moves down
12	**Extrusion Selection**	Allows for extrusion of filament when hot end is at temperature.
13	**Macro Selection**	Allows for selection of macros. Three macros are found on the right side of the Control Screen. Additional macros can be accessed by selecting Macro button.
14	**Control Screen**	Main menu for the control screen.
15	**Print Screen**	Similar to the control screen and only used when printing. Allows for pause, resume, and cancel commands.
16	**Console Screen**	Displays codes and commands recently entered in the printer.
17	**Setup Screen**	Options for adjusting the touchscreen display settings.
18	**Status**	Displays the status of the printer.

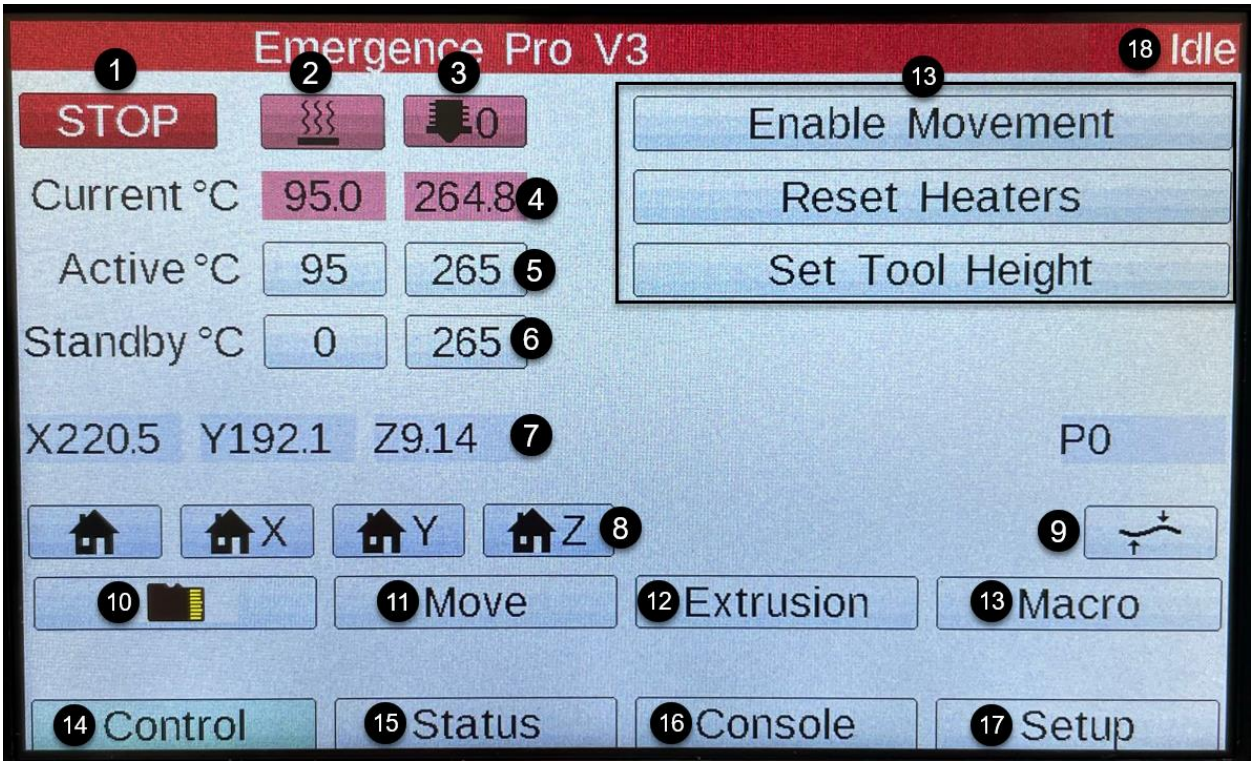


Figure 15: Printer Control Screen

2.4.2 Level Print Surface Relative to Gantry

1. Check the status on the Printer Control Screen in the upper right corner. It should say **Idle** (Figure 16).

2. If the status reads **Standby**, undo the red Emergency Stop button located on the front upper left corner of the machine. Rotate the Emergency Stop button clockwise to disengage. The status will turn to Idle.

Note: If the Emergency Stop Button is pressed when the printer is running, the status will read Halted. Rotate the Emergency Stop button clockwise to release. To undo the Halted status in the web interface, reconnect to the network.

3. On the Printer Control Screen, select **Bed Level** button on the right side of the display (Figure 16).

4. First, the printer will home and then measure the height of the four corners of the print bed. It will adjust based on these measurements until it is level. This sequence will be performed three times.

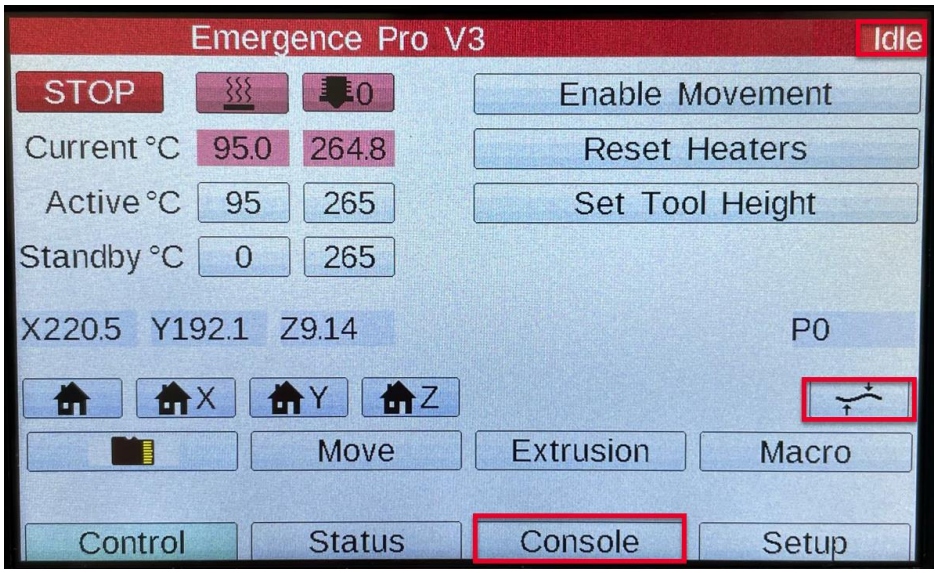


Figure 16: Bed Level

5. After the **Bed Level** is complete, the applied correction can be seen on the console tab if desired.

Note: If connected to the web interface, the message can be found under the G-code Console.

Note: Bed leveling will be performed prior to each print when using the default print start sequence.

2.4.3 Install and Gap Hot End

1. Install the hot end using a 2.5 mm hex key.
2. Plug the hot end wires into the appropriate connector.
3. Run the **Set Tool Height** macro.

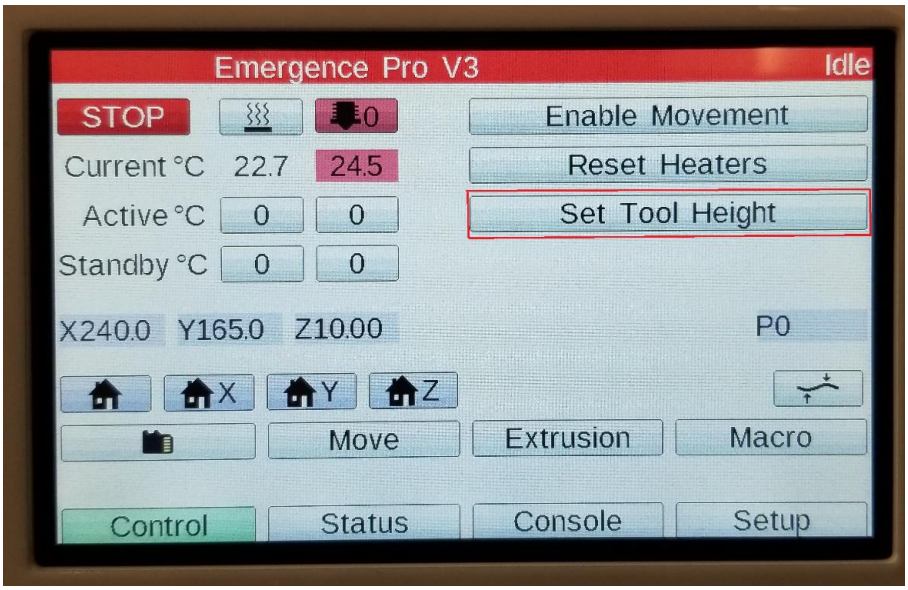


Figure 17: Set Tool Height

4. Before preparing to jog the print bed up towards the nozzle, place a piece of standard printer paper between the nozzle and the bed.

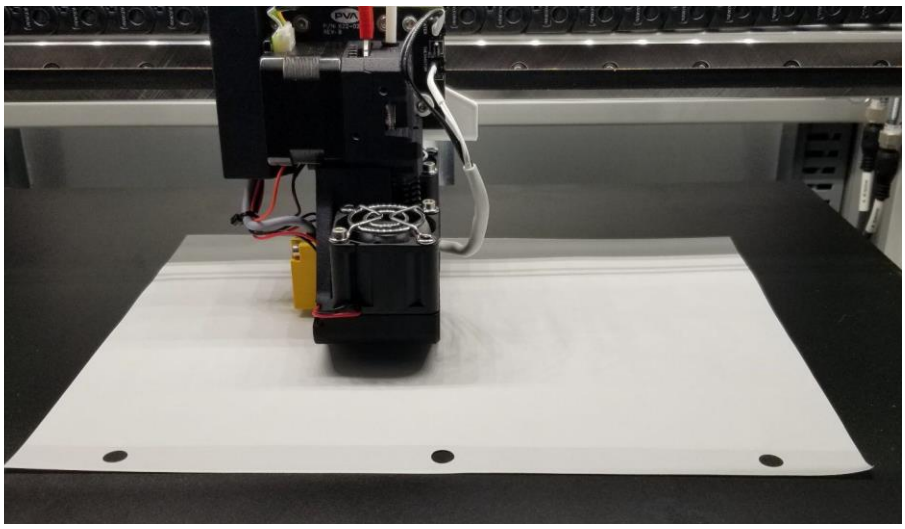


Figure 18: Place Paper on Bed

5. Slowly jog the bed to the nozzle until the printer paper touches the nozzle. Make sure to select the jog distance that still allows a little distance between the nozzle and the paper.

Example: If there is over 2 mm distance in between the nozzle and paper, it is safe to select the 2 mm jog option. If you are unsure, we suggest increasing the height in small increments (0.02 mm, 0.2 mm) to avoid collision between the print bed and nozzle.

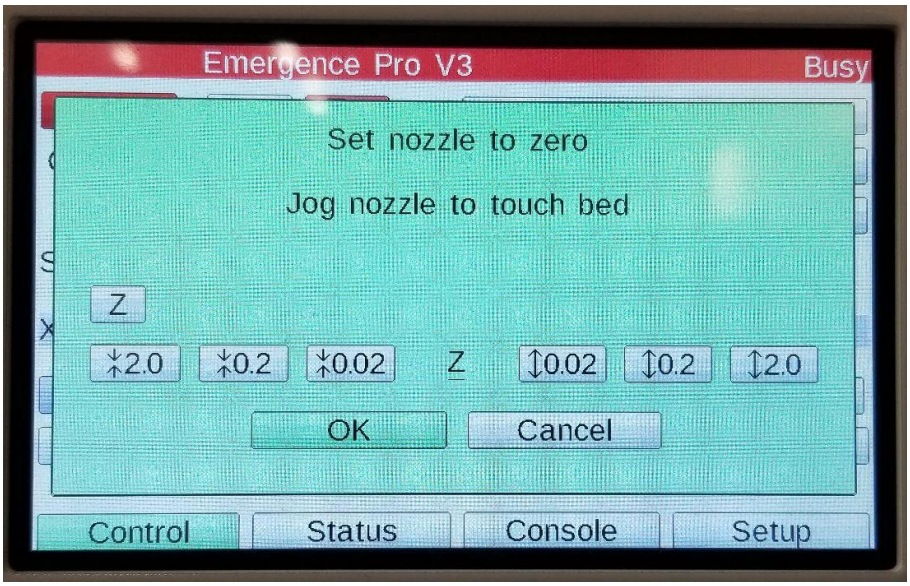


Figure 19: Jog Nozzle to Touch Bed

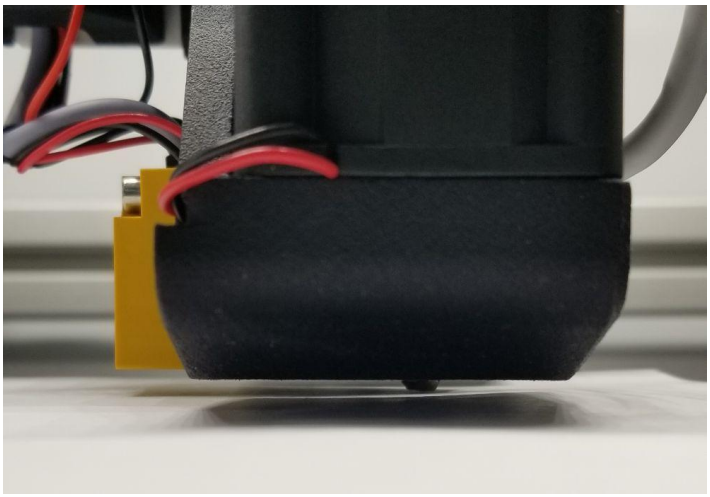


Figure 20: Nozzle Touching Bed

6. Ensure the distance between the nozzle and the print bed is similar to the figure shown below.

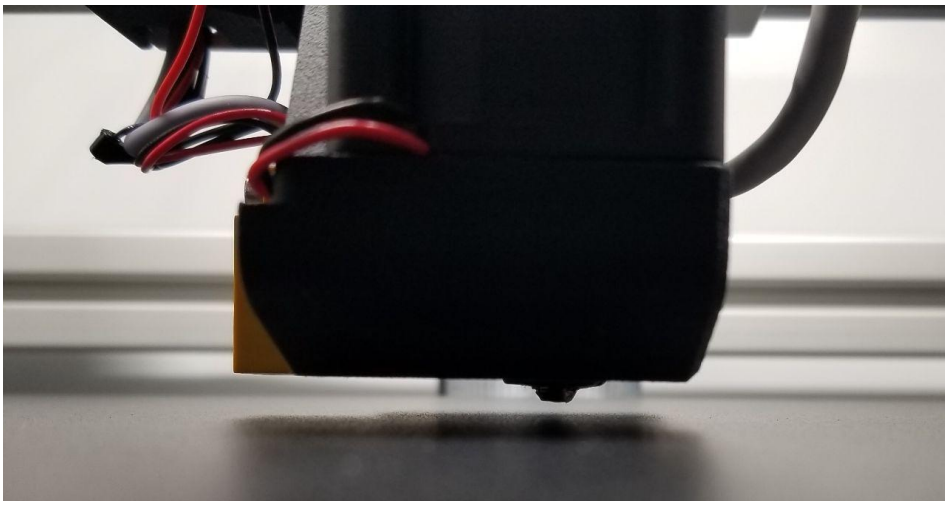


Figure 21: Distance Between Nozzle and Print Bed

2.4.4 Load Filament

1. Ensure the tension level on the extruder is at the correct position for the material being used.

Position	Lever Location	Filament Type
0 (Load/Unload)	Front	N/A
1	1 Click Toward Rear	Rigid Filament
2	2 Clicks Toward Rear	Semi-Flexible (~95A)
3	3 Clicks Toward Rear	Flexible (85 – 95A)
4	4 Clicks Toward Rear	Soft (75 – 85A)
5	5 Clicks Toward Rear	Very Soft (60 – 75A)

Figure 22: Filament Positions

2. On the Printer Control Screen, select **Move** and press 50 once in Z values to lower print bed 50 mm.

3. On the Printer Control Screen, set the **Active Bed and Hot End Temperature** to the appropriate print temperature for material.

Filament	Hot End/Nozzle	Bed Temperature	Hot End Temperature
ClearFit™	Stainless Steel	95°C	265°C
PCTG	Brass	95°C	240°C
FlexyFit™	Brass	40°C	235°C
PLA	Brass	65°C	210°C
Nylon 12	Stainless Steel	85°C	275°C
PLA/Carbon Fiber	Stainless Steel	70°C	210°C

Figure 23: Temperatures for Installing Filament

4. In order to set the Active Bed (2) and Hot End Temperature (3), select the Active nozzle button as shown by the right side of the 5 section in the figure below.

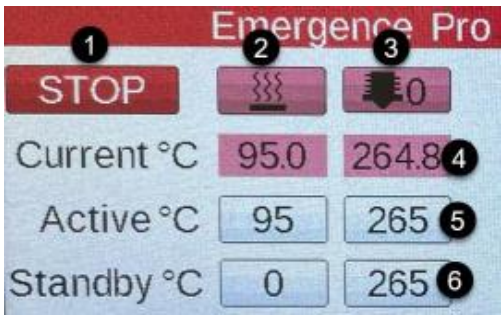


Figure 24: Active Nozzle Button

5. A window will open at the bottom of the screen. Select the interval to increase or decrease the active nozzle temperature. To add multiple increments faster, press and hold the increment button.

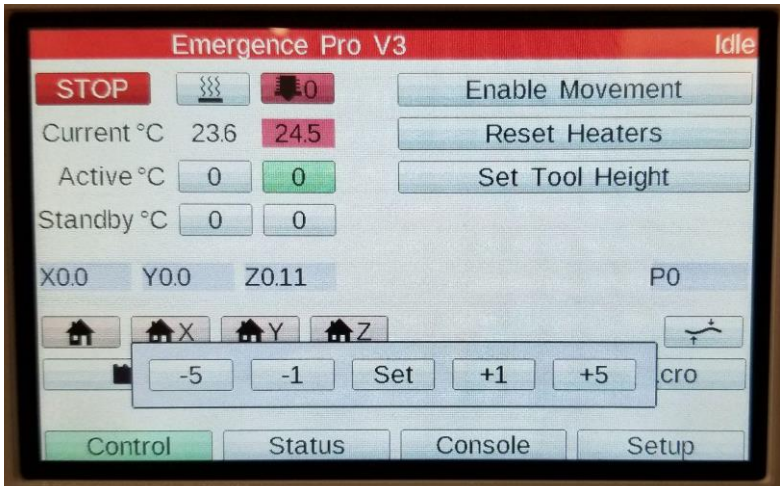


Figure 25: Increase/Decrease Active Nozzle Temperature

6. Once the intervals have been selected to the preferred value, the active nozzle temperature will display in the field. Press **Set** to finalize the desired temperature and allow the nozzle to heat up.

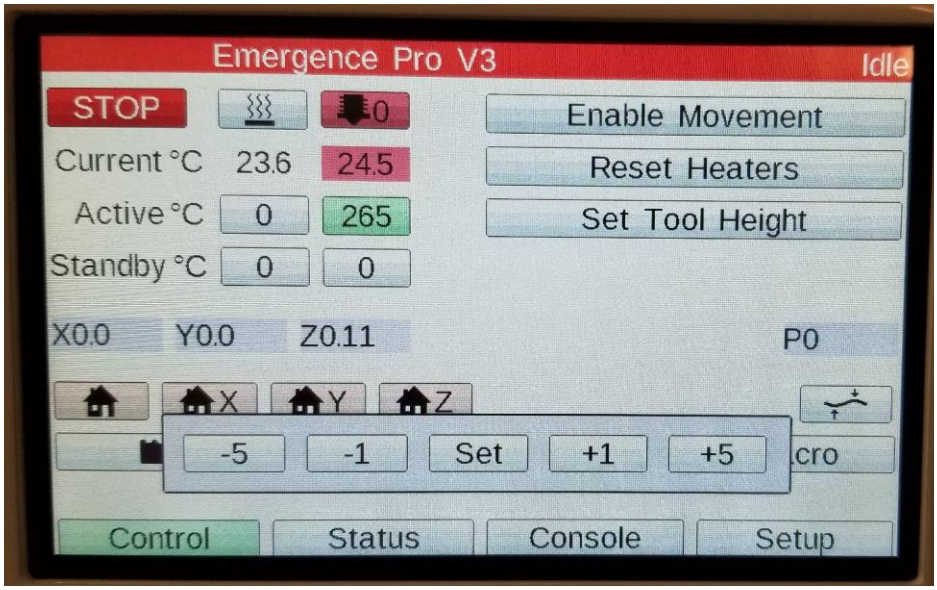


Figure 26: Set

7. Repeat the same steps for the bed temperature.

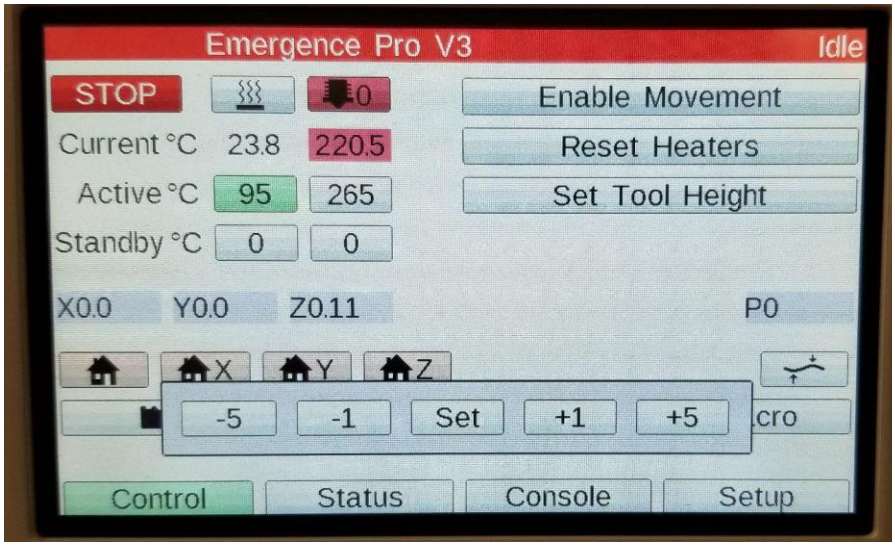


Figure 27: Bed Temperature

8. Wait until both the bed and nozzle temperature reach the set temperatures. These will be displayed in the Current Temperature field.

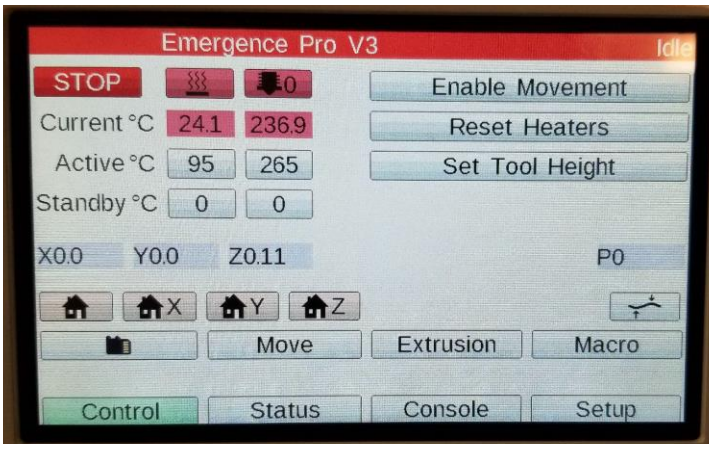


Figure 28: Current Temperature

9. Slide the appropriate filament onto the filament support roller. The filament roll should be oriented so the filament will be coming off the top of the roll toward the front of the machine (Figure 29).

WARNING: When removing the free end of the filament from the roll, ensure that the roll is always secured in your hand. If not properly handled, the roll can unwind and tangle which leads to extrusion issues.

10. Manually push the filament into the filament guide and continue to feed until it reaches the extruder. You will no longer be able to push the filament at this point.

Note: It is recommended to cut the beginning of filament to a 45 degree angle for easier feed into the filament guide.

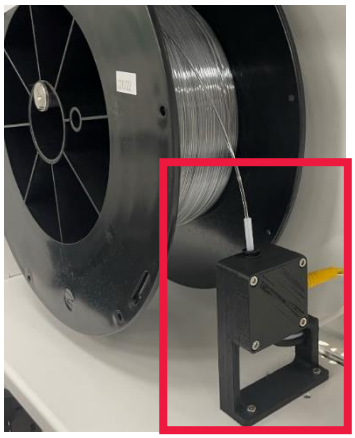


Figure 29: Filament Load

11. Via the **Extrusion** button on the printer display, extrude 200 mm to prime the hot end (Figure 31).

12. In the **Extrusion Amount**, select 100. In **Speed**, select 10. Press **Extrude twice**.

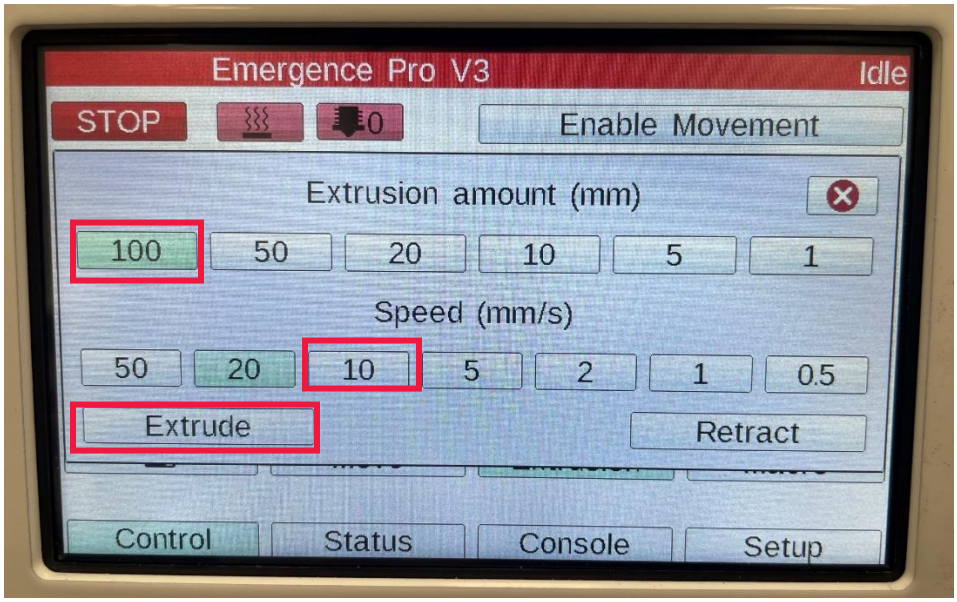


Figure 30: Extrusion

13. Wipe the nozzle with the wire brush from the tool kit and perform a 20 mm retract by pressing '**20**' once (Figure 31).

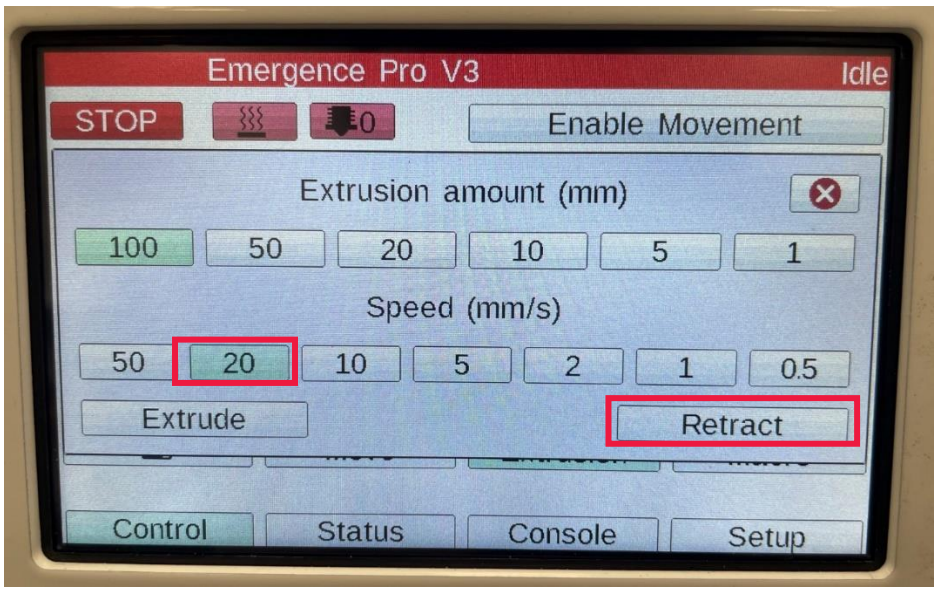


Figure 31: Retract

2.4.5 Load Filament Mid-Print

If a filament change is needed mid-print, perform the following steps.

1. Select the **Pause** button on the print screen if the printer is not already paused.

Note: If the filament runner sensor has been triggered, a message will display and the print will automatically be paused.

2. Use the **Move** button to jog the print head to a position that is away from the print.
3. Follow the steps outlined in 2.4.6 Unload Filament.
4. Follow the steps outlined in 2.4.4 Load Filament.
5. On the Printer Control Screen, select **Resume**.

Note: Changing filament mid-print can result in an imperfection within the print. It is best to track filament used on a roll and ensure you have the appropriate amount of filament to complete a print.

2.4.6 Unload Filament

1. On Printer Control Screen, set the **Active Hot End Temperature** to the appropriate print temperature for material.
2. Once the temperature is reached, select the **Extrusion** button on the printer display.
    - Set **Extrusion Amount** to 100.
    - Set **Speed** to 50.
    - Press **Retract** 1 to 2 times.
3. Once the filament is retracted, manually wind up the filament spool until the filament is free from the filament guide.
4. Be sure to properly secure the free end of the filament to ensure there are no tangles on the spool.
5. You may notice a blob at the end of the filament. This can be trimmed off to make re-loading easier.

2.4.7 Remove Hot End

After the filament is removed, perform the steps below:

1. Remove the **Heater Cartridge Connector** in the upper slot by clicking the lever on the right hand side and gently pulling.

Figure 32: Remove Heater Cartridge Connector

2. Remove the **Thermistor Connector** in the lower slot by clicking the lever on the right hand side and gently pulling.

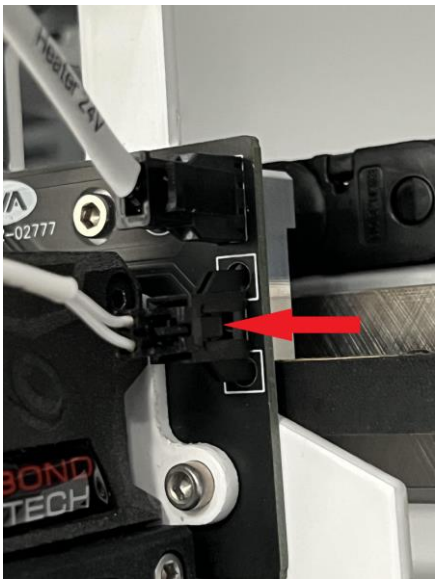


Figure 33: Remove Thermistor Connector

3. Unscrew the two 3 mm bolts using a 2.5 mm hex key.

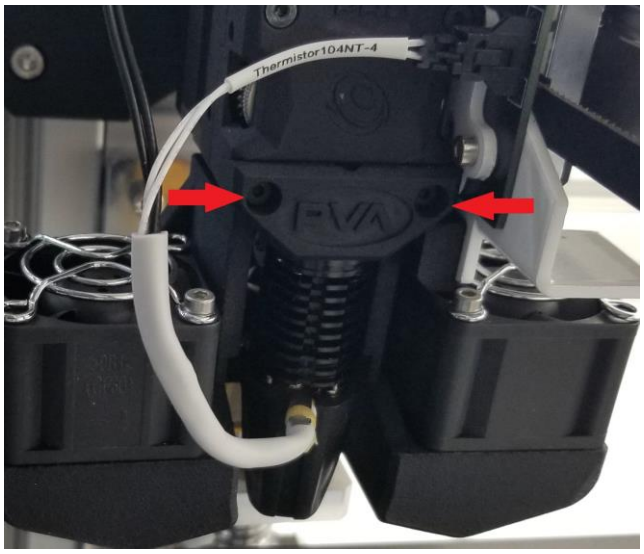


Figure 34: Unscrew Bolts

4. Remove the **Hot End**.
5. Once the Hot End is removed, ensure the PTFE tube remains level with the mount.

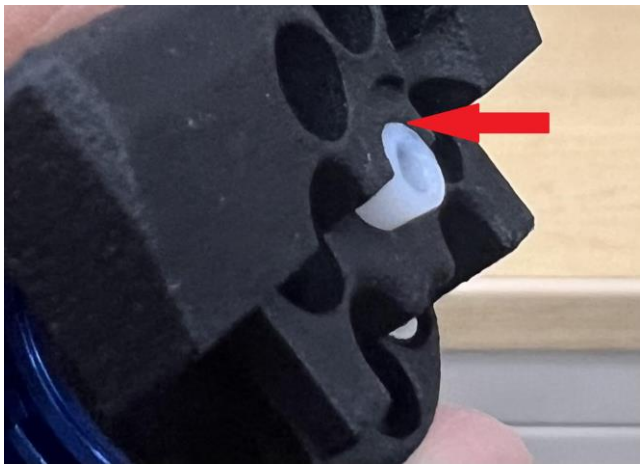


Figure 35: PTFE Tube

2.4.8 Setting Up the Emergence PRO™ Network Connection

1. Upon powering up, the machine will be assigned an IP address by the user's in-house router.

2. To view the IP address, select the **Setup** tab from the Control Screen.

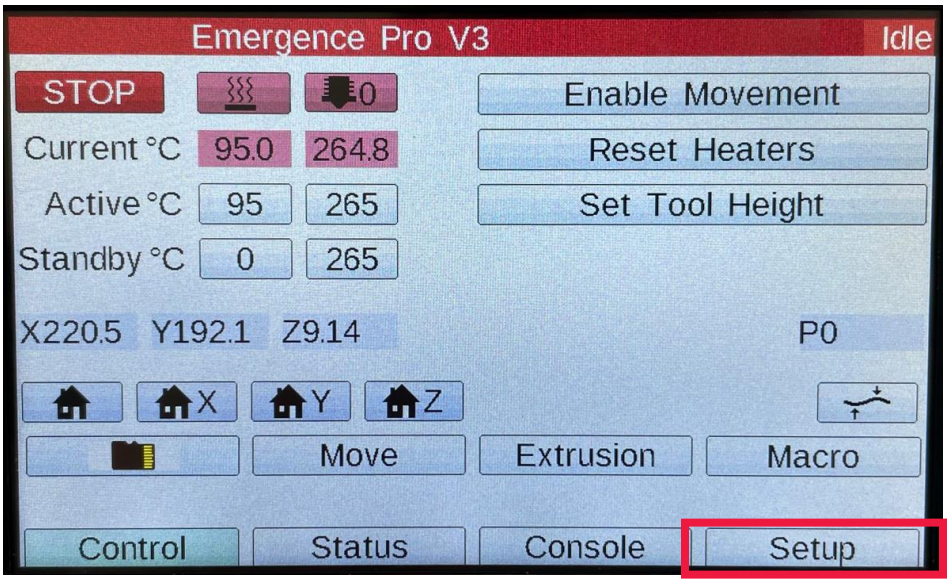


Figure 36: IP Setup Tab Location

3. On the bottom left corner in the **Setup** screen, the IP address that the network has assigned to the machine will be shown.

Figure 37: IP Address Location

4. This IP address can be entered into an internet browser to access the web interface of the printer.

5. On a new power cycle, the user's network may assign an alternate IP address based on the other devices connected. It is advised to assign a preset static IP address to the Emergence PRO™ to make the connection process easier. Consult any appropriate router manual and/or IT group to assign an IP based on the unique MAC address for the Emergence PRO™.

6. To find the Emergence PRO™ MAC address, select the **Console** tab. Enter **M540** in the terminal and the machine's MAC address will be displayed.

Note: If the IP address is displaying as 000.000.00.00, ensure that the front door is closed, and the E-stop is disengaged.

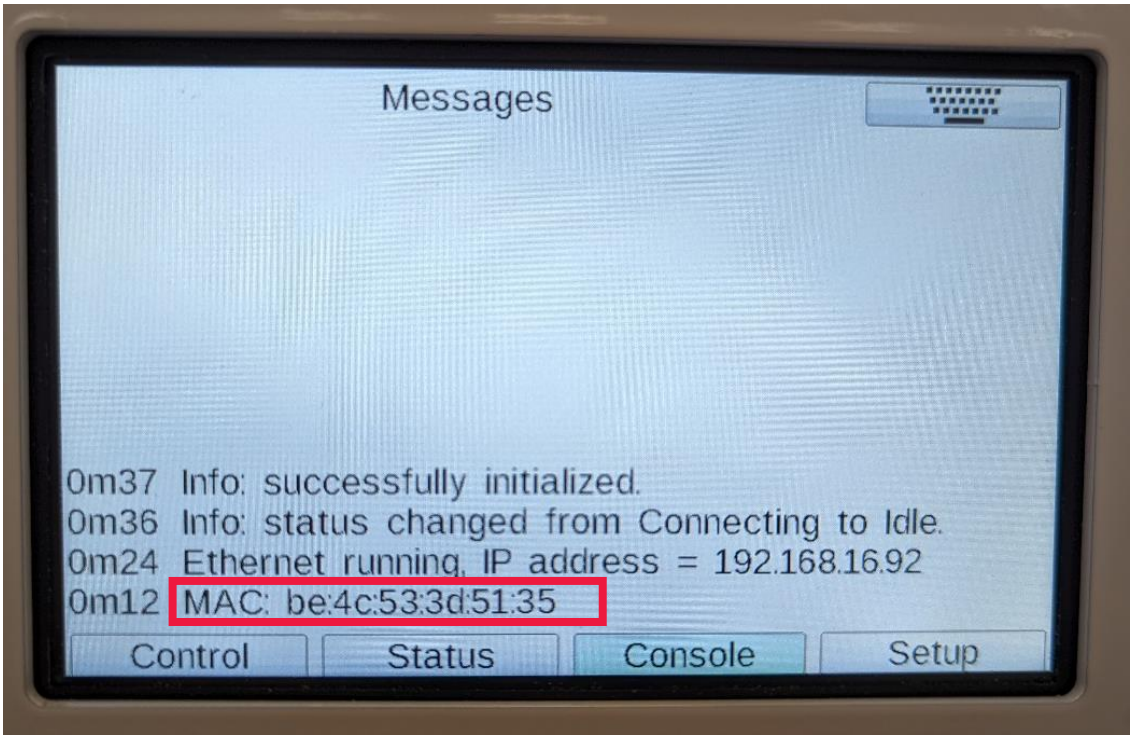


Figure 38: MAC Address Location

3. Print

3.1 Print Screen

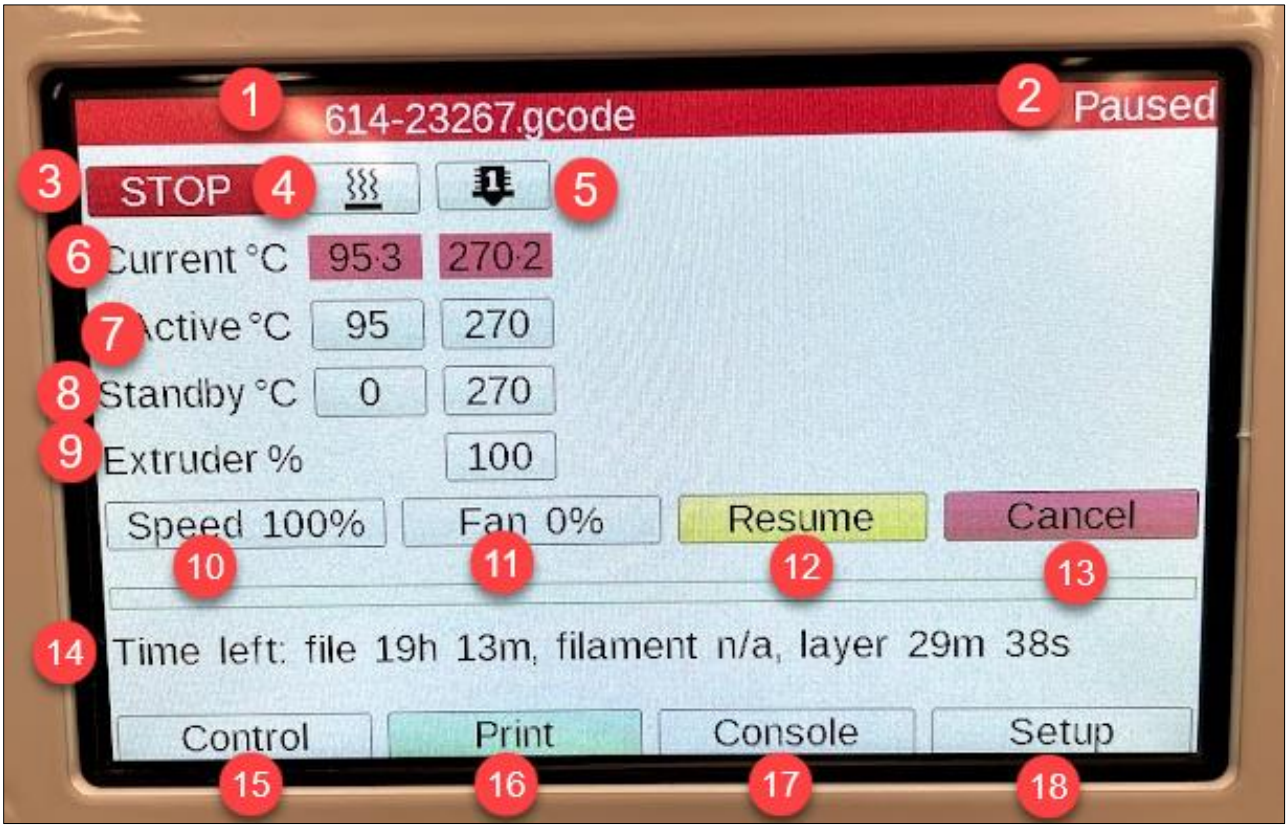


Figure 39: Print Screen

1	**Gcode File**	Displays which Gcode file is currently printing.
2	**Status**	Displays the status of the printer.
3	**Stop**	Stops the current print.
4	**Bed Button**	Sets bed to active state or standby.
5	**Hot End Button**	Sets hot end to active state or standby.
6	**Current Temperature**	Displays current tool temperature.
7	**Active Temperature**	Set point for active tool temperature.
8	**Standby Temperature**	Set point for standby tool temperature.
9	**Extruder**	Adjust the amount of extrusion for the current print.
10	**Speed**	Adjust the print speed for the current print.
11	**Fan**	Adjust the speed of the part cooling fan.

12	**Pause/Resume**	Allows you to pause and resume the print.
13	**Cancel**	Cancels the print.
14	**Time Left**	Displays the amount of time left on the print.
15	**Control Screen**	Main menu for the control screen.
16	**Print Screen**	Current Screen.
17	**Console Screen**	Displays codes and commands entered in the printer.
18	**Setup Screen**	Options for adjusting the touchscreen display settings.

3.2 Starting the Print

3.2.1 Pre-Print Checklist

- ✓ Ensure sufficient filament is loaded on the printer as indicated by the print preview in Rapid Plaster. Weigh the filament rolls and subtract 500 g then compare against the print preview estimated filament usage in the Rapid Plaster gcode viewer.
- ✓ Ensure the filament loaded on the printer is dry and does not have appreciable moisture content. If so, swap with dry filament or dry wet filament per recommendations in the printer manual.
- ✓ Confirm the printer has produced quality prints since the bed was last leveled through the Quick Level macro. Confirm the nozzle was gapped to 0.2 mm while at temperature (nozzle - 265°C, bed - 95°C). Otherwise, check Quick Level at room temperature, then nozzle gap at operating temperature.
- ✓ Confirm the printer bed is clean of oil and dust. Clean with a damp wet cloth as needed. A clean bed is required for socket adhesion to the print bed during print job. Be sure to remove the prime line of the prior print if it is still on the print bed.
- ✓ Ensure the extruder preset position. for ClearFit (one notch past fully open). See manual for correct tension preset position.
- ✓ Confirm the nozzle tip is clean and free of filament before homing.

3.2.2 MicroSD

The Emergence PRO™ allows for a G-code to be loaded through a MicroSD card or through a network upload. Once you have acquired your G-code, you can use either option

1. Copy the G-code file from your PC to a MicroSD card.

Note: You may need to insert the microSD card into an adapter. The micro SD card will typically show up as drive D.

Figure 40: MicroSD Card

2. Insert the MicroSD card into the SD card reader located underneath the display panel.

Note: The MicroSD card must be inserted with the metallic contacts facing the center of the printer.

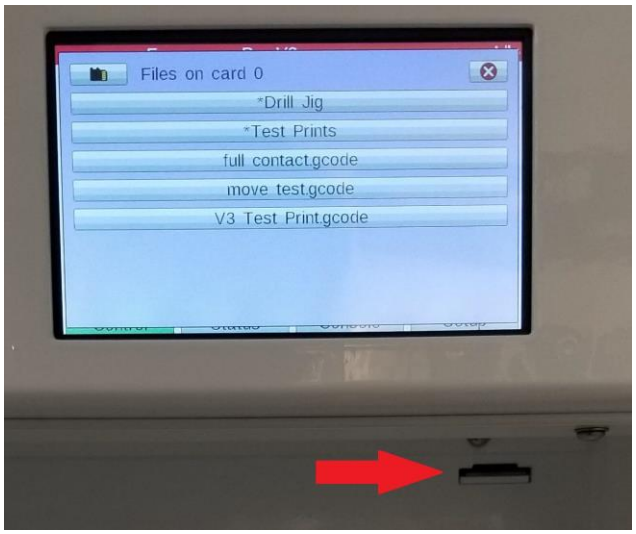


Figure 41: Insert MicroSD Card

3. Press the MicroSD card button on the Printer Control Screen.

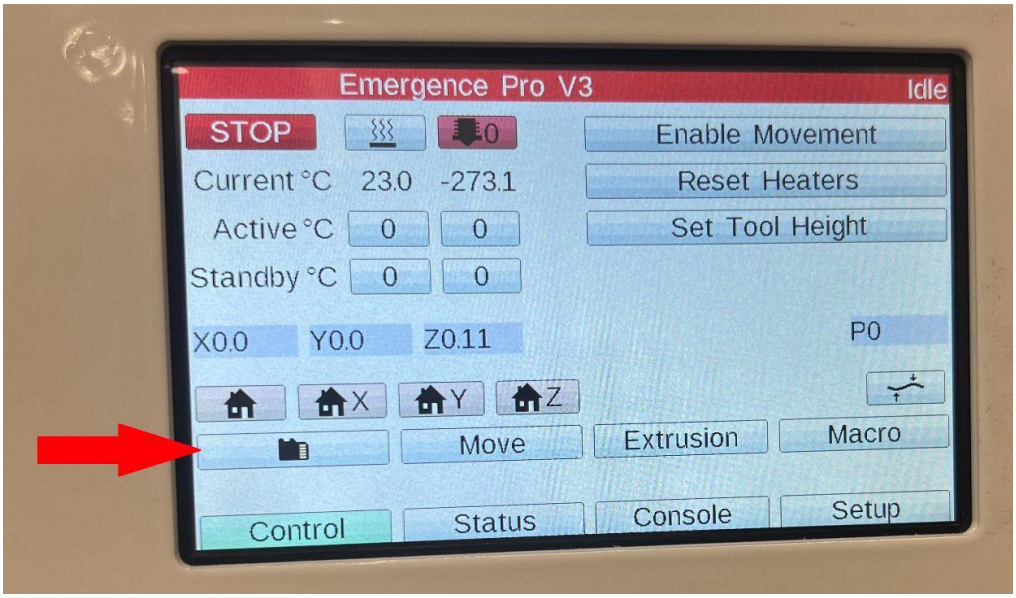


Figure 42: MicroSD Button

4. On the MicroSD screen, press the MicroSD card icon to switch between the onboard SD card (Card 0) and the secondary SD card on the top of the machine (Card 1).

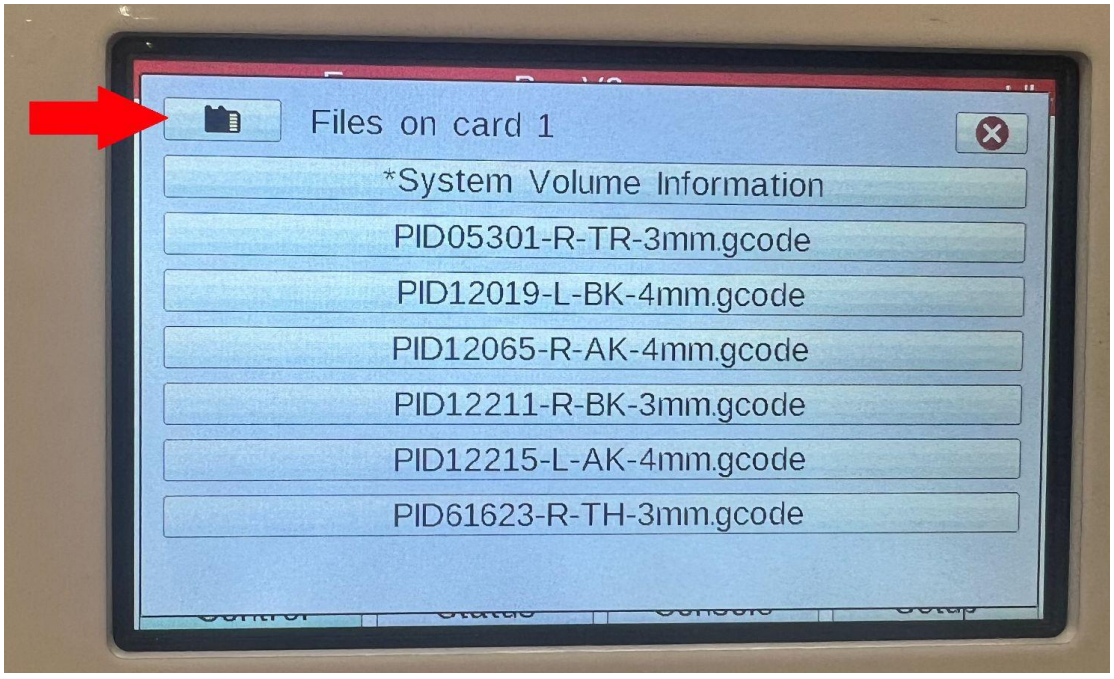


Figure 43: MicroSD Screen

5. Select a desired G-code to run.

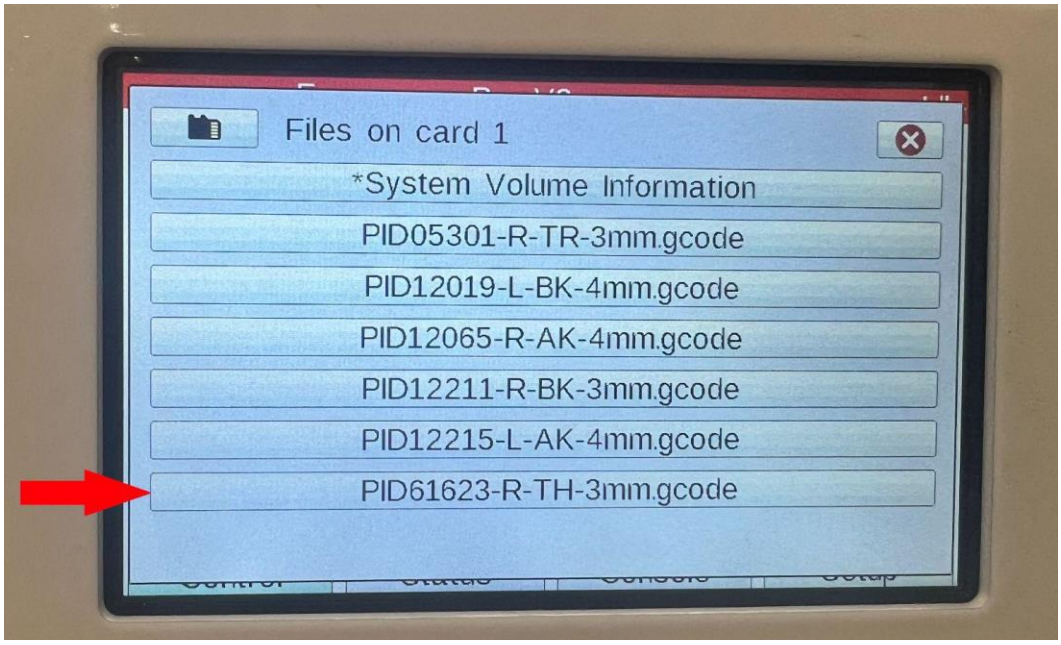


Figure 44: Select G-code

6. Select **Print**.

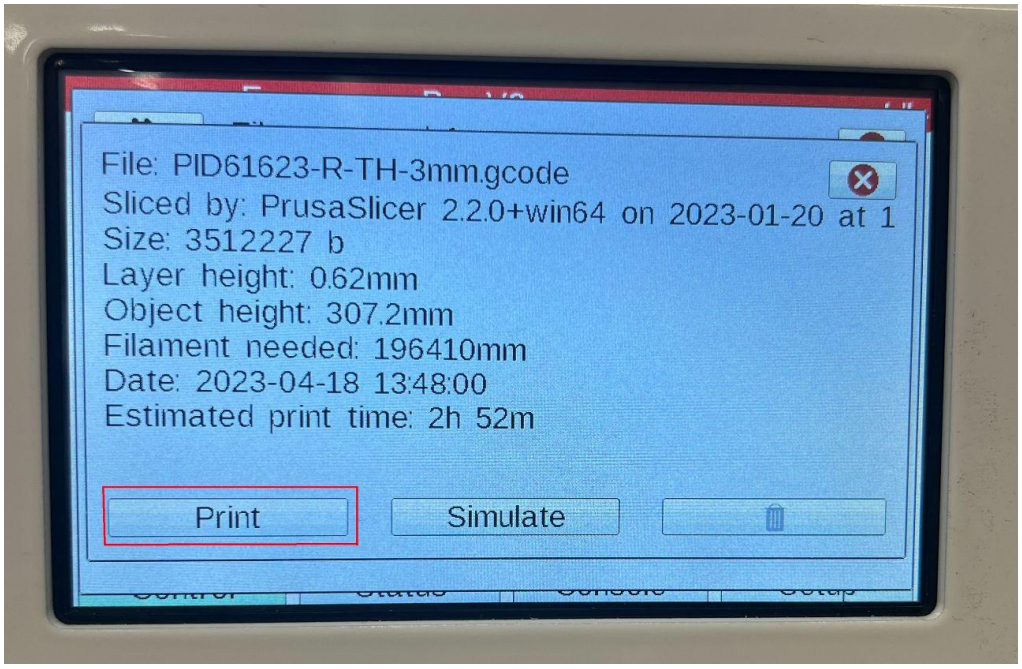


Figure 45: Print

3.2.3 Internet Upload

1. Connect to the printer via the Web Interface (Section 2.4.8).

2. To upload a new file from the Web Interface, click **Upload & Start** in the upper right-hand corner of the Web Interface Home Screen.

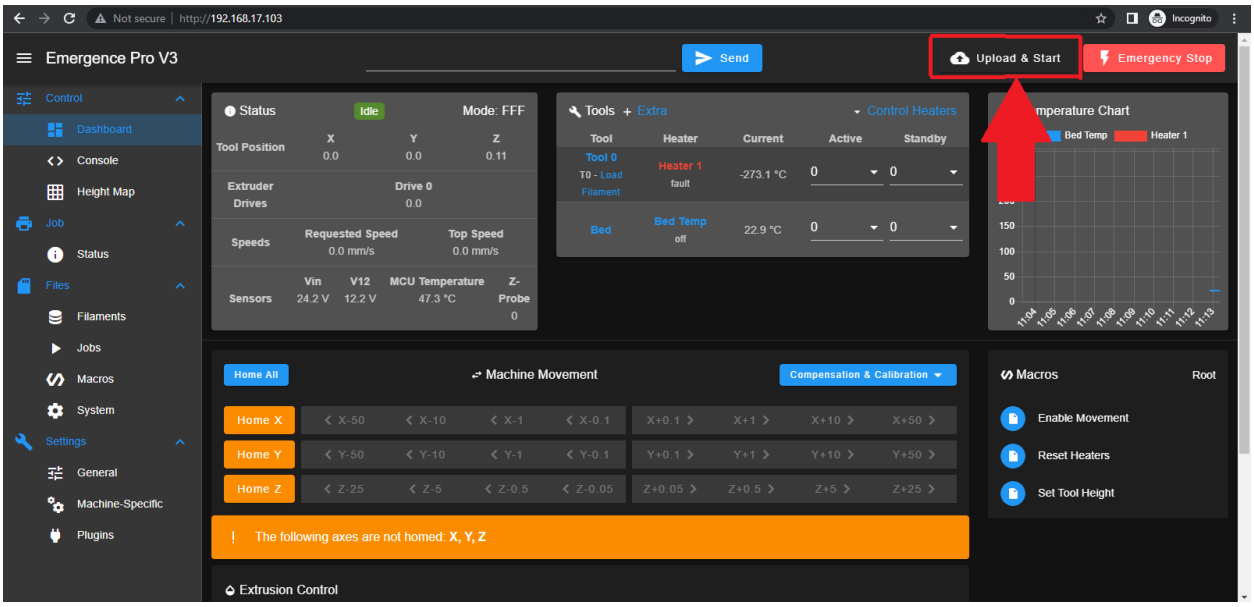


Figure 46: Emergence PRO™ Web Interface Home Screen

3. When prompted, select the desired G-code to print.

4. Select **Open**.

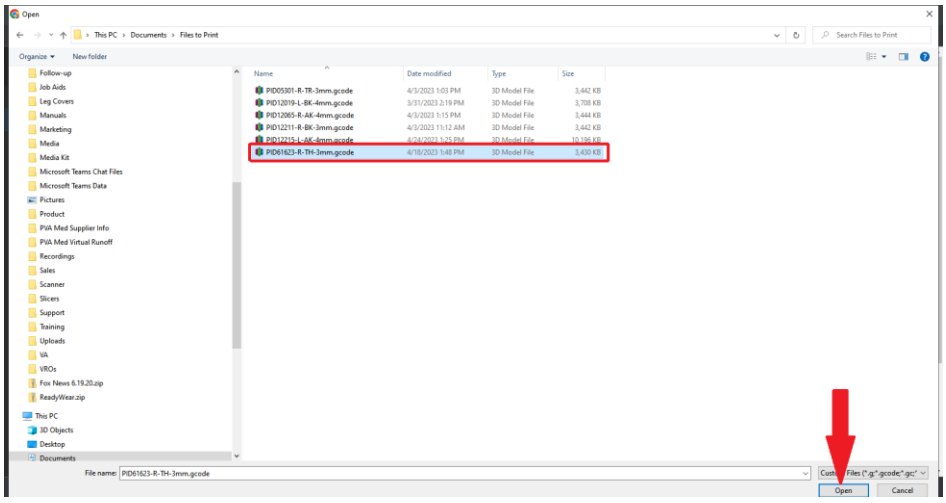


Figure 47: Select G-code and Open

5. Once **Open** is selected, the file will be uploaded to the printer and the print will begin. This file will be saved on Card 0, which is inserted into the printer controller.

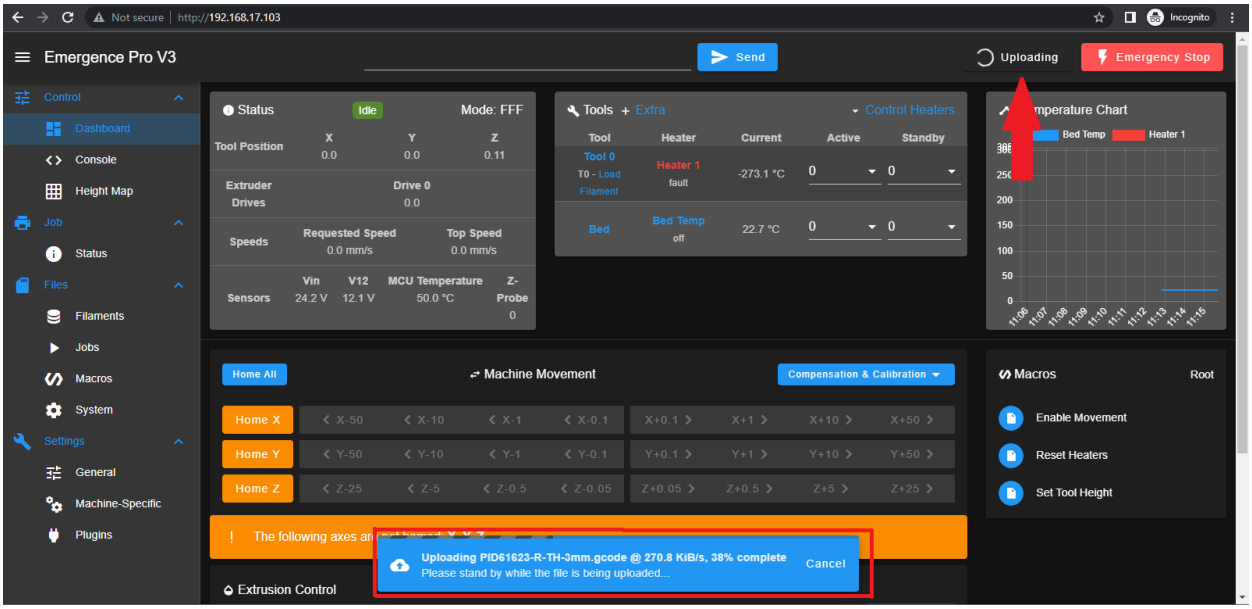


Figure 48: Upload Complete

A status bar will show the progress of the G-code file upload as it is being transmitted wirelessly to the printer. Once the file has been successfully uploaded, the printer will begin the print sequence for the selected G-code.

3.2.4 G-code Files

G-Code Files allows for G-code files to be uploaded, downloaded, deleted and sorted into sub directories.

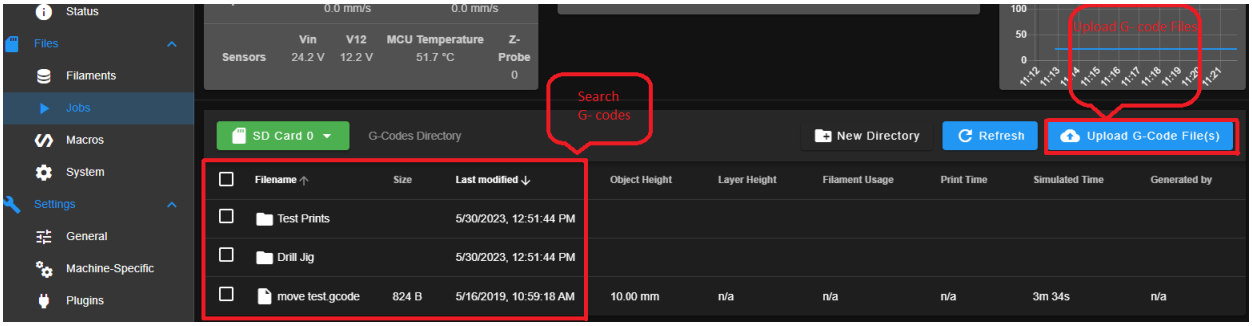


Figure 49: G-code Files

Files can be uploaded by browsing for them or dropping them onto the **Upload G Code Files(s)** button. The file upload functionality cannot be used while the machine is running.

Right-click on a G-code file to display a list of options. From here, you can run the dispense part (**Print File**), estimate the dispense path time (**Simulate File**), or download the G-code file (**Download**). You can also rename or delete the file, as well as manually edit the G-code.

Figure 50: G-code Right Click Options

3.2.5 Run Test Prints

To run test prints preloaded on your printer, follow the steps below.

1. On Printer Control Screen, press **File Selection** button (Figure 51).

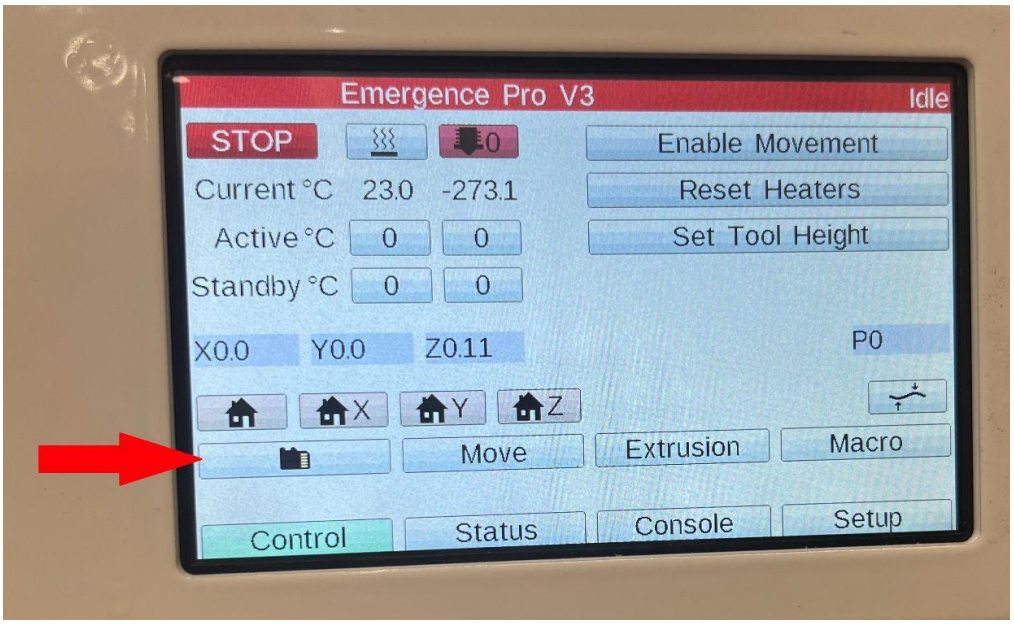


Figure 51: File Selection

2. Select **Test Prints** (Figure 52).

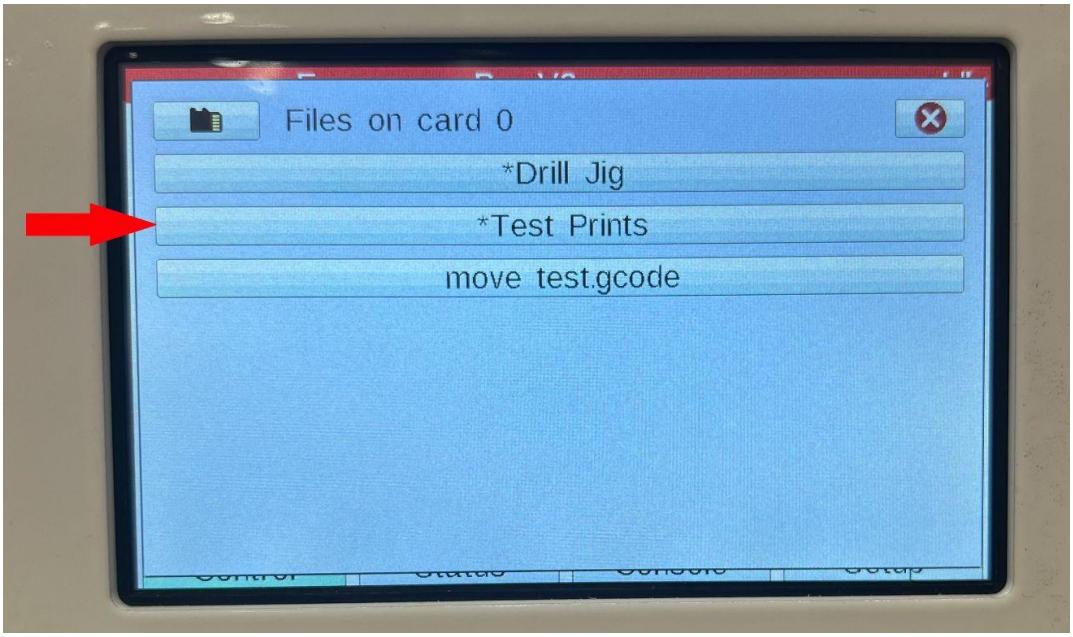


Figure 52: Test Print Files

3. The test prints loaded onto Card 0, which is part of the Printer Control Screen, will be listed. Select a test print for the filament loaded and hot end installed.

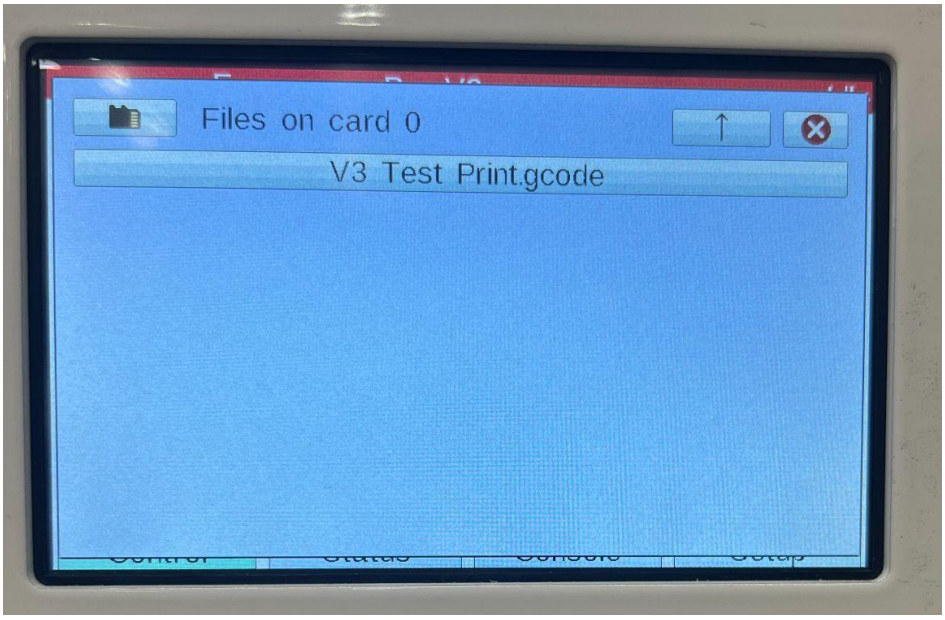


Figure 53: Select Test Print

4. Press **Print**.

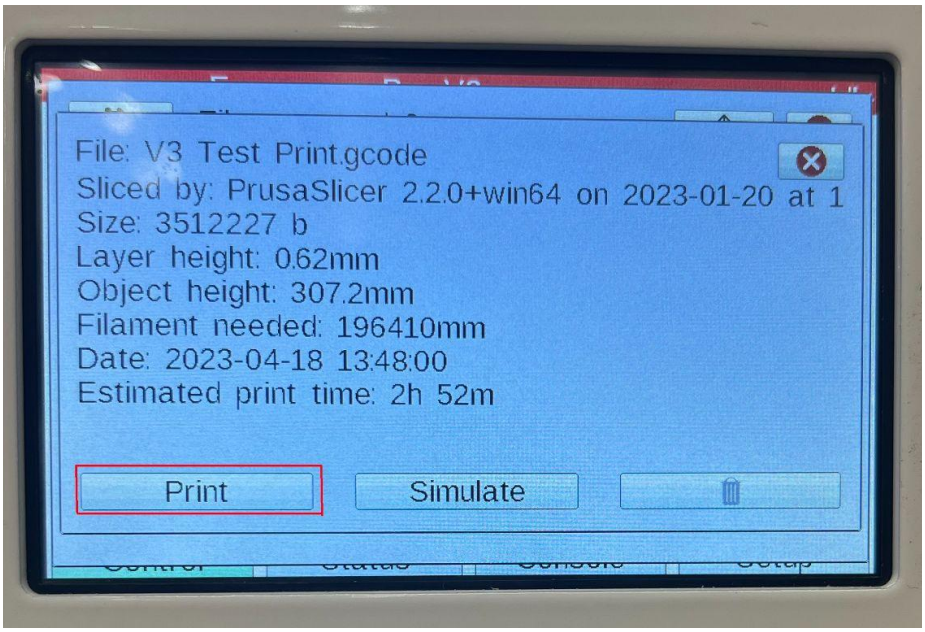


Figure 54: Print Test Print

3.2.6 Run G-Codes

To run other G-codes preloaded on your printer, follow the steps below.

1. Load the appropriate hot end and filament used to print the selected test print.
2. On Printer Control Screen, press **File Selection** button.
3. Select the **appropriate G-code**.
4. Press **Print.**

3.3 Monitoring the Print Process

While it is easy to start a print and walk away, it is recommended that you check in at regular intervals.

3.3.1 First Layer

The first layer should have a smooth and even finish. A good first layer will feel like a smooth and flat bump with little difference in height between the layer and the print bed. If filament is extruding, but not sticking, try applying each of the following suggestions alone, then together consecutively:

- Ensure that the nozzle is gapped.
- Decrease the print speed (see Section 4.4.1 for reference).
- Increase the flow rate (see Section 4.4.2 for reference).

3.3.2 Next Layers

A first layer can indicate that a print is off to a good start, but it will not guarantee a print without issues. The following layers will be important in determining the quality of your print. For example, if you notice that filament is not being extruded consistently or that the printed filament is cloudy, it may indicate that you have improper tension on the extruder or that the filament is saturated with moisture. Paying attention to the next layers will help you save filament and identify any issues with your print.

3.3.3 Opening the Door and Pausing the Print

If you need to access the print, you should always pause the print before opening the door.

1. On the Printer Control Screen, select **Print** and then press **Pause**. Note: There may be a slight delay between when the button is selected and the print is paused, the printer will complete all moves in buffer prior to pausing.
2. To resume printing, select **Print** and then press **Resume**.

The Emergence PRO™ also includes a door sensor that will pause an active print when opening the front door. This function acts as an added layer of protection for the printer and operators.

3.3.4 Filament Break Detection System

The Emergence PRO™ offers a filament break detection system that will pause your print when the roll runs out of filament. While the printer is paused, you can replace the filament without losing your print.

4. Helpful Recommendations

4.1 Best Practices

In order to increase your familiarity and comfort with the Emergence PRO™, we have included a few best practices.

4.1.1 Filament Storage and Drying

Moisture content in filament can cause a multitude of problems including inconsistent extrusion, poor surface quality, and ultimately, it will deliver a printed part with weak mechanical properties due to poor layer adhesion. In environments with less than 20% humidity, water molecules are quickly absorbed into the filament forming polar bonds with the polymer chain.

When the filament passes through the hot end, the moisture rapidly expands, boiling and rupturing the filament. This causes bubbles in between layers, inconsistent extrusion due to material expansion and poor surface quality due to the fluctuating flow rate.

For best printing results, it is recommended that open filament spools be stored in an airtight container with desiccant. A relative humidity level of 10% is ideal for storing filament, however, anything under 30% is acceptable.

If a filament is exposed to moisture, the roll can be dried in an oven. An estimated drying guide is below.

Note: Drying times may need to be increased for rolls over 500 g.

Material	Dryer Temperature	Drying Time
ClearFit™	65°C	4-6 hours
PCTG	65-70°C	4-8 hours
FlexyFit™	50°C	> 4 hours
PLA	45°C	> 4 hours
Nylon 12	70°C	> 12 hours
PLA/Carbon Fiber	45°C	> 4 hours

Figure 55: Recommended Drying Times

4.1.2 Tracking Filament

To avoid changing filament mid-print, PVA Med highly recommends tracking how much filament remains on a roll. To determine how much filament is left, weigh an empty roll to determine how much it weighs. Then, weigh the roll with the remaining filament and subtract the weight of the empty roll.

4.1.3 Hot End

The hot ends are completely made of metal which makes them resilient to the heating and cooling of multiple prints. However, in order to extend the life of the hot end, heat the hot end only when working on the printer or when the printer is fabricating a print.Filament should not be left in the hot end when the printer is not in use. Leaving filament in the hot end can lead to clogs and jams. In addition, leaving filament in the hot end may expose the filament to humid air which will affect the quality of the print.

4.1.4 Touch Probe

When removing a print, ensure that the print head has been moved. This will prevent the touch probe from being inadvertently hit and damaged. In the event of a failed print, it is important to inspect the touch probe and ensure that it was not snagged and bent on any errant filament.

4.1.5 Print Bed

Before each print, it is recommended to calibrate the print bed with the probe. This calibration is as simple as homing the axes and probing the print bed with the probe. Most G-codes received from PVA will already contain a command to run a bed probe before beginning a print. For materials certified by PVA Med (see Figure 55: Recommended Drying Times), there should be no need to prepare the bed with blue tape or spray adhesive before starting a print.

4.1.6 Printer

In order to keep the printer working in excellent condition, it is recommended to adhere to these best practices and to regularly clean the printer (see Section 4.2 for details). In addition, it is recommended that the front door remain shut during printing, the back door remain locked, and the printer turned off when not in use for extended periods of time.

4.1.7 Spare Parts Kit

Item	Part Number	Description	Qty
1	12877	TOOTHED IDLER, GT2, 20 TEETH, 9MM WIDE	1
2	1635	CONTACTOR	1
3	4792A32	LOW SCRATCH BRUSH WITH SHANK	1
4	3.5M-9MM-2GT	GT2 BELT, 9MM WIDTH, 2MM PITCH, 3.08M LG	1
5	614-25751-1	FILAMENT FEED TUBE, FILASTRUDER #12783, CUT TO LENGTH, 36""	1
6	122-07846	STEPPER MOTOR ASSEMBLY, EP X/Y	1
7	122-07847	STEPPER MOTOR ASSEMBLY, EP Z AXIS	1
8	FL606ZZ	Bearing, Flanged, 17mm OD, 6mm ID	2
9	BI2-M12-AN6X-H1141	SENSOR, PROX 2MM RANGE, NPN*	1
10	LGX Pro	LGX PRO	1
11	612-15869-1	PART COOLING FAN, 24V	1
12	612-15865-1	HOTEND COOLING FAN	1

Figure 56: Spare Parts Kit

4.1.8 Standby Temperature Tool

Standby temperatures can be used to keep the nozzle and print bed at or near normal operating temperature to reduce the time required for the printer to get to operating temperature between prints.

1. To set a Standby Temperature for the nozzle, select the Standby nozzle button (6).

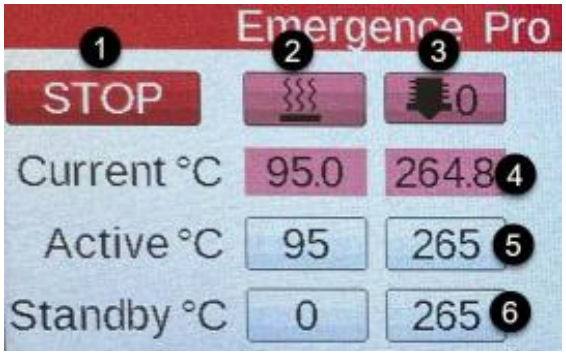


Figure 57: Standby Nozzle Button

2. A window will appear that allows you to increase or decrease the temperature interval. To add multiple increments faster, press and hold the increment button.

3. Once the intervals have been selected to the preferred value, it should be displayed as shown below. Press the Set button to finalize the desired temperature and allow the nozzle to approach the set temperature.

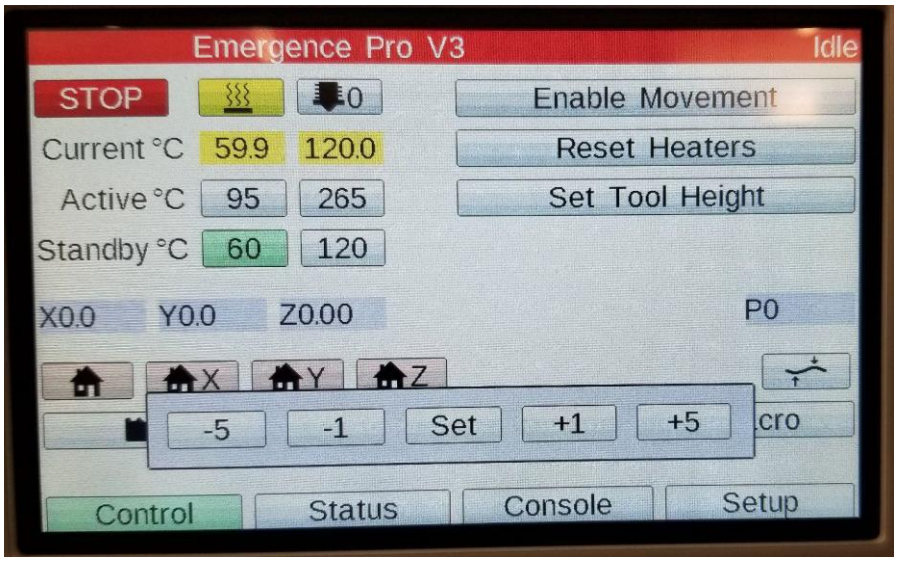


Figure 58: Set Standby Temperature

Note: When switching from active to standby temperature, the displayed numbers will be switched from red to yellow.

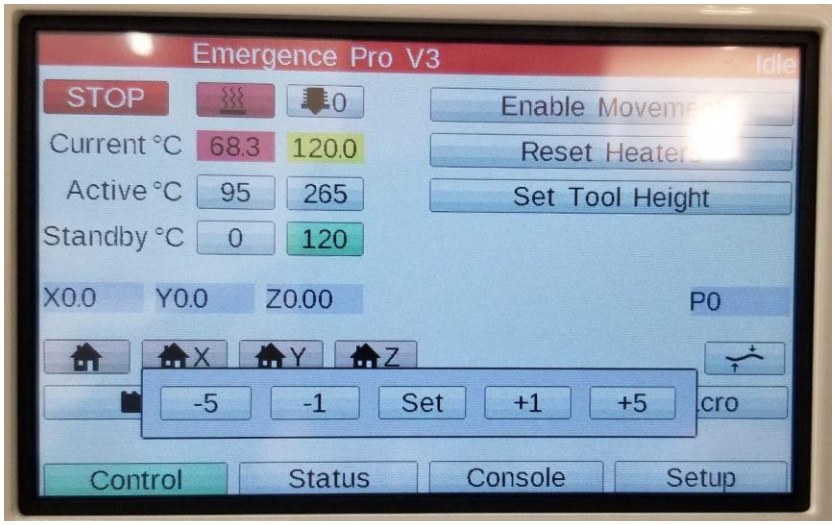


Figure 59: Standby Temperature in Yellow

4. Repeat the same steps for the bed temperature.

5. Wait until both the bed and nozzle temperature reach their set temperature as displayed by the Current Temperature status.

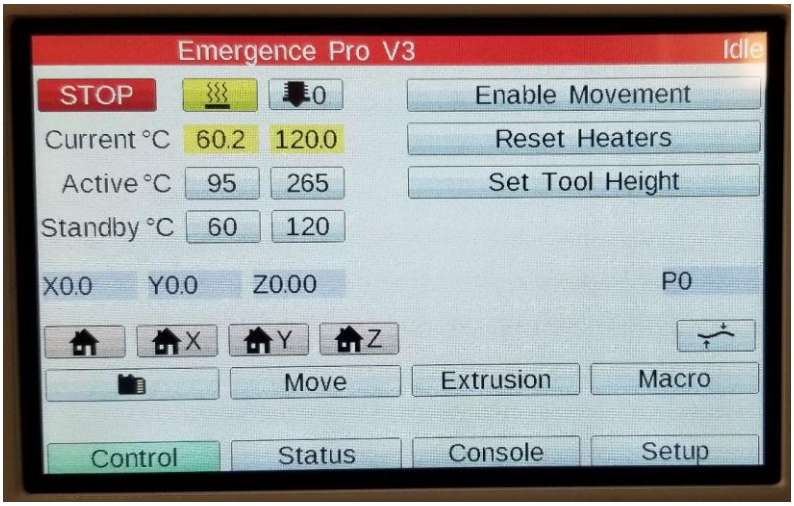


Figure 60: Standby Temperature as Current Temperature

4.1.9 Installing Nozzle and Melt Zone Extender

1. Unload any filament and heat the Hot End to 265°C.
2. Ensure the Melt Zone Extender hexagonal plane is smooth and free of any residue.
3. Tighten the nozzle and Melt Zone Extender together with the cylindrical side of the Melt Zone Extender facing the outlet of the nozzle.
4. Use a 7 mm socket head to tighten the component with about 1.5 -2 Nm of torque.
5. Use a 10 mm socket head to tighten the Melt Zone Extender to ensure that the hexagonal surface and the heated section are pressed tightly together.
6. Turn off the heat and wait for the hot end to cool down. After the hot end is cooled, install the silicone sock.

4.1.10 Removing Nozzle and Melt Zone Extender

1. Remove the silicone sock and unload the filament.
2. Heat the Hot End to 265°C.
3. Use a 10 mm socket wrench to loosen the Melt Zone Extender by one turn.
4. Use a 7 mm socket head to unscrew the Nozzle and the Melt Zone Extender.

4.2 Cleaning and Maintenance

4.2.1 Hot End Cleaning and Maintenance

It is highly recommended that a new hot end is installed every 3 to 6 months when under heavy use. This window may be shorter if using abrasive filaments like carbon fiber. After extended use, a filament jam, or discoloration in a print, it is recommended to clean the hot end.

To remove excess material from the exterior of the hot end, the nozzle can be heated to printing temperatures and a cotton swap can be used to wipe excess material.

To clean the inside of the nozzle, the Cold Pull Method is recommended.

4.2.2 Bed Maintenance

PVA recommends cleaning the print surface after every 2-3 prints. The print surface should be cleaned with isopropyl alcohol or soap and water to remove any oils or residue left behind when removing prints.

4.2.3 Dehumidifier Charging

The dehumidifiers included will need to be recharged occasionally. The interval between charges is dependent on the humidity levels at your location, but generally lasts about one week. If the beads within the humidifier viewing window are no longer orange, remove the humidifier and plug it into a 120V wall outlet for 8-12 hours until beads return to orange.

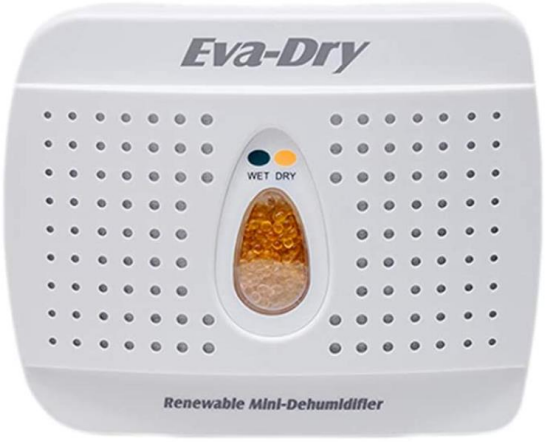


Figure 61: Charge Dehumidifier

4.2.4 Rail Maintenance

The Emergence PRO™ uses linear guide rails for all axes. Maintaining these rails takes a small amount of synthetic lubricant applied once per month. In the printer kit is a small bottle of synthetic lubricant. To lubricate the rails:

- Dust the rails and remove any excessive buildups of dirt or grime.
- Apply a small amount of lubricant directly to the grooves in the rails.
- Use the control screen to move the extruder assembly along the entire length of each axis.

Note: The z-axis screw should also be lubricated with the supplied grease.

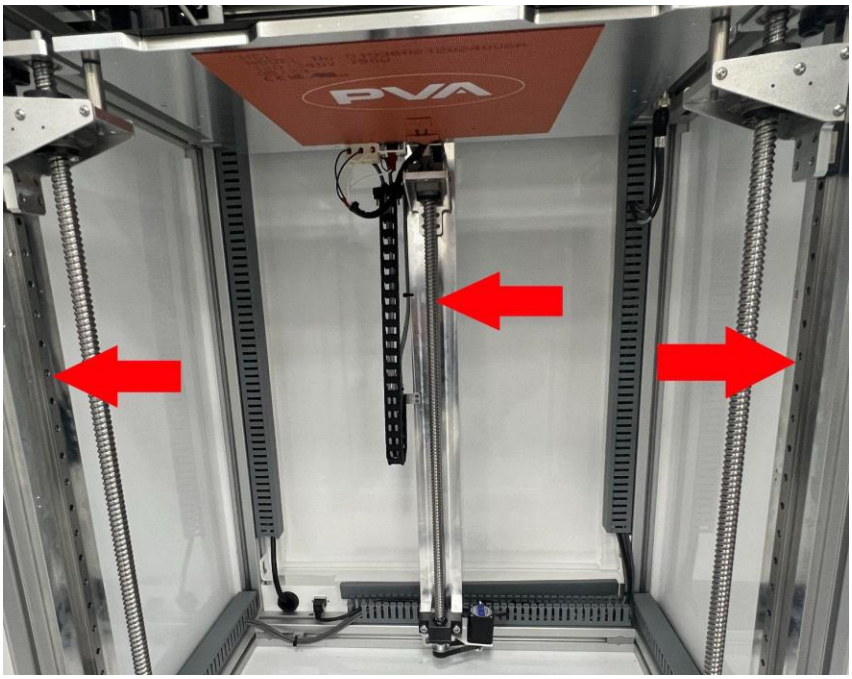


Figure 62: Bottom Rails

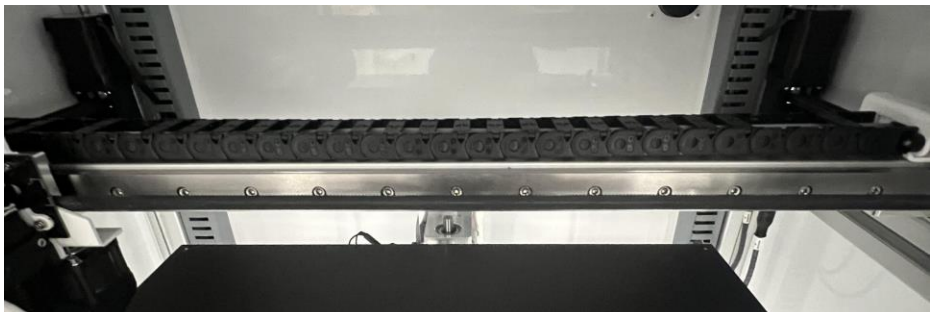


Figure 63: Front Rail

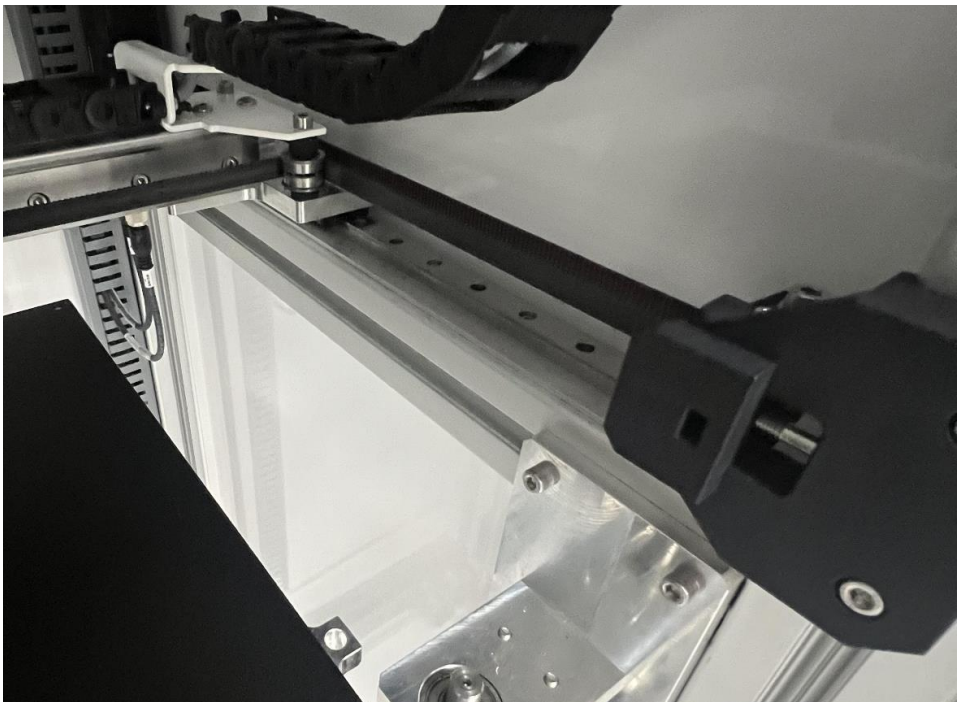


Figure 64: Right Rail

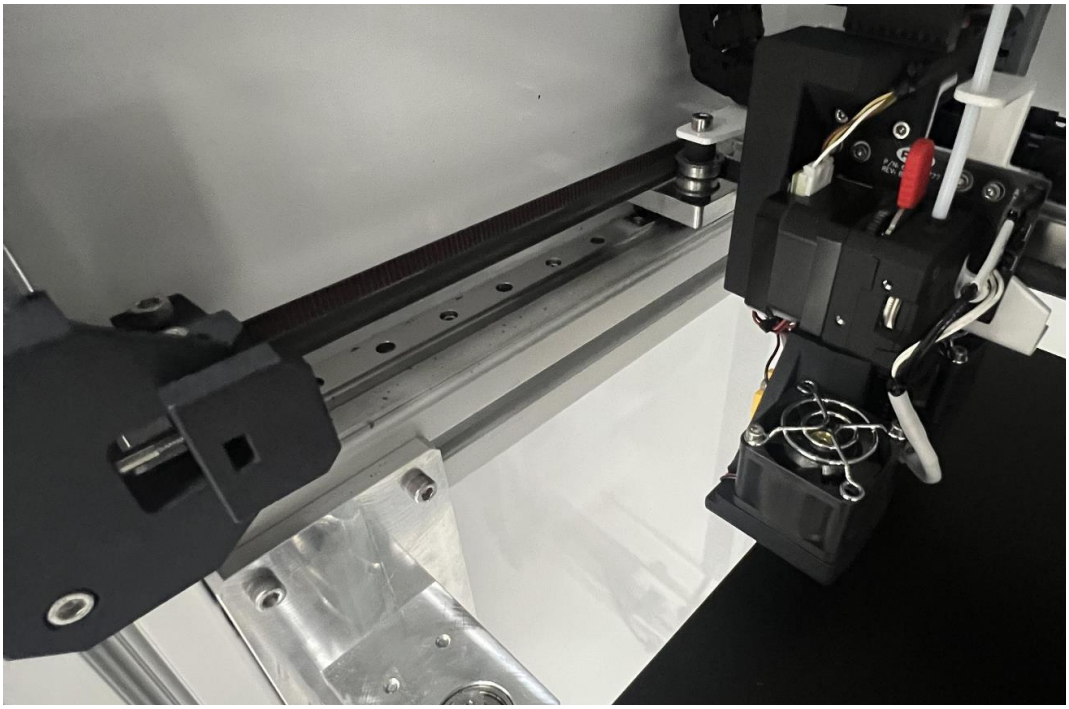


Figure 65: Left Rail

4.2.5 Belt Maintenance

The Emergence PRO™ uses a single belt for moving along the X-/Y-axis. While testing is performed on the Emergence PRO™ before shipping, it is recommended that the belt be examined before use in case of looseness developed during shipping. In addition, it is recommended that the belt be checked weekly for the first few weeks as the printer is used more frequently. Eventually, the belt may be checked once a month, or as determined necessary, as the printer is used on a more regular basis.

- Check the belt by plucking it. The belt should resonate with a low noise and should feel taunt but not tight.

Figure 66: Check Belt

- To tighten the belt, locate the tensioning screws (located on the gantry). Use a 4 mm hex wrench to tighten the tensioning screws.

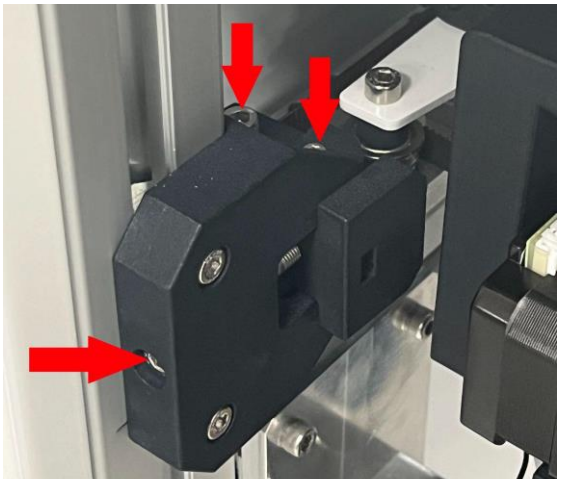


Figure 67: Tighten Belt

- Check the belt again by plucking it. Adjust the belt as necessary.

Please refer to Appendix B for a breakdown of the X-/Y-assembly.

4.3 Check for Quality

Many print quality issues associated with 3D printing are a result of incorrect slicer settings or variance in filament from manufacturer to manufacturer. However, if you continue to experience the same issues with different slicer settings, there may be a mechanical issue.

The quality checklist below can be used as a guide to assist you in diagnosing an issue. Please call us or submit a support request if you need assistance diagnosing or fixing an on-going issue.

4.3.1 Quality Checklist

Under-extrusion: This occurs when too little filament is extruded, or it is unable to lay down properly. Small amounts of under-extrusion can manifest as delamination. More severe under-extrusion will appear as inconsistent extrusion. To remedy this issue, we recommend loosening or tightening the tension screw.

Over-extrusion: This occurs when too much filament is extruded and can potentially damage the printer. The printed part will appear as if it is oozing filament and create extremely textured walls. Minimal amounts of over-extrusion will create thick walls and slight discoloration; however, it will have minimal effect on the overall print quality.

Delamination: This is a specific type of under-extrusion. The outer shell looks good visually; however, it feels like it is not well-adhered to the rest of the model. This is a structural concern and indicative of future complications with prints. Any time the printer creates a print with delamination, it should be thoroughly cleaned.

Missing layers: This is an example of temporary under-extrusion and will be considered a weak layer. This can be a result of mechanical or filament issues. If this appears on the print, you should perform a thorough mechanical check of the printer, which includes checking for: z-axis screw alignment, movement of axis carriages, and rail lubrication. If these appear to be in working order, the issue was probably a mishap related to the filament. For example, this happens if the filament diameter varies too much or experiences a moment of increased friction. A missing layer may occur if the filament is changed mid print.

Gaps in thin walls: This occurs when there is a spot in the STL that is too thin to print. The STL appears normal but the layer view in the slicer, and resulting print, will have a hole. This cannot be salvaged and requires the STL or printing profile to be modified. This issue is sometimes hard to diagnose without looking at the slicer. This issue may be remedied by using a smaller nozzle and reslicing.

Layer Shifting and Separation: This is a result of the profile settings when two consecutive layers do not adhere. To manually fix this, try increasing the temperature by 5°. Layer shifting and separation causes significantly weaker layers.

Inconsistent texture: Inconsistent texture can be a sign of moist filament, under extrusion, and poor layer adhesion. If the filament finish is not as expected, moisture within the filament is likely the reason.

Overheating: This can cause drooping, poor layer adhesion, and gaps in the print. To solve this, first check if the fans are on. If they are not, it is worth stopping the print and fixing them. The cooling that the fans offer allow higher print speeds. Without fans, the print does not have enough time to cool before the next layer is extruded.

Blobs and Zits: These are small amounts of extra filament melted onto the product. They are not a sign of structural damage and can be removed using a razor blade or grinder. Be careful not to remove too much material, which would sacrifice some structural integrity. If this happens in excess, it is a sign that the nozzle must be cleaned.

Poor First Layer Adhesion: This is a sign that the print bed needs to be recalibrated. The first layer is essential in providing a sturdy base for the rest of the print. If the first layer does not lay down smoothly and adhere to the bed well, stop the print. Recalibrate the nozzle height and ensure filament is dry before trying to print again.

Dimensional Accuracy: Is an important factor to consider when printing. Some materials are more likely to shrink than others. Prints should be checked for dimensional accuracy.

4.4 Quick Tips

As you gain more experience, you will be able to judge how to best address issues with prints. To get you started, here are some tips.

- Printing slower (5% to 10%) will help with print quality.
- Prints containing overhangs with angles greater than 45° should have support structures.
- Clean the hot end if you observe consistent under-extrusion.

4.4.1 Changing Print Speed

Slowing down the print speed may help improve print quality and improve first layer adhesion. However, slowing down too much may introduce new problems, such as drooping. Slowing down the print speed by 5% or 10% is a good start (remember that the speed is listed as a percentage).

4.4.2 Changing Flow Rate

The flow is the amount of extruded material and is dictated by several factors. Increasing the flow rate may help with first layer adhesion or in cases where slight under-extrusion is observed. The hot end should be cleaned using the Cold Pull method after any print where the flow is increased. The printer will also remember the last flow rate. Set the flow rate back to 100% before the next print.

4.5 Frequently Asked Questions

4.5.1 Under Extrusion

Refer to Section 4.3.1 for more information regarding under extrusion. If there is little to no filament coming out from the hot end, follow the steps below.

1. Loosen or tighten the tension screw on the extruder.
2. Ensure there are no tangles on the filament roll and the filament can easily be pulled from the roll.
3. Increase the extrusion percentage on the Printer Control Screen or Web Interface.

Note: Filament diameters can occasionally be under diameter.

4.5.2 Over Extrusion

Refer to Section 4.3.1 for more information regarding over extrusion.

If there is excess filament coming out of the hot end, follow the steps below.

1. Reduce the extrusion percentage on the Printer Control Screen or Web Interface.

Note: Filament diameters can occasionally be over diameter.

4.5.3 First Layer Not Sticking to Bed/Print Lifting from Bed

If the first layer is not sticking to the print bed, confirm the following items:

- ✓ The bed temperature is at the correct temperature. If not, wait until the temperature is met. Once bed temperature is reached, allow the bed to “soak” for 15 minutes before starting the first print.

Note: The bed can be preheated to the print temperature to allow for extra time for heat to transfer from the heater to the build plate.

- ✓ An approved material is being used.
- ✓ The end of the nozzle is clean of excess material.
- ✓ The nozzle height is properly set
- ✓ The bed is level. If using the standard start sequence this will be leveled prior to each print.
- ✓ The filament is dry. Consult the manufacturer for the appropriate drying procedure.

- ✓ The bed is residue-free. The bed can be cleaned with isopropyl alcohol or soap and water.
- ✓ Confirm appropriate bed material is being used. Some material may require blue masking tape or adhesive to ensure the first layer is stuck to the bed.

4.5.4 Print Sagging or Drooping

If the print is sagging or drooping, review the geometry of the model. With a 1.5 mm nozzle, the maximum printable overhang angle with WalkStrong filament is 50°.

4.5.5 Print Appears Cloudy

If the print appears cloudy, the filament is not dry. For ClearFit™, PVA recommends drying the filament for 4-6 hours at 65°C. Refer to Figure 55: Recommended Drying Times for PVA's recommendations on other filament or consult the filament manufacturer for the appropriate drying procedure.

4.5.6 Layer Shift

If a print unexpectedly shifts in the middle of a print, follow troubleshooting steps below.

- ✓ Ensure that the nozzle is clear of any excess material build up that could hit the existing print.
- ✓ Confirm that the belts are tensioned. If plucked, the belt should audibly resonate like a guitar string.

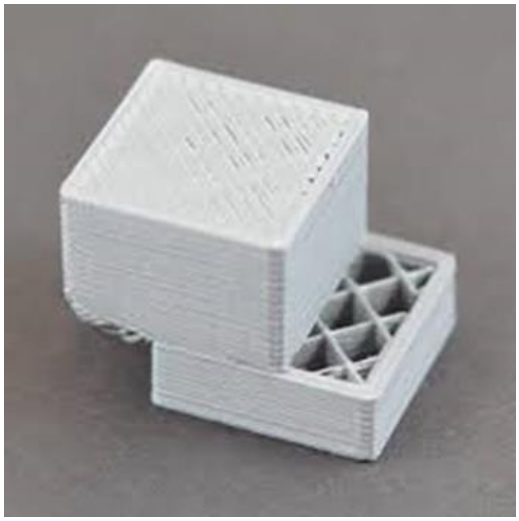


Figure 68: Layer Shift

4.5.7 Clogged Nozzle

1. Perform the Cold Pull method on the nozzle to remove any old material.

   - Remove the filament feeder tube from the extruder head.
   - Heat up the hot end to the printing temperature of your chosen cold pull filament, preferably the material most recently used in the hot end, while removing the old filament.
   - Feed the cold pull filament through the nozzle until it begins to ooze out.
   - Cool the hot end while applying constant pressure on the filament strand. This ensures the tip of the strand molds to the shape of the nozzle's interior while cooling.
   - Heat the nozzle up again to the printing temperature of your filament and pull on the filament while the hot end is heating until the filament comes free with excess debris on the end.
   - You may need to repeat the process additional times as some debris may remain after the initial pull.

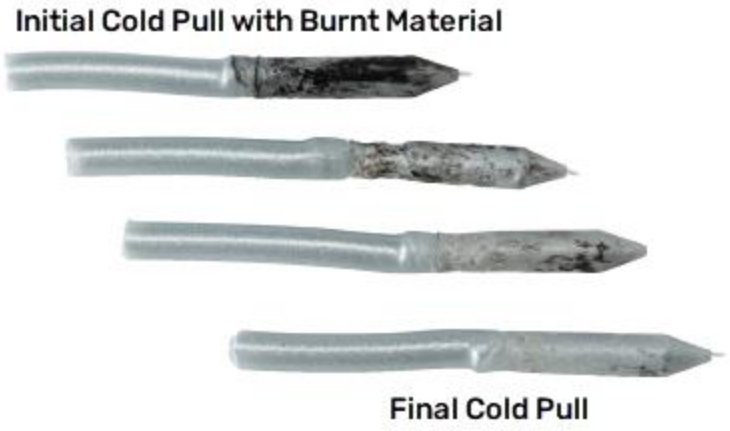


Figure 69: Cold Pull Examples

2. Heat the nozzle to the correct temperature and gently insert a cleaning needle up through the end of the nozzle, then purge.

Note: It is not necessary to remove all the material. This method is to break up the blockage.

4.5.8 Materials Errors

Refer to the filament manufacturer's recommendations or contact us with questions.

4.5.9 Printer Warning Messages and Remedies

Error Message	Possible Cause	Corrective Action
Warning: Vin Under-Voltage Event	Input voltage to control is below acceptable range	Ensure Emergency Stop button is disengaged
Error: G0/G1: insufficient axes homed	An attempt to perform a move without a homed axis.	Home the axis and try again. If this error occurs during the home sequence, ensure the Emergency Stop button is disengaged.
Error: Heating fault on Heater 1. Temperature rising much more slowly that the expected	Hot end is not heating as quickly as expected. Hot end 1 temperature will now be highlighted in purple on the display.	Ensure that Emergency Stop is disengaged. Run the heater reset macro then try again.

Figure 70: Printer Warnings

5. APPENDIX A

5.1 Printing Terminology

3D Model	Any digital shape occupying three dimensions.
Extruder	Allows for filament to be extruded; includes the hot end.
Feed Rate	The speed at which the extruder moves filament.
Flow Rate	The volume of filament extruded per unit time.
G-code	The file type that the printer will use to print the model. This file contains all the printer settings and model information needed to print.
Printer File	Has a .gcode file extension.
Print Speed	Defines at which speed (in millimeters/second) the print head moves while printing.
Profile	The saved settings applied to the 3D model when slicing in a slicing software.
Slicer	The software used to generate the toolpath and convert a 3D model into a .gcode.
STL	A file type common for 3D models. Has the file extension ".stl".

6. APPENDIX B

6.1 Printer Dimensions and Parts

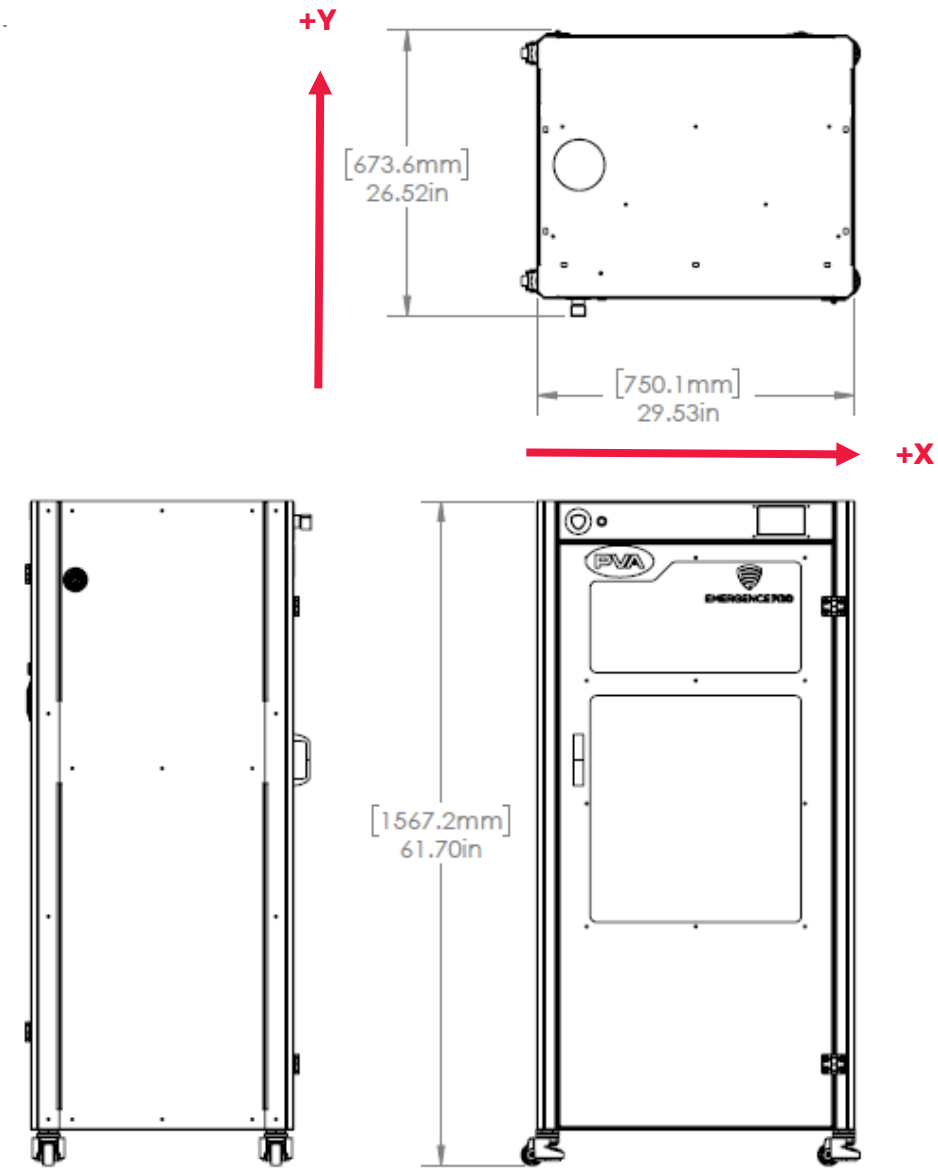
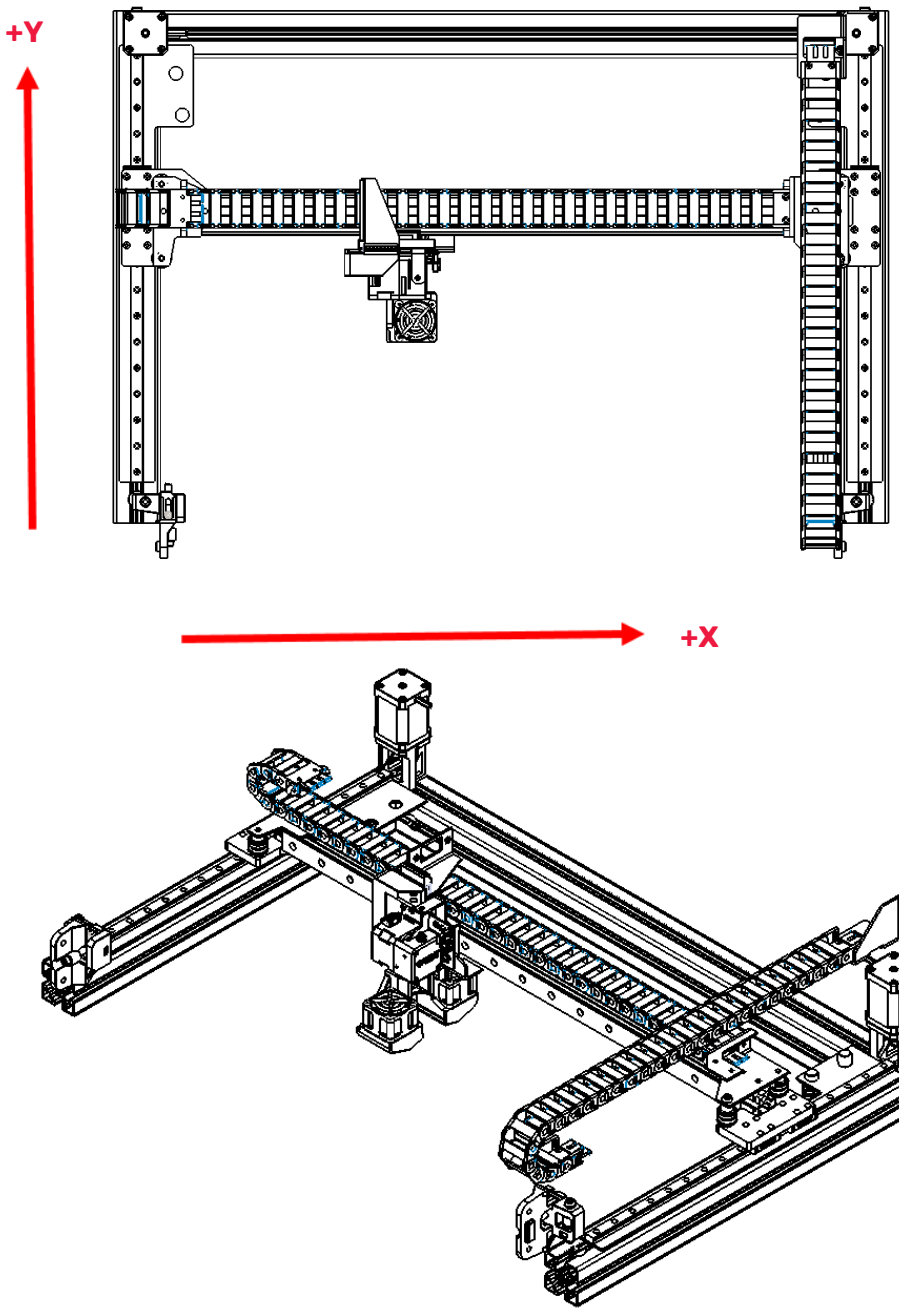


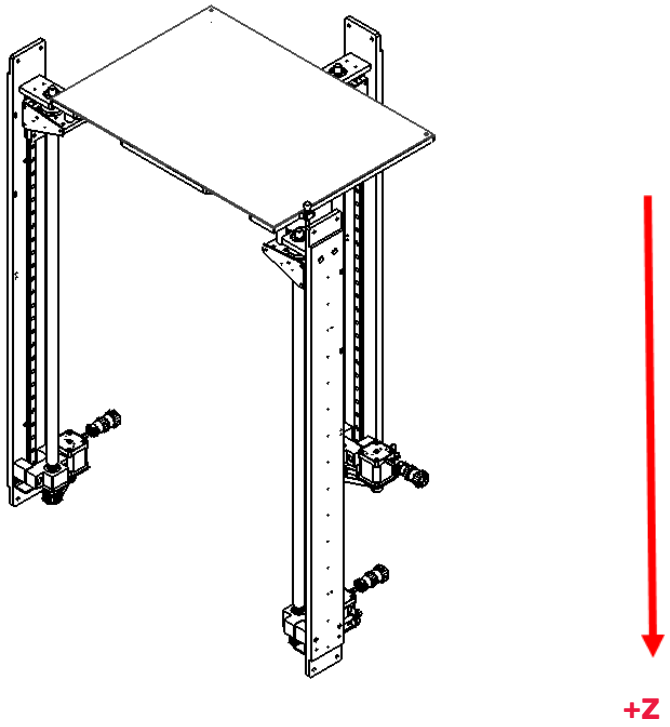
Figure 71: Printer Dimensions

6.1.1 X-/Y-Assembly

A breakdown of the X-/Y-assembly.



6.1.2 Z Assembly



6.1.3 Print Head

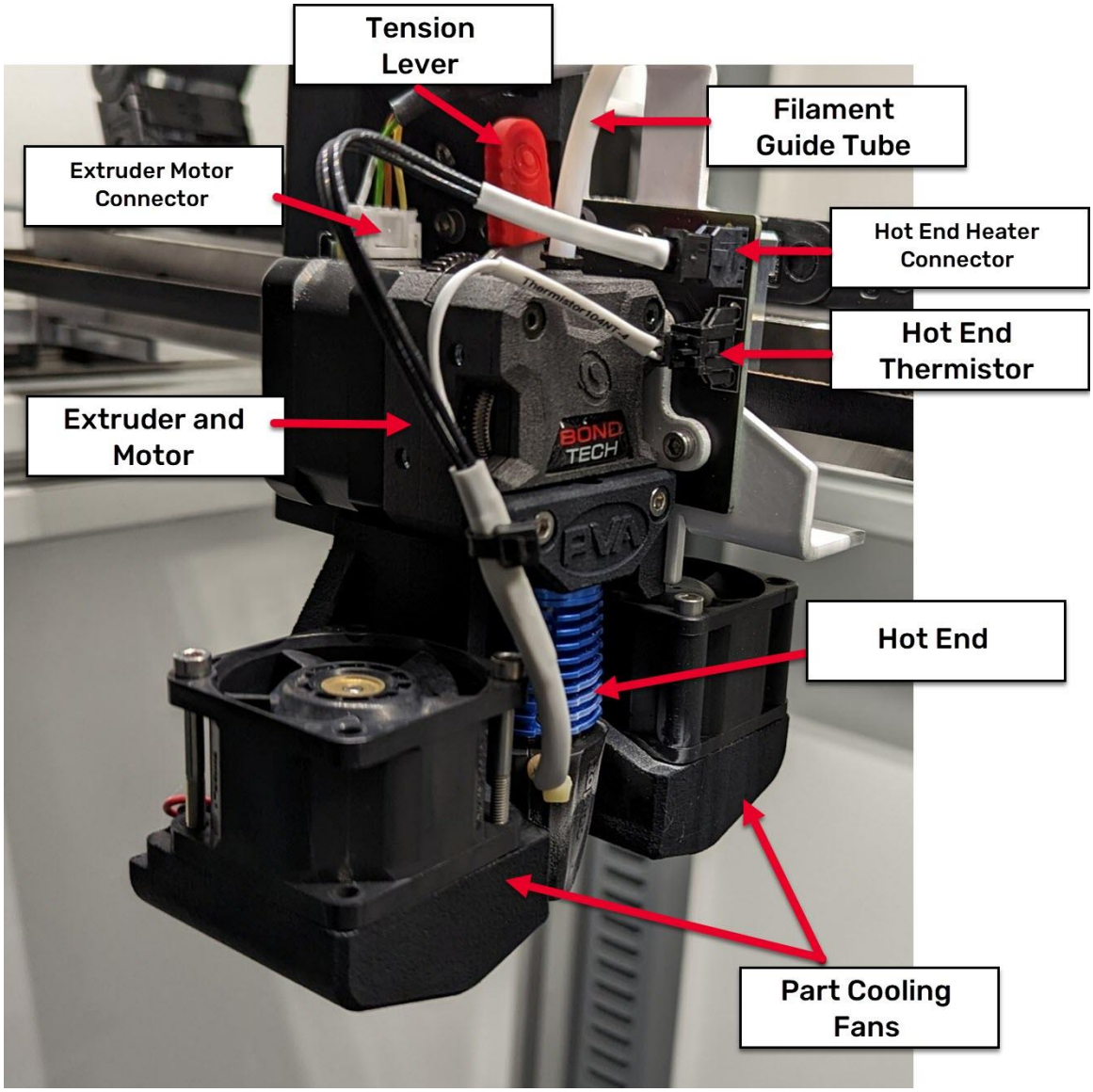


Figure 72: Print Head

6.2 Technical Specifications and Warnings

Build Volume	480 mm X 330 mm X 635 mm (19 in x 13 in x 25 in)
Power Requirements	Volts: 120/220V (Refer to machine serial tag) Amps: 10A Frequency: 50/60Hz
Hot End Temperature Limit	Up to 300°C (572°F)
Heated Print Surface Temperature Limit	Up to 115°C (239°F)
Layer Height	100 - 1000 microns
Print Head Speed	Up to 400 mm/sec (16 in/sec)
Available Nozzle Diameter	0.4 – 1.5 mm (0.02 - 0.05 in)
• Heated Build Platform • 5-inch Touch Interface • Wired Network Connection • Auto Bed Leveling	• Optical Filament Break Detection • Front-Loading Enclosed Material Storage • Removable Print Bed • Precision Ball Screw Z-Axis • Filament Pre-Tension Level

6.2.1 Warnings

- Do not use if wires are frayed, connections are loose, or you detect unusual conditions that could indicate a short.
- Do not use hot end in or around water.
- This product is designed to melt plastic. During and after use, parts of the hot end and printer may burn or ignite items that touch it. Do not touch or allow any item to touch the hot end until it has completely cooled.
- Do not use near volatile or flammable substances.
- This machine is made of machined metal which may retain sharp edges. Improper handling may result in property damage or personal injury.
- Supervise any children who are near or using this product.

7. APPENDIX C

7.1 Recommended Maintenance Schedule

Task	Frequency	Date Last Performed					
Recharge Dehumidifier	Once per Week						
Check Belt Tension	Once per Month						
Clean Hot End	Every 5 prints						
Lubricate Rails	Once per Month						
Replace Hot End	Every 3 to 6 Months						
Clean Bed	Every 2-3 Prints						

8. Table of Figures

Figure 1: Remove Plastic Wrapping 10
Figure 2: Remove Metal Plates 10
Figure 3: Secure Metal Ramp to Wooden Pallet and Move Printer 11
Figure 4: Raise and Lower Feet 11
Figure 5: Remove Exhaust Flange Cover 12
Figure 6: Exhaust Flange 12
Figure 7: Secure Exhaust Flange 13
Figure 8: Tool Kit 14
Figure 9: Tool Kit Contents 15
Figure 10: Remove Bracket from Front Door 16
Figure 11: Remove Brackets from Print Bed 16
Figure 12: Install Nozzle Brush 17
Figure 13: Insert Dehumidifier 17
Figure 14: Connect Power Cord 18
Figure 15: Printer Control Screen 20
Figure 16: Bed Level 21
Figure 17: Set Tool Height 22
Figure 18: Place Paper on Bed 22
Figure 19: Jog Nozzle to Touch Bed 23
Figure 20: Nozzle Touching Bed 23
Figure 21 : Distance Between Nozzle and Print Bed 24
Figure 22: Filament Positions 24
Figure 23: Temperatures for Installing Filament 25
Figure 24: Active Nozzle Button 25
Figure 25: Increase/Decrease Active Nozzle Temperature 25
Figure 26: Set 26
Figure 27: Bed Temperature 26
Figure 28: Current Temperature 27
Figure 29: Filament Load 27
Figure 30: Extrusion 28
Figure 31: Retract 28
Figure 32: Remove Heater Cartridge Connector 30
Figure 33: Remove Thermistor Connector 30
Figure 34: Unscrew Bolts 31
Figure 35: PTFE Tube 31
Figure 36: IP Setup Tab Location 32
Figure 37: IP Address Location 32
Figure 38: MAC Address Location 33
Figure 39: Print Screen 34
Figure 40: MicroSD Card 36

Figure 41: Insert MicroSD Card 36
Figure 42: MicroSD Button 37
Figure 43: MicroSD Screen 37
Figure 44: Select G-code 38
Figure 45: Print 38
Figure 46: Emergence PRO™ Web Interface Home Screen 39
Figure 47: Select G-code and Open 39
Figure 48: Upload Complete 40
Figure 49: G-code Files 40
Figure 50: G-code Right Click Options 41
Figure 51: File Selection 41
Figure 52: Test Print Files 42
Figure 53: Select Test Print 42
Figure 54: Print Test Print 43
Figure 55: Recommended Drying Times 45
Figure 56: Spare Parts Kit 46
Figure 57: Standby Nozzle Button 47
Figure 58: Set Standby Temperature 47
Figure 59: Standby Temperature in Yellow 48
Figure 60: Standby Temperature as Current Temperature 48
Figure 61: Charge Dehumidifier 50
Figure 62: Bottom Rails 51
Figure 63: Front Rail 51
Figure 64: Right Rail 52
Figure 65: Left Rail 52
Figure 66: Check Belt 53
Figure 67: Tighten Belt 53
Figure 68: Layer Shift 58
Figure 69: Cold Pull Examples 59
Figure 70: Printer Warnings 60
Figure 71: Printer Dimensions 62
Figure 72: Print Head 65

9. Warranty

9.1 PVA Warranty Policy

PVA warrants the enclosed product against defects in material or workmanship on all components for one year from the date of shipment.

The warranty does not extend to components damaged due to misuse, negligence, or installation and operation that are not in accordance with the recommended factory instructions. Unauthorized repair or modification of the enclosed product, and/or the use of spare parts not directly obtained from PVA (or from factory authorized dealers) will void all warranties.

All PVA warranties extend only to the original purchaser. Third-party warranty claims will not be honored at any time.

Prior to returning a product for a warranty claim, a return authorization must be obtained from PVA's customer service department. Authorization will be issued either via the telephone, facsimile, or in writing upon your request.

To qualify as a valid warranty claim, the defective product must be returned to the factory during the warranty period. Upon return, PVA will repair (or replace) all components found to be defective in material or workmanship.

(Retain this for your records)

Product Information

PRODUCT:

SERIAL NUMBER:

DATE OF PURCHASE: