

Serial Number

BotFactory SV2

Desktop Circuit Printer & Assembler

USER MANUAL

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WELCOME TO THE WORLD OF PRINTED ELECTRONICS!

Build a Fully Functional Circuit in Hours from your Desktop!

Every year, millions of Electrical Engineers, Academics, Students and Hobbyists spend billions of dollars creating Printed Circuit Boards yet suffer long waiting times for their design to be fabricated. We took it upon ourselves to bring PCB prototyping tools closer to the designer, creating a product that integrates all the steps of PCB fabrication into a compact, intuitive package. Building upon the maturation of conductive nanoparticle inks and image recognition technology.

SV2 delivers a solution at several magnitudes of cost lower than in-line manufacturing equipment, heralding one of the rare moments where the rules of manufacturing and innovation are up-ended by miniaturization.

It uses three interchangeable heads to inkjet print conductive and insulating ink, extrude dots of conductive glue or solder paste, and pick-and-place electronic components, rotating parts and correcting misalignment using computer vision.

The BotFactory SV2 has an onboard computer running a web browser-based software, compatible with any platform - no installation required. It provides an intuitive experience, guiding the user through the different steps with illustrations and animations.

We stand behind our product and actively improve the software of the BotFactory SV2 to better utilize the hardware. The BotFactory SV2 makes updates automatically available from our servers whenever it is connected to the internet.

DISCLAIMER



Please read and understand the contents of this user manual carefully. Failure to comply with the manual may lead to personal injury, inferior results or damage to the BotFactory SV2. Anyone using the device needs to know and understand the contents of this manual.

We put every effort to make this manual as accurate and complete as possible. We believe this information to be correct, but the manual does not aim to be all inclusive and shall be used only as a guide. Should you discover any errors or omissions, please bring this to our attention at support@botfactory.co, so that we can improve our documentation and better serve you. You can refer to our website or contact us for the most up-to-date information.

The BotFactory printers are designed and built for prototyping electronic circuit boards with BotFactory-branded consumables (such as, but not limited to, conductive/insulating ink and epoxies) within a commercial/business environment. Other materials can be used at the user's own risk.

While we have achieved a high standard in the reproduction of Printed Circuit Boards through BotFactory's unique software, printed electronics are an advanced field and the software is frequently improved. As such, the user remains responsible to qualify and validate the application of the PCB for its intended use, especially critical for applications in strictly regulated areas like medical devices and aeronautics.

SAFETY

Caution alert symbols can be found on the machine and in this manual. These symbols indicate a potential safety hazard that could harm you or others or cause product or property damage.



Warning: The BotFactory SV2 has a heat bed that generates high temperatures. The LED ring around the camera will turn red while the heat bed is hot. Do not leave combustible material on or near the printer. Always allow enough time for the heat bed to cool down before reaching the work area.



Warning: The BotFactory SV2 includes electromechanical elements that move and can cause injury. Stay clear of the device while it is in operation. The work area moves front and back. Make sure you leave at least 8 inches (20cm) of free space on the front and back of the machine.



Warning: The SV2 Paste head, its cartridge, and some SV2 accessories (e.g., the shear) contain sharp edges. Do not remove the safeguards on the shears and always store the micro-dispensing tips in their container when not in use.



Warning: The BotFactory SV2 uses conductive ink and insulating ink for printing electrical traces, and conductive glue for bonding components to the traces. Keep these materials away from mouth and eyes and DO NOT ingest. Always wash your hands with soap and water before eating or drinking after handling. Please refer to the SDS available online or with the SV2 accessories box.



Warning: The SV2 print head uses low-power UV light to cure the insulating ink. While using a very low power, avoid looking directly at the light when in use.



Warning: Always disconnect the power to the equipment and unplug before performing any service or maintenance.



Warning: An earthed main socket must be used. The socket must be located near the equipment and must be easily accessible.



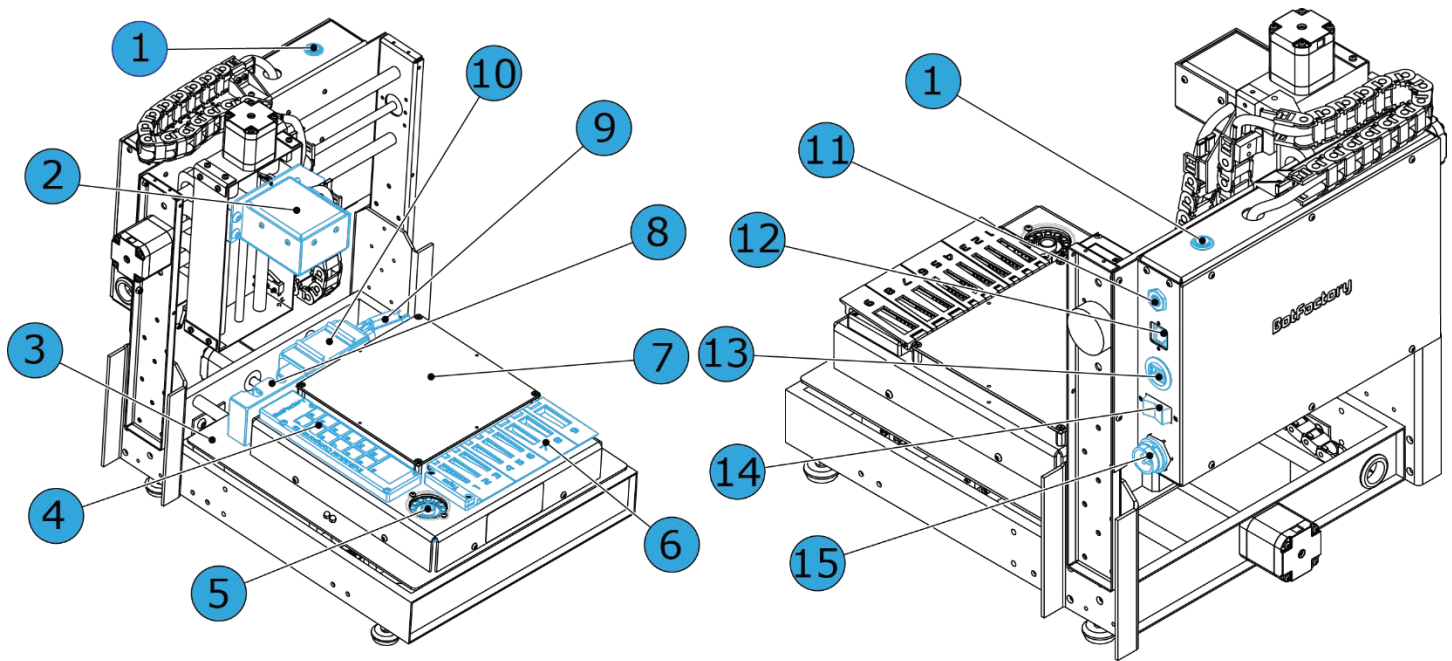
Warning: Do not leave the BotFactory SV2 unattended during operation.



Warning: The SV2 Print head uses thermal inkjet technology, also known as “bubblejet”. Odors can be emitted during the printing operation. Make sure to set up the BotFactory SV2 in a well-ventilated area.

GETTING TO KNOW YOUR SV2

THE BOTFACTORY SV2 DIAGRAM

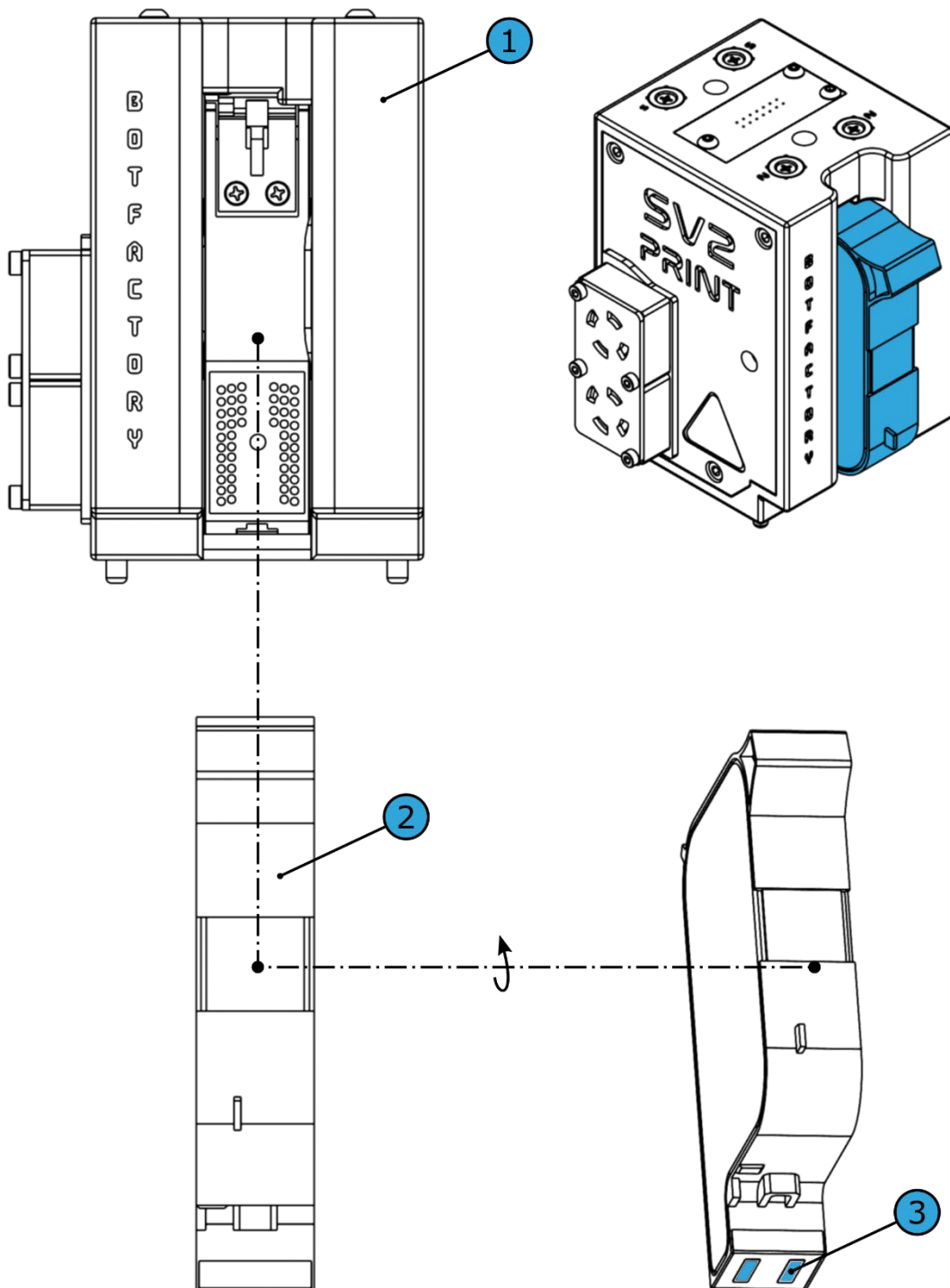


- 1. Power button
- 2. Head holder
- 3. Work area
- 4. PNP tray
(Individual components)
- 5. Camera & LED ring
- 6. PNP tray (Tape)
- 7. Heat bed

- 8. PNP tip holder
- 9. Paste head cleaning station
- 10. Print head cleaning station
- 11. Enclosure switch connector
- 12. Ethernet port
- 13. USB port
- 14. Kill switch
- 15. Power supply connector

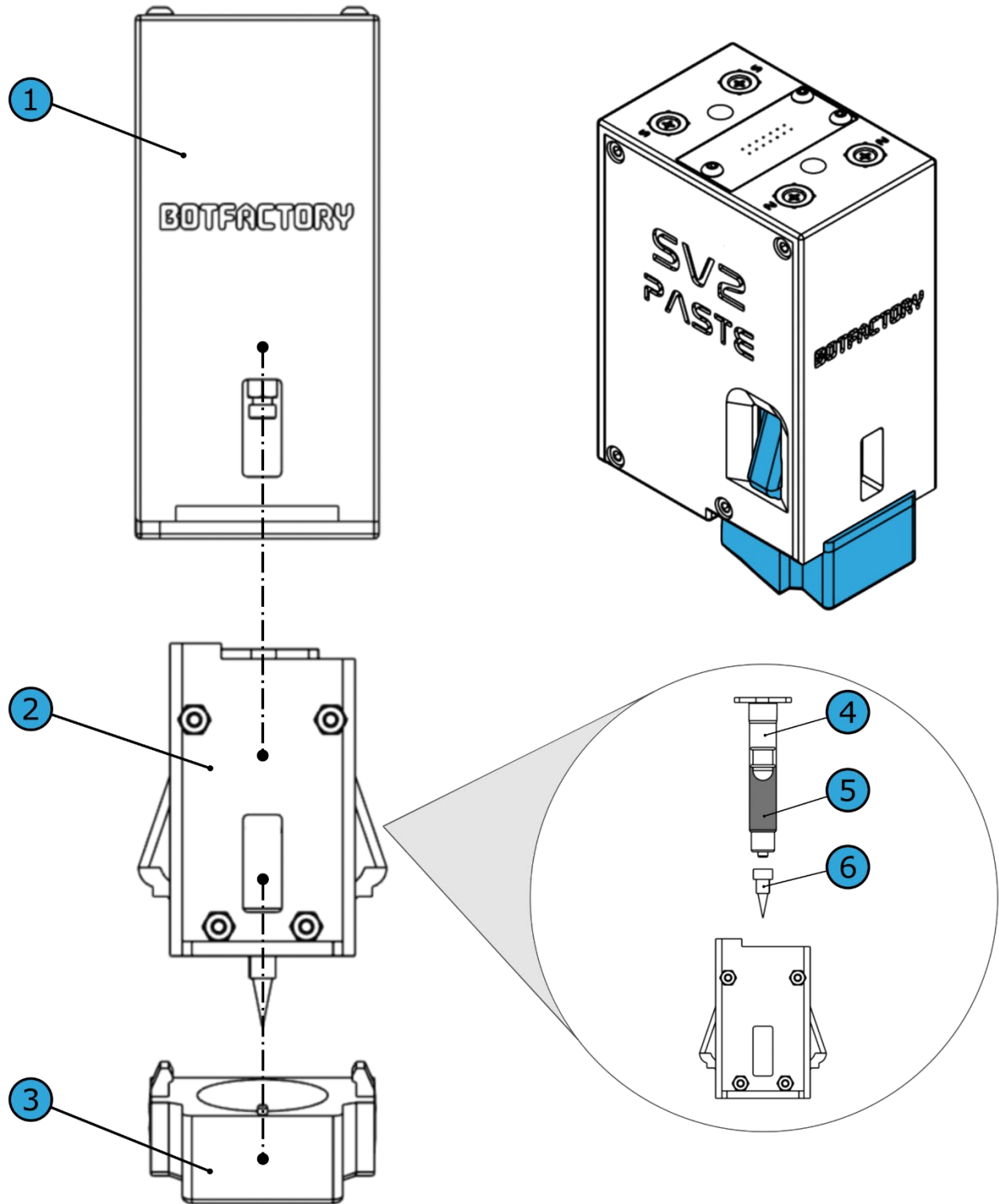
THE SV2 HEADS

PRINT HEAD

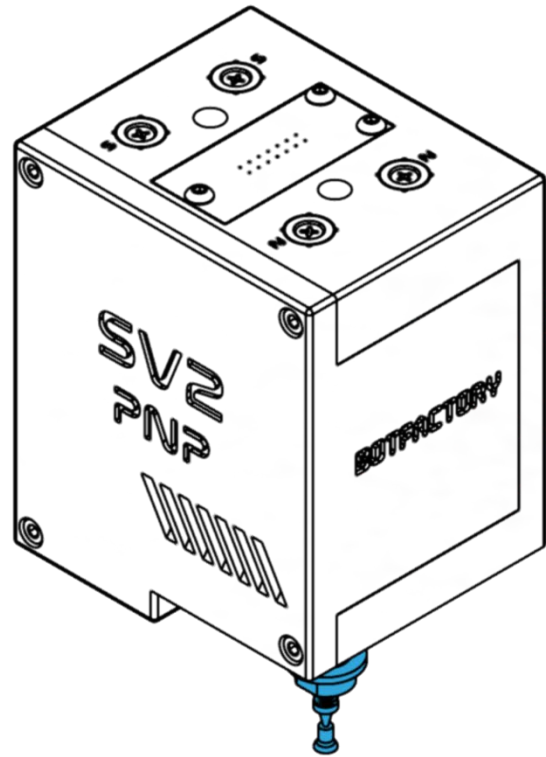
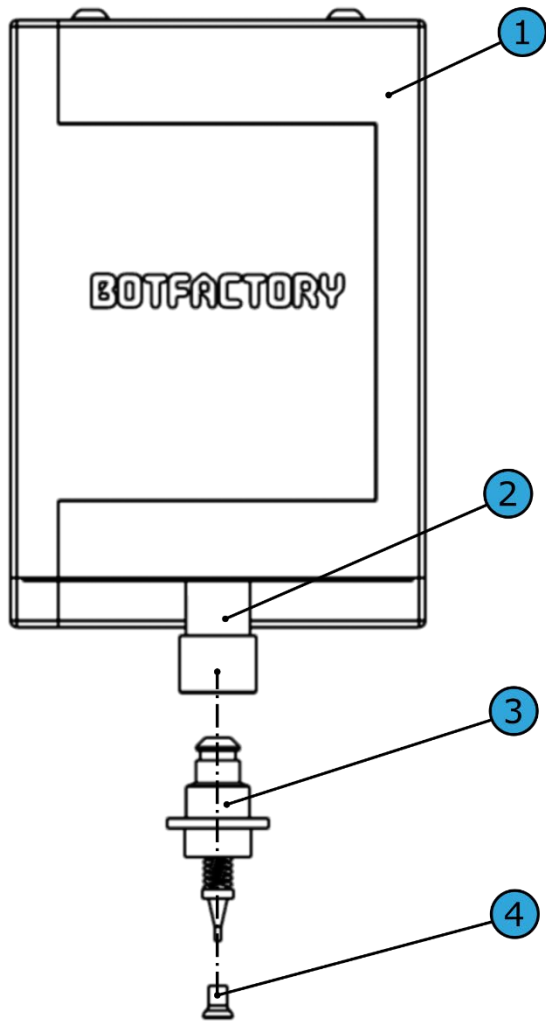


1. Print Head
2. Ink Cartridge
3. Nozzles

PASTE HEAD



PNP HEAD



1. PNP Head
2. PNP Tip Adapter
3. PNP Tip
4. Suction Cup

SPECIFICATIONS

MECHANICAL

GENERAL

Max. Substrate Size	6" x 6" [152 x 152 mm] [X/Y]
Max. Circuit Size	4.6" x 6" [117 x 152 mm] [X/Y]
Heads: Weight	Less than 1.1 lbs. [500g] per head
XYZ Positioning Repeatability	±2.76 mil [70 microns]
XYZ Positioning Precision	0.39 mil [10 microns]

WITHOUT THE ENCLOSURE

Frame: Size	16.5" L x 14" W x 17.5" H [42 x 35.5 x 44.5 cm]
Additional Clearance Req.	3" [7.5 cm] in front, 4" [10 cm] in the back
Frame: Weight	30 lbs. [13.5 kg]
Shipping Box: Size	21.5" L x 17" W x 27" H [55 x 43.2 x 68.6 cm]
Shipping Box: Total Weight	50 lbs. (22.5 kg)

WITH THE ENCLOSURE

Enclosure: Size	24.8" L x 17" W x 18" H [63 x 43 x 46 cm]
Additional Clearance Req.	6" [15 cm] on the right
Enclosure: Weight	46 lbs. [21 kg]
Unit: Total Weight	81.5 lbs. [37 kg]
Shipping Box: Size	30" L x 28" W x 22" H [76 x 71 x 56 cm]
Shipping Box: Total Weight	106 lbs. [48 kg]

ELECTRICAL

Power	DC 24V 22A
Connection	Ethernet, Wi-Fi

PRINT

Print Technology	Thermal Inkjet Printing
Number of Inkjet Nozzles	300
Ink Types (curing method)	Conductive (heat), Insulating (UV)
Min. Trace Width	8 mils [200 microns]
Min. Pin Pitch	SV2 – Starter: 24 mil [600 microns] SV2 – Enhanced: 20 mil [500 microns] SV2 – Professional: 16 mil [400 microns]
Min. Via Dimension	Diameter: 25 mil [600 microns] Drill Size: 15 mil [400 microns]
Max. Printable Area	4.6" x 6" [117 x 152 mm] [X/Y]
Conductive Ink Sheet Resistance	40 mΩ/square
Number of Layers	1-2 (Starter & Enhanced) or 1-4 (Professional)
Solderable	Only onto a copper PCB rivet. We recommend using conductive glue.
Supported Formats	GERBER RS-274X, .jpg, .png, .tiff, .bmp

PASTE

Paste Technology	Syringe Extrusion
Paste Types	Conductive Epoxy and Solder Paste
Extruded Dot Size	8 mils [200 microns]
Curing Method	Heat
Supported Formats	GERBER RS-274X, .jpg, .png, .tiff, .bmp

ASSEMBLY (PNP)

PNP Technology	Vacuum Pickup, Computer Vision, Automatic Tip Swap
Camera	5 MP, Upward Facing
Speed	4 parts per minute
Tray: Types	Tape, Individual components
Tape Tray: Number of Slots x Tape Width	6x 8mm, 2x 12mm, 1x 16mm Cut Tapes
Tray: Parts Loaded	Max. 42 per batch
Min. Part Size	0603 [1608 Metric]
Max. Part Size	0.78" x 0.78" [20 x 20 mm]
Supported Formats	Centroid file (text file describing Reference Designator, Footprint, X/Y location, and Rotation). The file can be generated by your CAD tool

SOFTWARE

Installation	None (Software runs on-board)
System Requirements	Web browser (Platform-independent)
Recommended Browser	Firefox, Chrome
Offline Updates	Available on demand (USB3.0)

TEMPERATURE

Ambient: Operating	50-100°F [10-40°C]
Heat Bed: Pinning	75-120°F [25-50°C]
Heat Bed: Curing	75-300°F [25-150°C]
Heat Bed: Max	340°F [170°C]
Conductive Ink: Storage	See packaging instructions
Insulating Ink: Storage	See packaging instructions
Conductive Glue: Storage	See packaging instructions

AMBIENT OPERATING REQUIREMENTS

Ambient Temperature	50-100°F [10-40°C]
While operating without the enclosure	Protect the work area from air flows Avoid camera exposure to direct sunlight to improve the reliability of the Computer vision
Other	Operation in well ventilated area is recommended



For more product information, visit <https://www.botfactory.co/page/botfactory-sv2-pcb-printer>

In case of conflicting information, the specifications on the website take precedence.

GETTING STARTED

BEFORE OPENING THE BOX



Please retain the original packaging.



Cartridges can degrade rapidly if not **handled properly as soon as you receive them**, please refer to the packaging and follow the instructions section of our website: <https://goo.gl/I9UE7E>

UNPACKING THE BOTFACTORY SV2

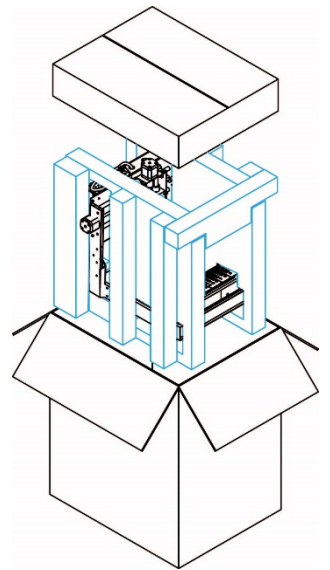
Open the BotFactory SV2 box. The packaging indicates which side is top. A smaller accessories box sits on top of the printer with your documentation, consumables, peripherals, and SV2 heads.

Verify that all the heads, consumables, and peripherals are present. You can refer to page **Error! Bookmark not defined.** of this User Manual, your Sales Order, and the packing slip.

Some of those consumables need to be refrigerated immediately. Please follow the instructions on the packaging.

Once the accessories are stored away, you can access the printer sitting at the bottom between three pieces of hard foam. Remove the entire assembly by grabbing by a ridge on each side and pulling upwards. Remove the smaller center foam piece at the front first, before pulling the side pieces one-by-one.

Place the hard foam and the accessories back into the large box and store it away.



SETTING UP THE HARDWARE

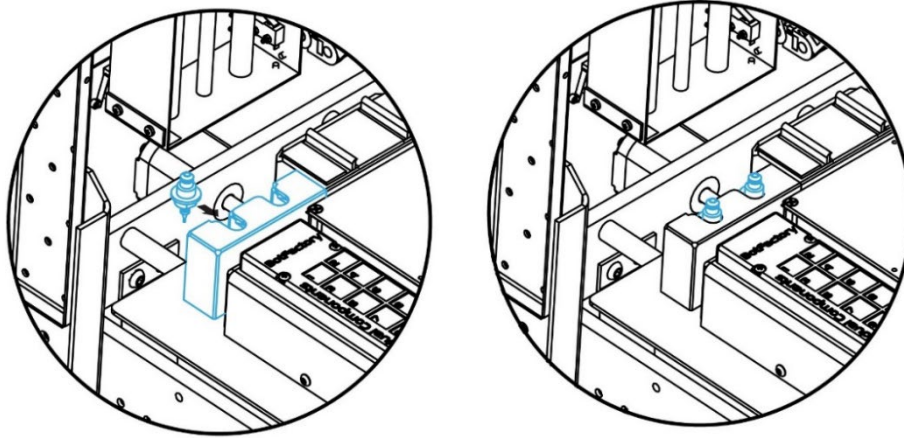
Place the BotFactory SV2 on a stable surface.



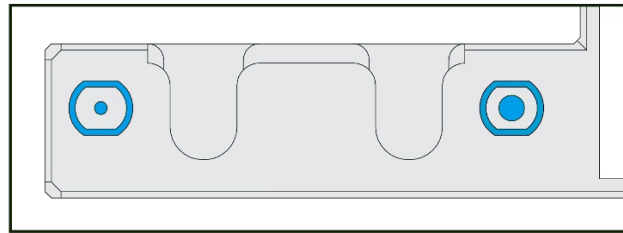
Make sure you transport the BotFactory SV2 by lifting the thick body at the base (do not lift it from the back box, work area, or head holder!)

SET UP THE PICK-AND-PLACE TIPS

Take the two PNP tips from the accessories and place them in the right slot on the PNP tip holder by sliding them from the back of the BotFactory SV2.



i Two icons on the top of the PNP tip holder indicate which slot is for the small and large PNP tip.



TURN THE BOTFACTORY SV2 ON

Make sure the Kill switch is in the OFF position (0 pressed).

Gently connect the power cable to the power supply connector on the back box. First push then rotate the moving part of the cable to screw it in.

Connect the power cable to the power supply and plug it into a wall socket.



An earthed main socket must be used to protect against over-current and the building should have dedicated means to protect against short-circuit. The socket must be located near the equipment and must be easily accessible.

Turn the Kill switch ON (I pressed).

Press the Power button.

CONNECTING FOR THE FIRST TIME

When the BotFactory SV2 is turned on for the first time, the LEDs on the LED ring will transition from blinking yellow to green, indicating that the machine has entered Easy Connect mode and that you can connect to it.



All BotFactory SV2 machines are now shipped in Easy Connect Mode by default. Easy Connect enables users to connect to the printer the first time to set up the BotFactory SV2 network configuration. **Easy Connect is an OFFLINE mode, preventing any internet access.**



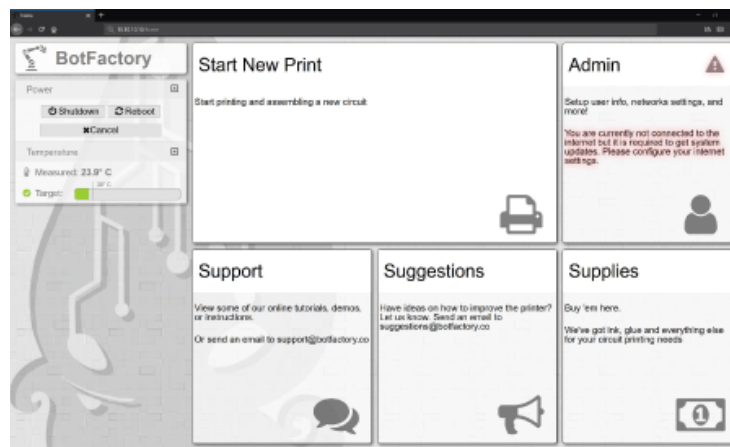
Internet access is required to download software updates.

CONNECTION IN EASY CONNECT MODE

Two options are available to connect to the BotFactory SV2: Ethernet or Wi-Fi.

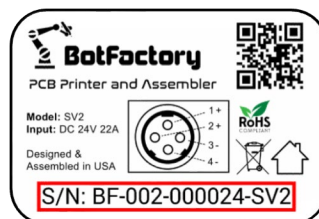
CONNECTION OVER ETHERNET

1. Locate the Ethernet port at the right side of the SV2.
2. Connect the printer to your computer with an Ethernet cable.
3. If you are using a USB Ethernet adapter, install any necessary drivers¹.
4. In the address bar of your web browser, enter **10.10.10.10**
5. The following SV2 home page should appear.



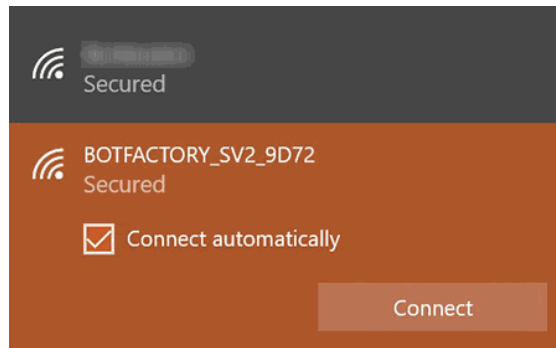
CONNECTION OVER WI-FI

1. Locate the sticker showing the serial number at the back of the BotFactory SV2 (sample shown on the right). Write down the serial number (All the letters are UPPERCASE, start with the "BF" characters, and include the dashes). You will need it in the next step.

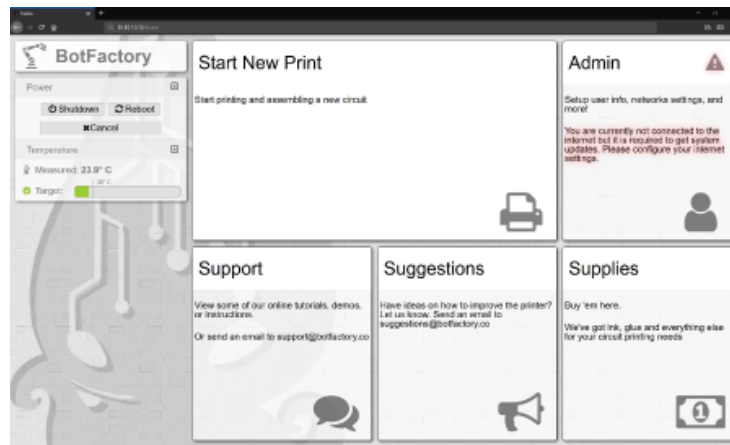


¹ Note that the Ethernet interface must be configured as a DHCP client

- The Wi-Fi interface on the BotFactory SV2 acts as an access point during Easy Connect mode. Any Wi-Fi enabled device can then connect to it.
- In the wireless connection menu of your OS, look for an SSID named "BOTFACTORY_SV2_XXXX", where XXXX is 4 alphanumeric characters that are unique to each printer.



- When prompted for the password, enter the serial number of your SV2 in **upper case**, starting with the characters "BF" and including the dashes.
- After you have connected to the BotFactory SV2 Wi-Fi access point, navigate to **10.10.9.9**
- The following SV2 home page should appear.



SETTING UP INTERNET ACCESS



SV2 needs to be assigned an IP address by a router or your computer (using Ethernet or Wi-Fi). We will cover both options below.

CONNECTING VIA ROUTER / EXISTING INFRASTRUCTURE

You can configure SV2 to connect to an existing network infrastructure (router, switch, etc.). You can then simply type in <http://sv2/> or <http://sv2.local/> in your browser to connect to SV2.

You can create a Wi-Fi connection between SV2 and your router by clicking on 'Admin'.

CONNECTING DIRECTLY THROUGH A COMPUTER

If you prefer not to use a router, you can connect directly via Ethernet using these steps below.

If you are having trouble, please send an email to support@botfactory.co – we'd love to help you out!

VIA MAC (OSX 10.9 'MAVERICKS' – OSX 10.11 'EL CAPITAN')

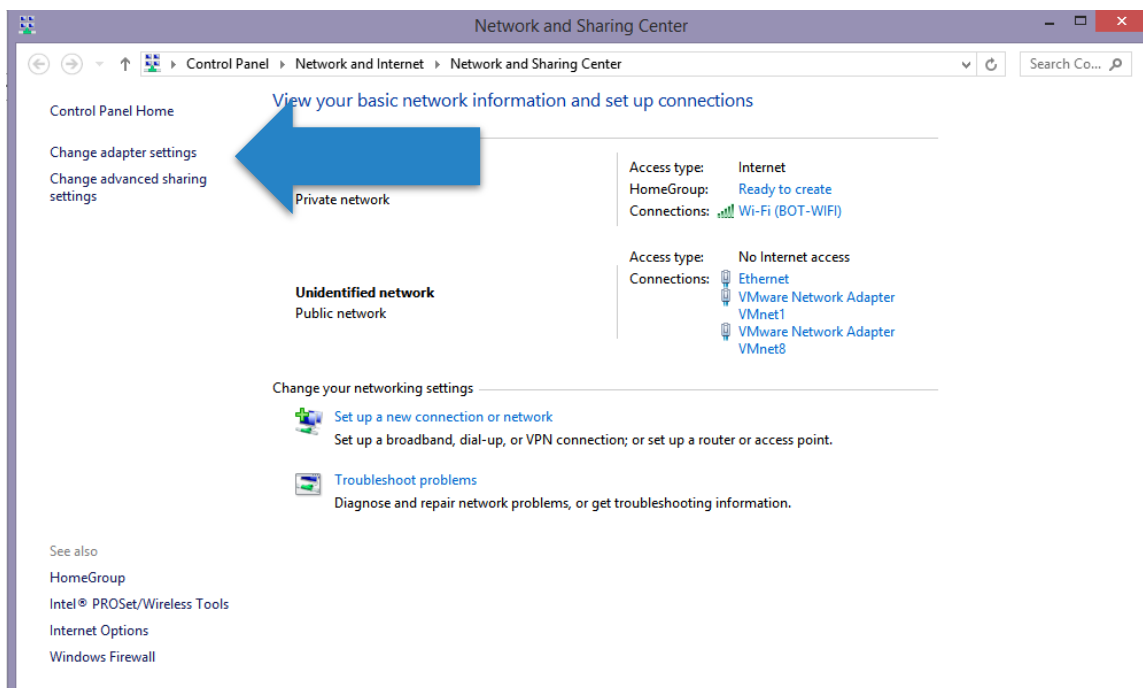
1. Ensure that you have an Internet connection – SV2 prefers to swim to the Cloud to get updates.
2. Go to '*System Preferences*' > '*Sharing*'.
3. Ensure that '*Internet Sharing*' is turned ON, usually by bridging Wi-Fi (or any source of your internet) to the Ethernet.
4. Connect your Mac to SV2 using the Ethernet cable and turn on SV2.

 SV2 will blink the LED ring **blue** twice when it is done booting.

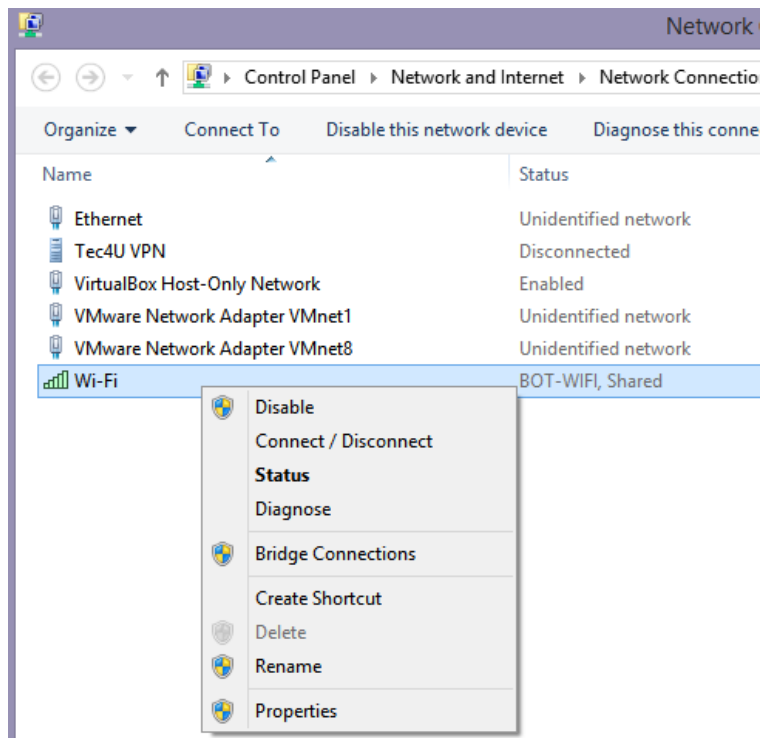
5. Type in <http://sv2.local/> on your browser once SV2 is ready.

VIA PC (WINDOWS 7 AND UP)

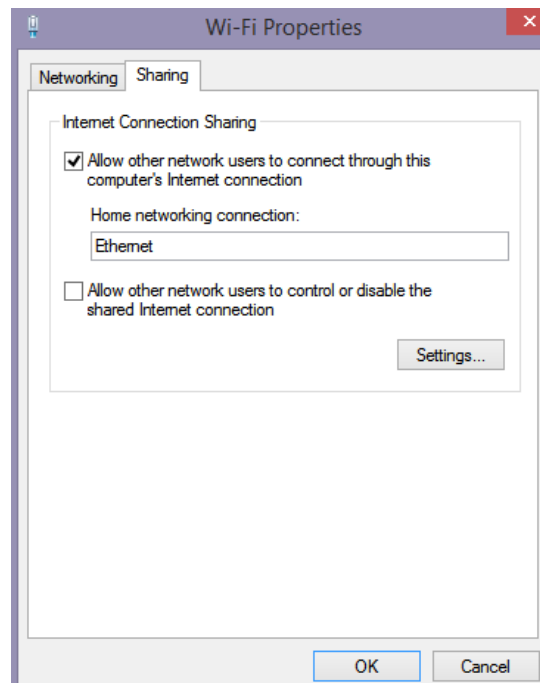
1. Ensure that you can surf the web from your PC.
2. Right-click on the wireless connection icon on the bottom right-hand corner.
3. Open '*Network and Sharing Center*' > '*Change Adapter Settings*'.



4. Find the network adapter that connects you to the internet (usually Wi-Fi), right-click on it and select '*Properties*'.



5. Select the '*Sharing*' tab and click on '*Allow other network users to connect through this computer's internet connection*'. If not selected, select '*Ethernet*' in the '*Home networking connection*'.



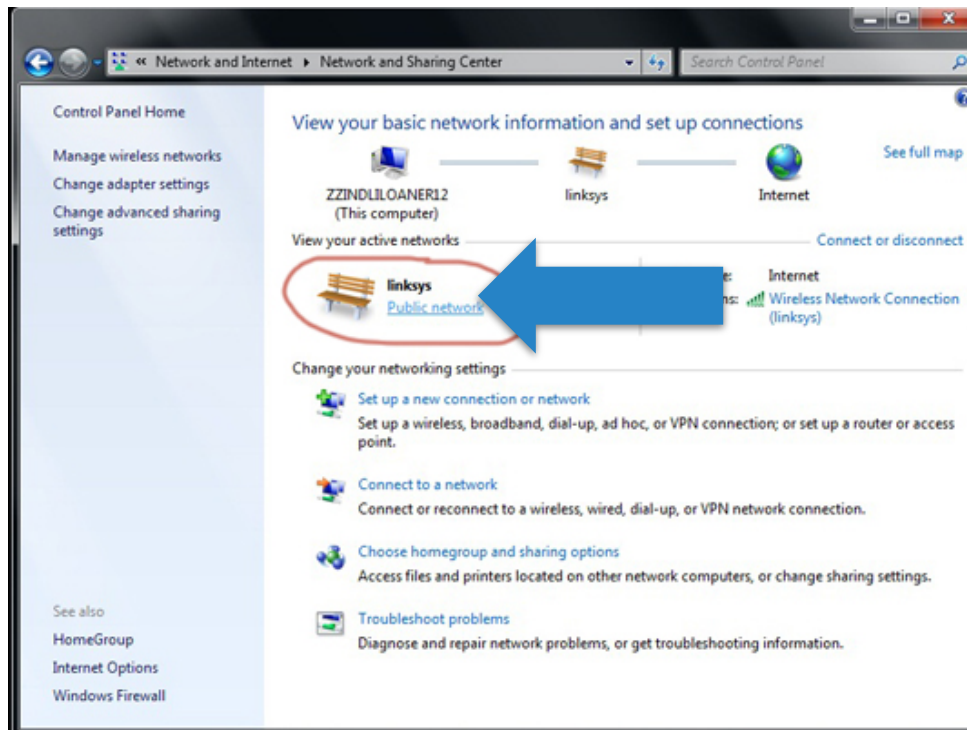
6. Reboot SV2 (with the Ethernet cable connected).



SV2 will blink the LED ring **blue** twice when it is done booting.

7. Open browser and type in <http://sv2.mshome.net>

Note: If you are having trouble, go back to the 'Network and Sharing Center' and look for your Ethernet connection, click on the link that says 'Public' and change the security settings to 'Work'. Reboot SV2 and try step 4.

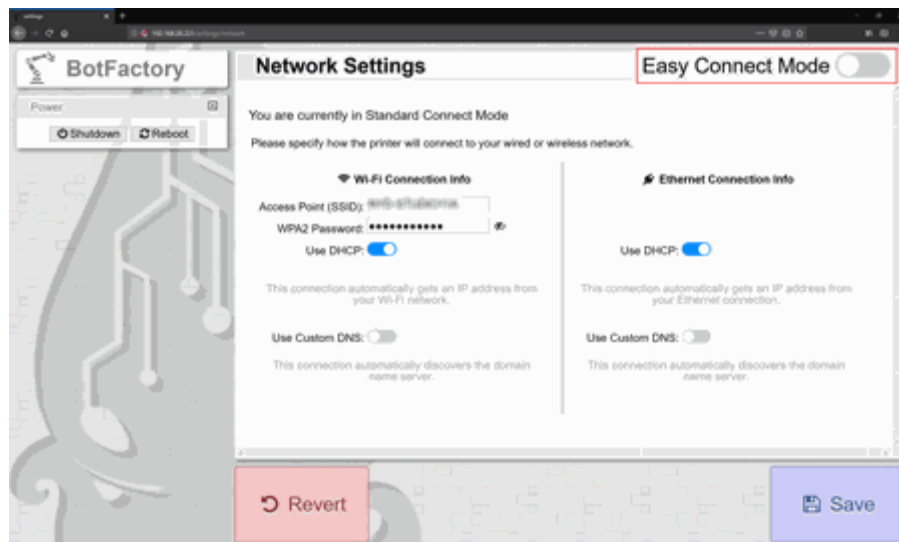


GOING BACK TO EASY CONNECT MODE

If you are having trouble getting a network connection on SV2, you can manually enable Easy Connect mode and reconfigure the network settings. There are two ways to do this, using the **software interface** and using a **mechanical toggle**.

IF YOU CAN CONNECT TO SV2 ON THE BROWSER

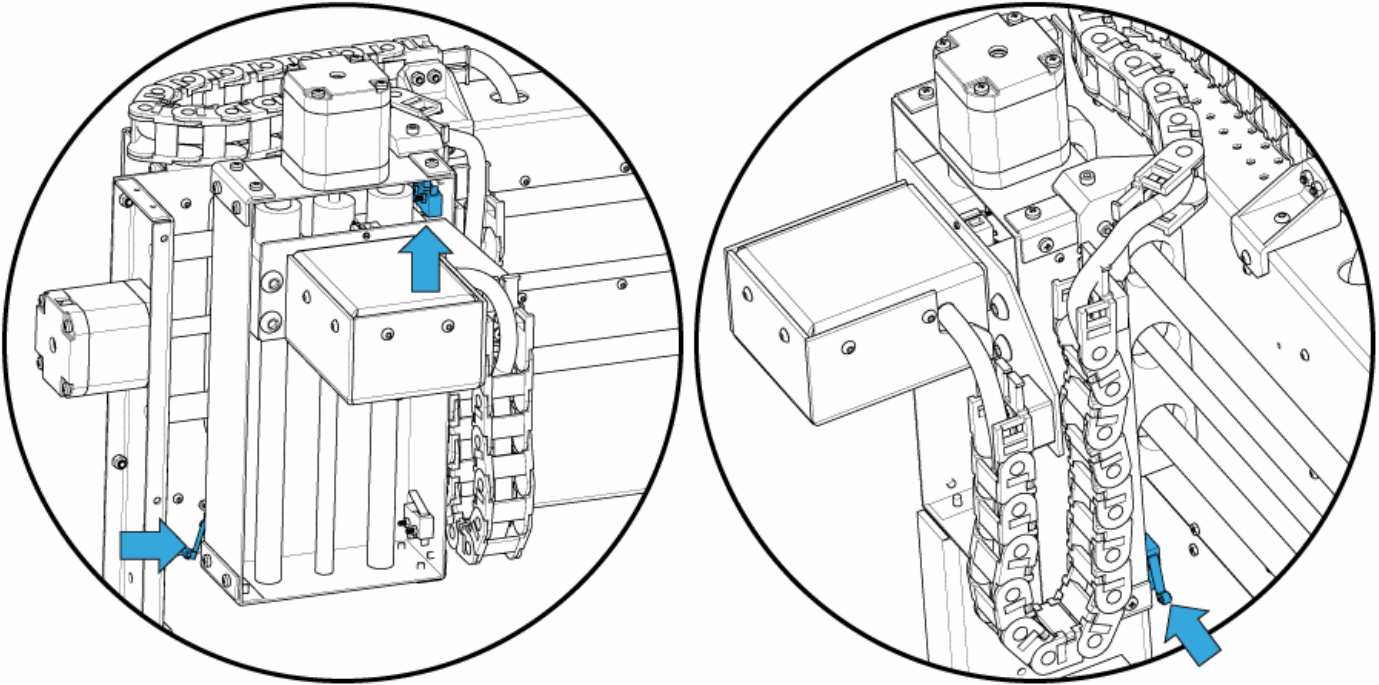
1. Go to the SV2 home page by typing in the hostname or IP address of SV2.
2. Click on the "**Admin**" panel.
3. At the top of the page, find and click on the button labelled "**Manage Network Settings**".
4. At the top right corner of the page, find the toggle slider for Easy Connect mode and enable it.



5. Reboot the BotFactory SV2.
6. The printer will be in Easy Connect mode when the LEDs turn green after blinking yellow.
7. Refer to the instructions in the previous section to connect to the BotFactory SV2 using Easy Connect mode.

IF YOU CANNOT CONNECT TO SV2 ON THE BROWSER

1. Turn the BotFactory SV2 OFF by pressing the power button.
2. Locate the 3 Z-Axis switches on the image below. You will need to press all 3 switches at the same time. If you have difficulty reaching for the switches, move the Z-Axis assembly to the top left corner as shown in the image. This way, 2 of the switches will be activated, you only need to press on the third switch on the right side.



3. While NOT pressing any switch, press the power button and turn the BotFactory SV2 ON.
4. When the LED ring is flashing yellow, press and hold on all 3 switches until the LED ring is a solid green.
5. The BotFactory SV2 will be in Easy Connect mode when the LEDs blink yellow before turning green.
6. Refer to the instructions in the previous section to connect to the BotFactory SV2 in Easy Connect mode.

OPERATING PRODEDURE

Congratulations! Your BotFactory is ready for action, and you are on your way to print your first circuit. If you are not already connected to the machine, refer to the previous section.

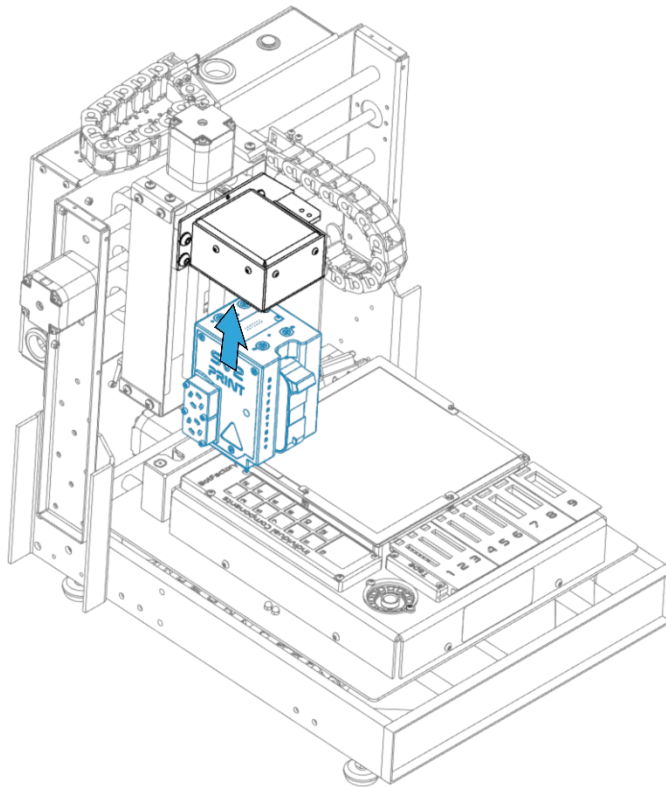
The software will now guide you throughout the process and will prompt you to place and switch different heads as the BotFactory SV2 builds the board from the ground up. Let's show you how to swap the SV2 heads and prepare them.

ATTACHING AND REMOVING AN SV2 HEAD

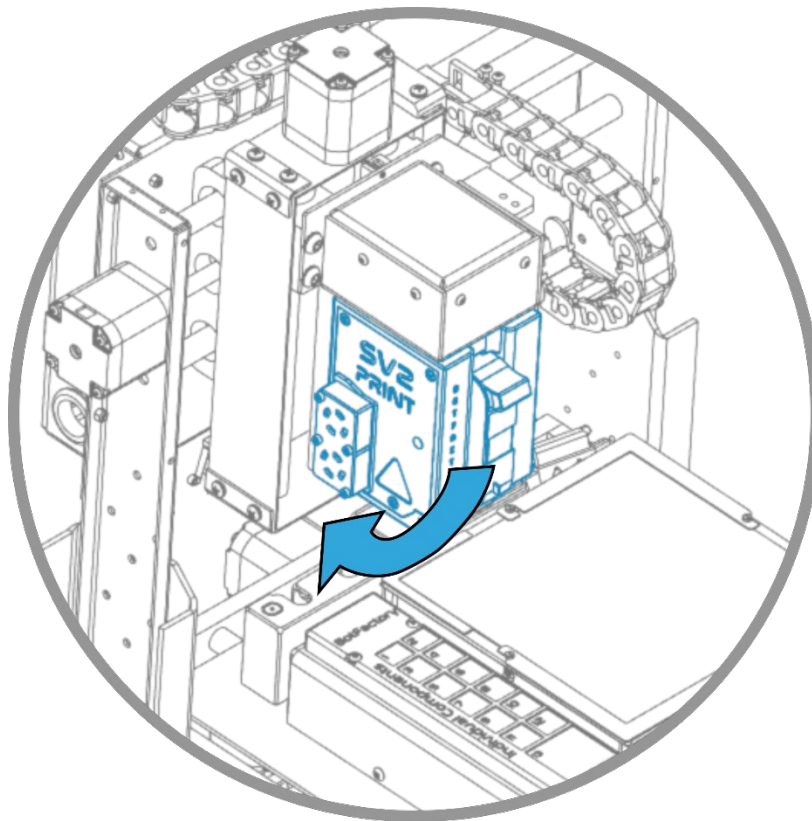
To attach a head, simply position the head under the head holder in the correct orientation (you should not be able to see the "Back side" engraving on the head) and lift the head upwards until the magnets on the head connect with the magnets on the head holder.



The SV2 head should connect with the 2 locating pins on the BotFactory SV2 head holder on its own. Do not force the head in, as it could damage both the head and the head holder.



To remove the head, gently apply a leftward torque on the bottom of the head to decouple the magnets, before pulling downwards.



HANDLING THE CONSUMABLES

i The BotFactory SV2 consumables may require to be stored under well-regulated conditions, e.g. temperature, light, etc. Each consumable carries clear marking advising for the suggested storing conditions. In some cases, it may be required to store the consumables with their respective head.

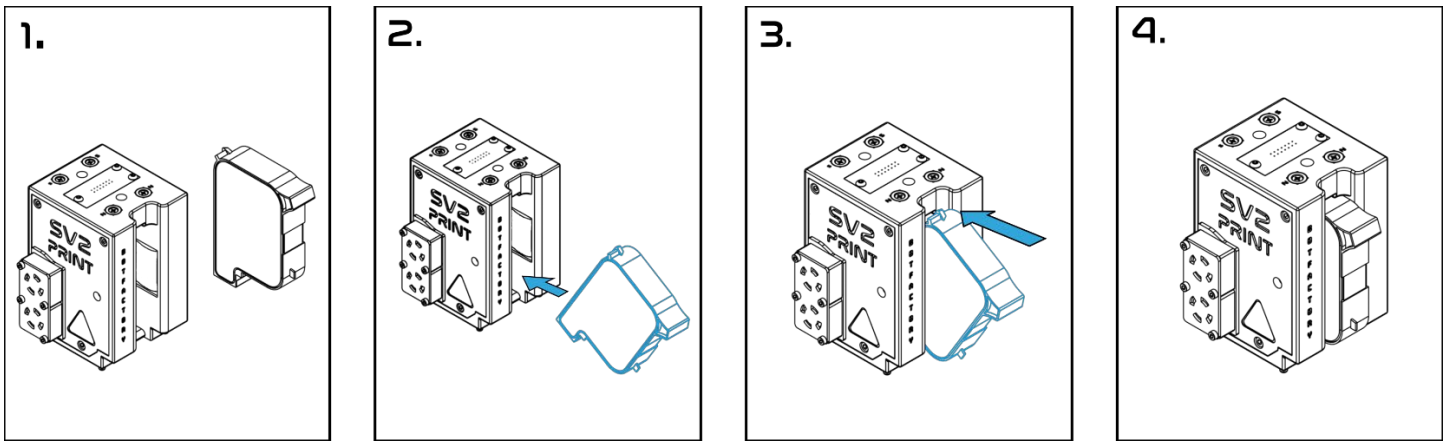
PREPARING THE PRINT HEAD

The print process uses an ink cartridge to either lay down conductive traces or an insulating layer onto a substrate.

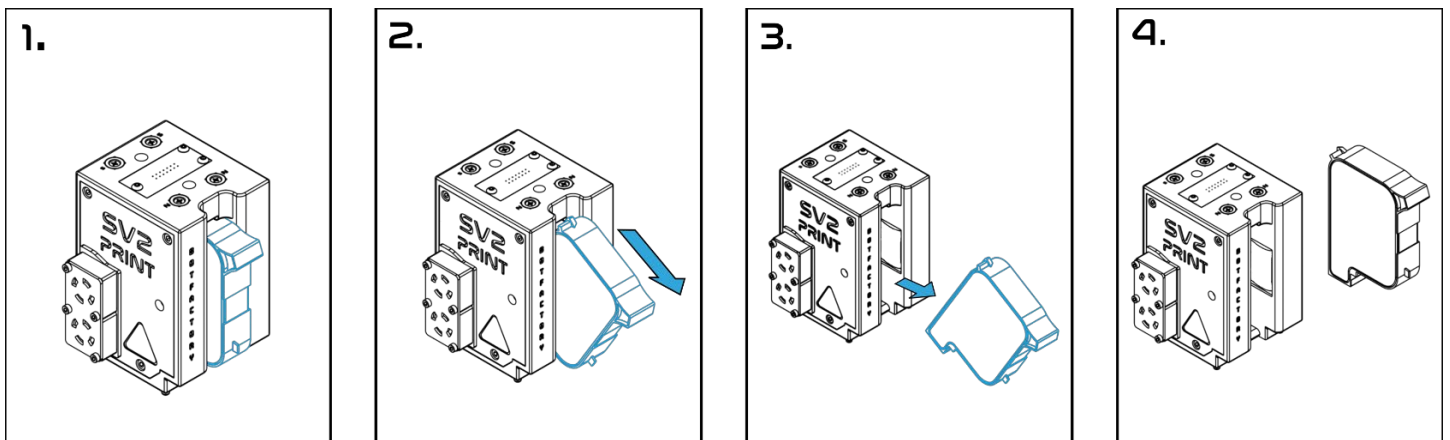
Before you begin, make sure you have removed any protective tape from the nozzles and/or electrical contacts of the cartridge.

i Inspect the nozzles and make sure there is no residual ink. If so, use a soft lint-free wipe to gently clean the nozzles in order to ensure good ink flow and consistent printing.

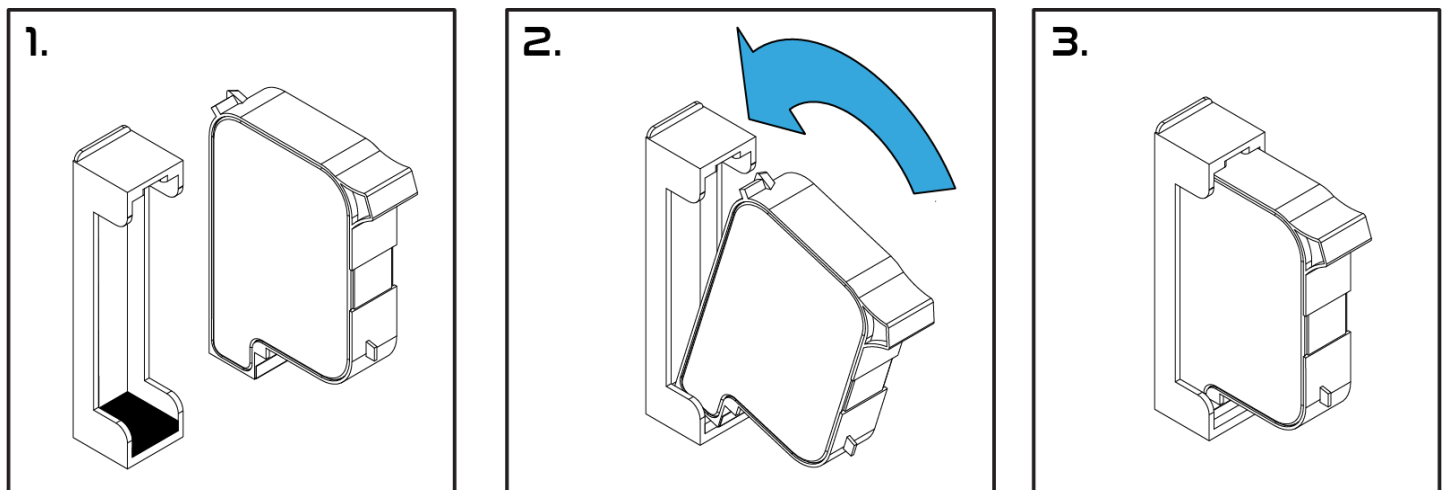
To place the cartridge in the head, slightly tilt the cartridge backwards, push it straight into the cartridge until it reaches the end. Finally, tilt it forward until you hear a '*click*' and the cartridge is firmly in place.



Once the print is done, the cartridge is removed through the reverse motion: tilt, then pull the cartridge out.



To improve cartridge longevity, clean the nozzles with a soft, lint-free wipe and replace any protective tape, before following the instructions on the cartridge for proper storage conditions. Do not forget to place the cartridge back into its protective clip with the nozzles facing the black foam

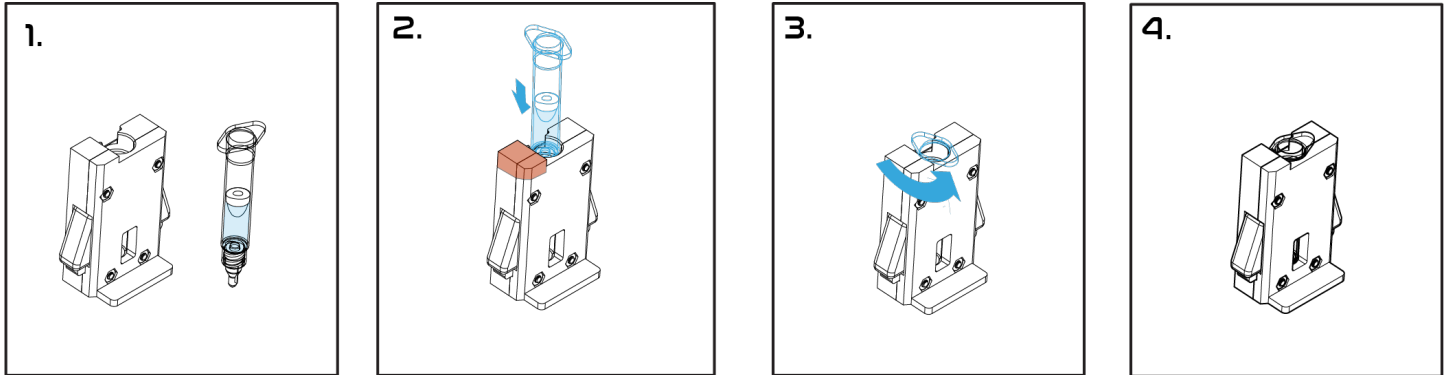


PREPARING THE PASTE HEAD

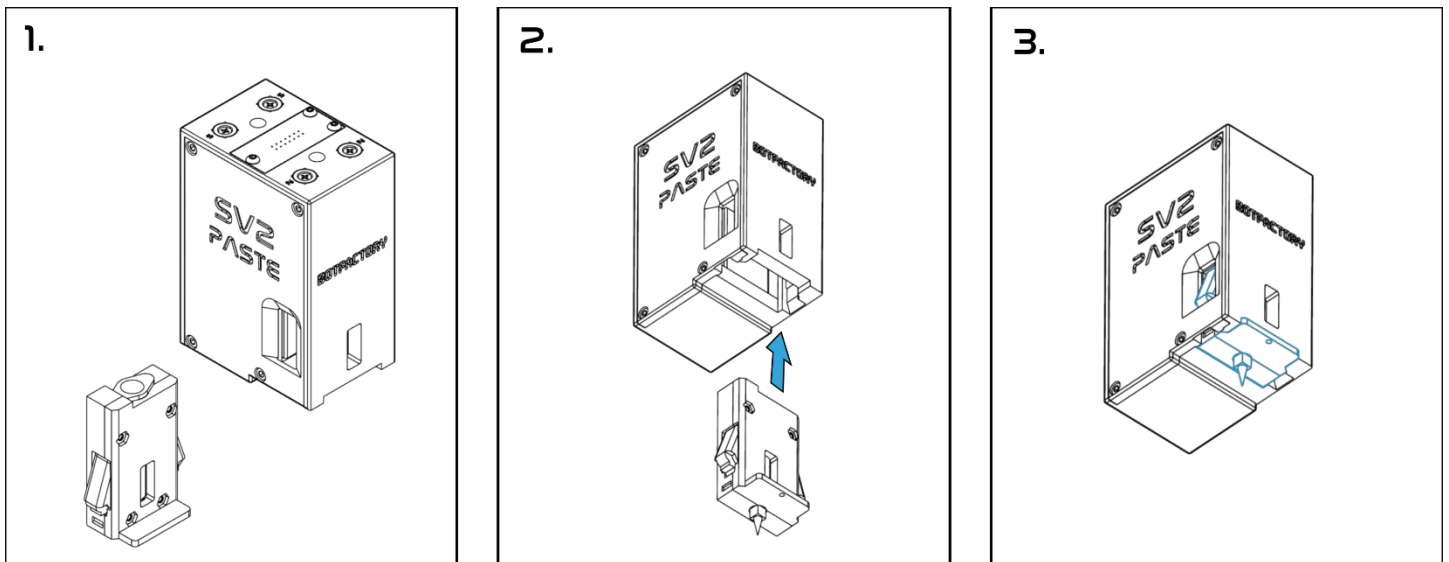
The BotFactory SV2 paste head extrudes conductive glue or solder paste from a syringe through a micro-dispensing syringe needle appropriate for achieving high resolution dot placement.

The conductive glue comes in a capped preloaded syringe equipped with a rubber plunger. To load the syringe into the paste head, it first needs to be placed in the syringe cartridge.


Start by pushing the syringe inside the cartridge until it is flush against its top part (the syringe flange should be clear of the red protrusion). Rotate the flange counter-clockwise until the syringe is locked under the protrusion.



Gently insert the cartridge into the paste head. You might feel some resistance as the paste head latches onto the rubber plunger inside the syringe. Keep pressing until the cartridge is firmly secured inside the paste head. The buttons of the cartridge should stick out from the sides.




When prompted by the software, swap the cap from the syringe with the micro-dispensing needle.

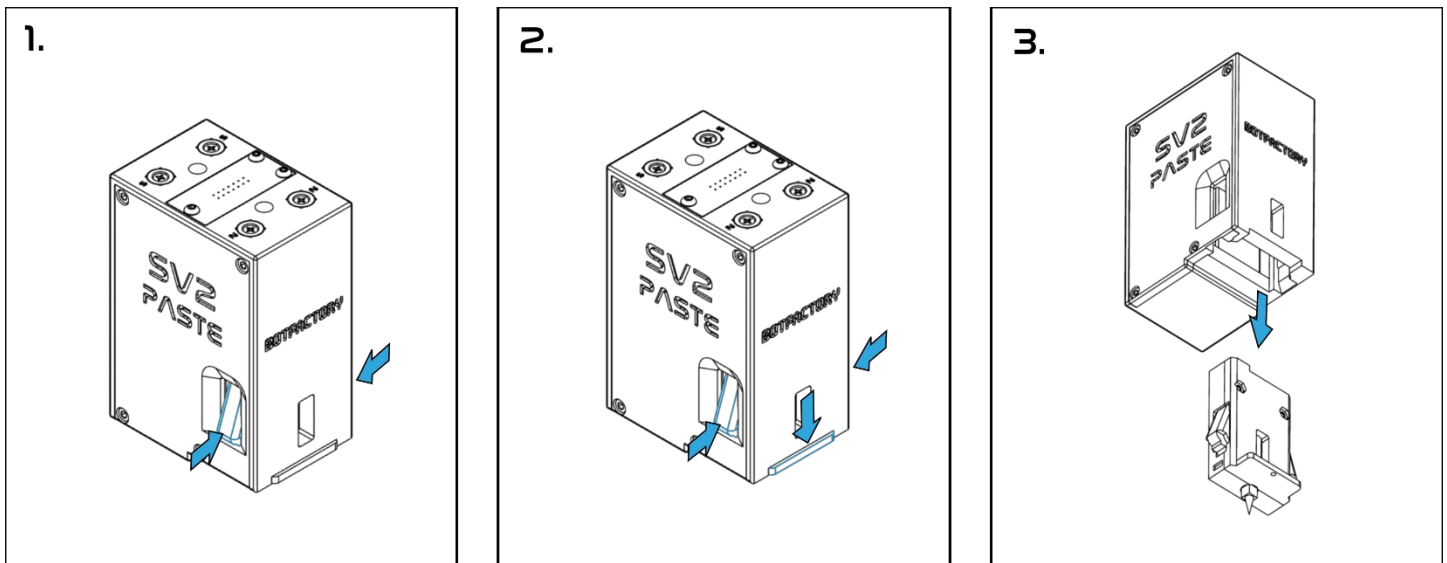
 Use caution while handling the micro-dispensing tip to avoid injuring yourself or damaging the tip.


Once you are done with the paste process, you can choose to keep the remaining glue (and store it with the head) or remove the syringe cartridge. A small window in the front of the paste head allows you to see how much material is remaining in the syringe.

If the syringe is empty, SV2 is stored for an extended period, or a different material is to be used next time, you should then select the option to remove the cartridge.

 Do not manually remove the cartridge unless prompted by the software. The paste head latches onto the syringe's rubber plunger during the first gluing process. If the cartridge is forcefully removed, the rubber plunger will stay inside the paste head, potentially projecting glue all around it and introducing air bubble in the next syringe, greatly reducing the performance.

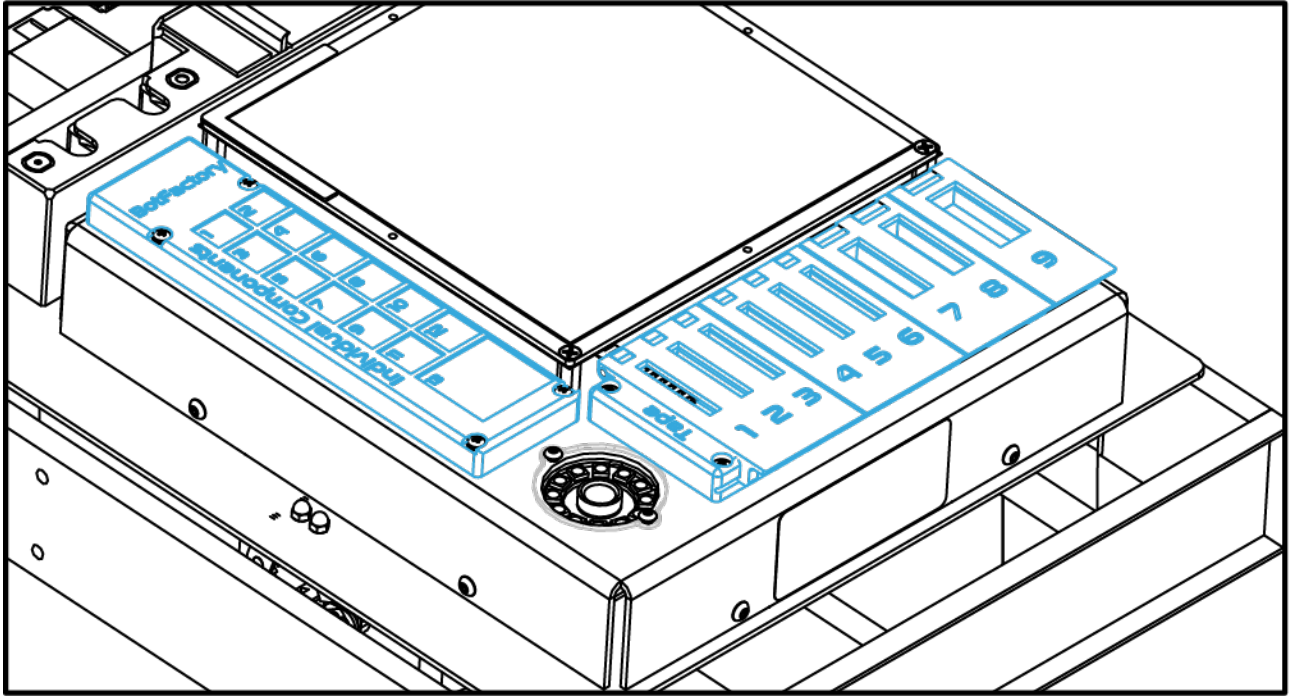
To remove the cartridge, press on both side buttons and pull the cartridge lip downwards.



 While discarding the syringe, make sure you pack the dispensing needle in the provided container.

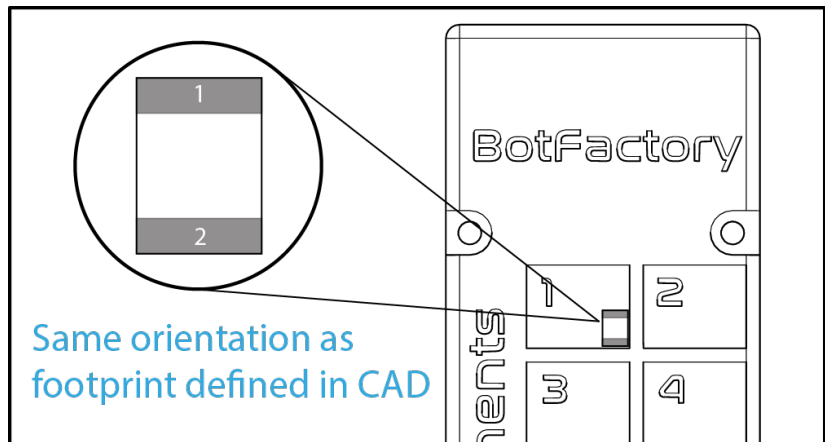
PREPARING THE PICK-AND-PLACE (PNP) HEAD

The assembly simply requires loading the head on the machine without a PNP tip, making sure the PNP tips are both placed in the right slots on the PNP tip holder, and placing the components on the trays. There are 2 trays available: one tray has separate slots for individual component (left on the figure below), and the other tray holds tapes of components for multiple instances of the same part (right on the figure below).



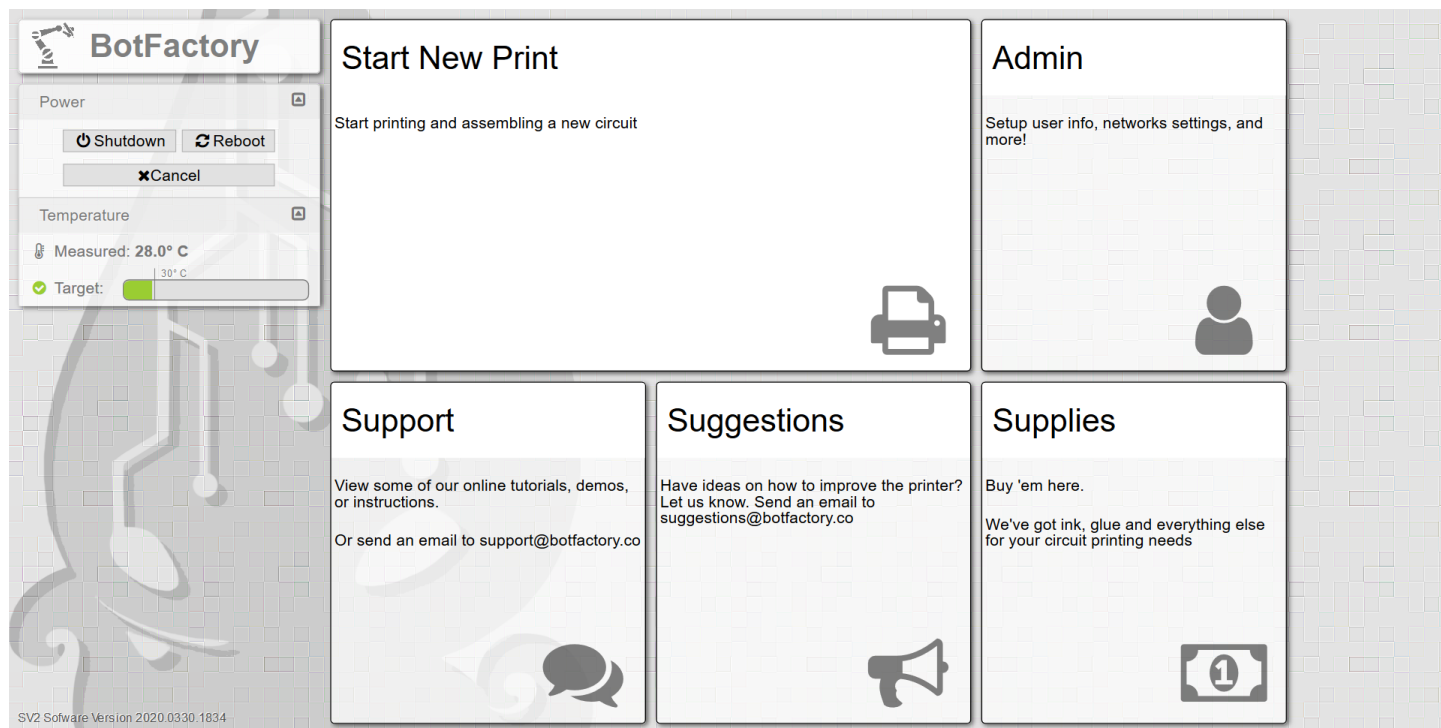
It is critical to keep the orientation of the part identical to that defined in your CAD tool.

Place parts in the bottom right corner of the tray, as shown in the image.



Once you are done with the assembly, the tip is removed with the reverse motion and placed on the PNP tip holder on the work area.

SOFTWARE



SV2 places the knowledge built over decades by the PCB industry in your hands. From an on-board computer, it provides users with a smooth and reliable process for electronic circuit manufacturing from their desk.

By working with **Gerber** and "**Centroid & Rotation**" files, SV2 enables you to gain all the advantages of rapid PCB prototyping without requiring you to change your favorite CAD tool.

Every step of the process is explained in the user interface using pictures and animations. You need to do is connect to SV2 via Ethernet or WiFi and use your browser to interface with the machine - no need to install additional software. Even better: SV2 constantly gets smarter with updates accessible at the click of a button.

WHERE TO FIND MORE INFORMATION

You can find up-to-date information on the software on our how-to page: www.botfactory.co/page/how-to

TROUBLESHOOTING

This section looks at some of potential problems you might encounter. If you are experiencing issues not covered in this section, visit our *Troubleshooting* page at <https://www.botfactory.co/blog/tutorials-and-demos-2>.


Still cannot find a satisfying answer? Send us a detailed email at support@botfactory.co so we can take care of you as quickly as possible.

FIRST STEP: UPDATE

Desktop PCB fabrication is improving constantly at a rapid pace! A great first step to solving any issue is a firmware update. We often tweak ink printing settings and other dispensing and assembly processes, optimizing SV2 by taking into consideration issues that we or other users have encountered and shared with us. Your issue may have been resolved and all you need is to update your machine.

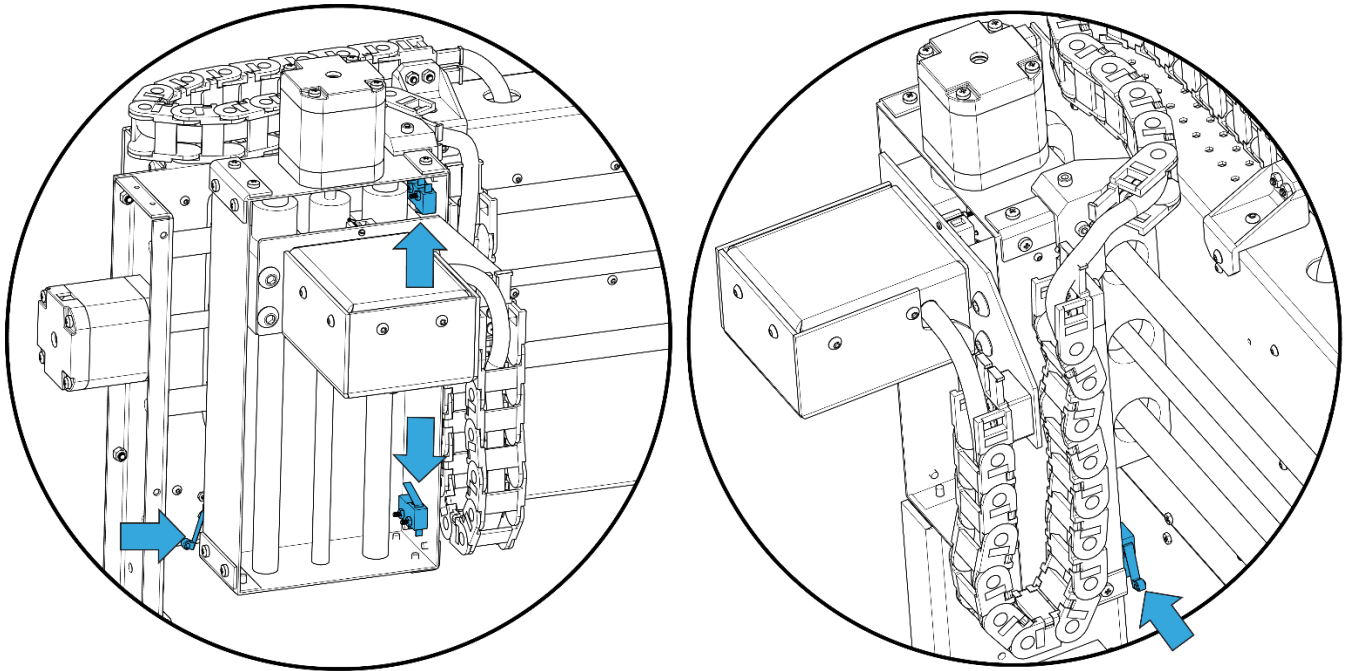
FACTORY RESET

A factory reset will attempt to connect to the Internet and update your machine to the latest version.

 **All configurations, print-settings and other custom preferences will be reset to default.** If you need to reuse them later, make sure to save your settings elsewhere before starting this process.

Factory reset is initiated by

- 1) Turning the BotFactory SV2 OFF
- 2) Connecting to the BotFactory SV2 via Ethernet cable. Keep in mind that
 - a. The SV2 will need internet access.
 - b. During factory reset the SV2 will request an IP address using DHCP. Static IP is not supported.
- 3) Activating the four X- and Z-axis limit switches. You can manually move the head holder and the Z-axis to activate two of those switches for you.



- 4) Turn the BotFactory SV2 ON while keeping the switches activated until the LEDs flash **green**. You can then let go of all the switches.

The BotFactory SV2 will then look for a connection to download the new software, before resetting the machine to its default settings. Each process is marked with a different LED color:

- **Fast Spinning WHITE:** Entering factory reset
- **Spinning YELLOW:** Testing internet connection
- **Steady RED:** No internet connection found
- **Spinning GREEN:** Installing package
- **Steady BLUE:** Update done

Refresh your browser to reconnect to the device. If you have changed the host-name, it will be erased and replaced with the default name.



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